8th INTERNATIONAL SCIENTIFIC CONFERENCE ON KINESIOLOGY

KINESIOLOGY 1857 2017

- 20th Anniversary -

May 10 – 14, 2017, Opatija, Croatia

UNIVERSITY OF ZAGREB FACULTY OF KINESIOLOGY

Proceedings

Editors-in-Chief

Dragan Milanović, Goran Sporiš, Sanja Šalaj and Dario Škegro

Organiser:
University of Zagreb, Faculty of Kinesiology, Croatia

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Dear Colleagues, Conference participants and Proceedings' readers

We are exceptionally happy that we can greet you once more on this occasion. The Faculty of Kinesiology, as a proud member of the University of Zagreb and a higher education institution that is 57 years old, is organizing The International Scientific Conference on Kinesiology for the 8th time. Identically as three years ago, this is a good opportunity to remember some important anniversaries. First of all, this year we celebrate 160 years since Nicolas Dally published his work in 1857 under the title "Kinesiology – Science of Movement in Relation to Education, Hygiene and Therapy". This was the first book that introduced Kinesiology as a science of movement. The second important anniversary is 20 years since the establishment of our Conference. In 1997 the first International Scientific Conference on Kinesiology was held in Dubrovnik. Until today a great number of leading experts in the field of contemporary kinesiology were keynote lectures and presenters of the most important scientific breakthroughs in the field.

Once again, the Conference will be a great opportunity for broadening of scientific insights into this miraculous, beautiful phenomenon of physical activity and its effects – its perfection when performed by sport artists, as seen at the XXXI Olympic Games, its joyfulness when happy children enjoy being competent to be in motion, or when we see eager people who enjoy life and nature because they have enough energy and they are healthy thanks to an active lifestyle. We are especially proud of the 17th place on the medal list thanks to the ten Olympic medals won by Croatian athletes.

All fundamental and applied fields of our science will be discussed within 10 tentative sessions and 3 Satellite symposiums. The ultimate purpose of papers or abstracts published in this Proceedings book is to know and understand human beings and to apply the findings in everyday practice of education, sports, health promotion, recreation, sports management and kinesitherapy. The Proceedings Book contains 249 contributions, which were submitted by the submission deadline, written by 557 authors from 30 countries from all over the world. We expect a number of graduate, doctoral and postdoctoral students from Croatia and abroad for whom the Conference School of Kinesiology for Postgraduate and Doctoral Students will be organised during the Conference.

From the very beginning the Croatian Academy of Sciences and Arts has given its highly respected patronage to the Conference, thus underpinning the recognition of kinesiology in the structure of sciences. Special thanks go to our partner institutions: Beijing Sports University, China and the Faculty of Sports Studies, Masaryk University, Brno, Czech Republic, to our collaboration institutions: the Lithuanian University of Educational Sciences, Lithuania, the Otto-von-Guericke University, Magdeburg, Germany and the Faculty of Sport and Physical Education, University of Novi Sad, Serbia. We wish to express much gratitude to all the authors, reviewers, participants, members of the Organisation and Program Committee, Section Editors, technical support staff, and sponsors for their contributions, time and effort inbuilt in the quality of the 8th International Conference on Kinesiology and its Proceedings.

We wish success in the conference work to all the participants and a pleasant time in Opatija. Convinced that the Conference will give the expected impetus to further cooperation between scholars and institutions, we are looking forward in advance to meeting you again at the 9th International Conference on Kinesiology in 2020.

Organising Committee

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1857 2017

Adapted Physical Activity and Kinesitherapy

8th INTERNATIONAL SCIENTIFIC CONFERENCE ON KINESIOLOGY

Editors:

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UNIVERSITY OF ZAGREB FACULTY OF KINESIOLOGY

IMPAIRMENT AND TRAIN-ABILITY OF POSTURAL STABILITY AND RELATED FUNCTIONS IN ELDERLY

Nejc Šarabon

University of Primorska, Faculty of Health Sciences and Andrej Marušič Institute, Koper, Slovenia
S2P, Science to Practice, ltd., Laboratory for Motor Control and Motor Behavior, Ljubljana, Slovenia

Decline in muscle mass along with changes in neural function leads to impaired balance and muscle strength in elderly, which increases the incidence of falls. Balance in an upright posture can be improved with exercise. Conversely, prolonged bed rest causes muscle weakening. The presentation will summarize some of our past studies that addressed relationship between postural balance and muscle strength as well as changes of this abilities as a result of (de)training in elderly. Study 1: We used a cross-sectional design in order to test the relationship between maximal isometric strength and balance. 48 older adults participated. Centre-of-pressure (CoP) derived parameters used to describe body sway during a quiet semi-tandem stance task were recorded. Additionally, maximal voluntary contraction of knee flexors and extensors, hip abductors and hand grip was measured. The correlation between strength and average CoP velocity was fairly low. There was also no direction specific links between the measured parameters. Study 2: We investigated the effects of a two-week horizontal bed rest without countermeasures on postural sway evaluated by rambling-trembling methodology, precision of voluntary torque matching and maximal voluntary isometric strength. Sixteen male subjects were measured before, immediately after and 14-day after the bed rest. The increase in frequency and amplitude after BR was comparable for both rambling and trembling in medial-lateral direction. However, rambling increased more in frequency while trembling increased more in amplitude in anterior-posterior direction. The decrease in strength after the bed rest was observed for plantar flexion but not for dorsal flexion. The subjects became less precise in the dorsal flexion torque matching task. With the exception of the dorsal flexion torque matching error, all the parameters returned back to the pre values after the two weeks of re-conditioning. Our results indicate that body sway subcomponents respond differently to detraining such as the bed rest. Study 3: Our aim was to explore the effects of two types of 10-week strength training on static balance in elderly. 74 subjects above 65 years of took part in the study. They were randomized to the control, electrical stimulation or leg press group. Subjects in both of the training groups participated in training 3x/week for 9 weeks. In the electrical stimulation group, neuromuscular electrical stimulation of the anterior thigh muscles was provided. In the leg press group, the subjects performed strength training on a controlled leg press machine using the combined slow movements and superponated vibrations mode. The three groups of subjects showed statistically significant differences between the pre-training vs. post-training in CoP velocity, amplitude and frequency. The training effects after the leg press conditioning seems superior to electrical stimulation. It shows that training strength can improve postural balance in elderly. Body sway parameters were improved after the training in both leg press and electrical stimulation group. No straightforward relationship between strength and balance could be observed from our studies, however, improvements in strength generally seem to elicit balance improvements.

ASYMMETRY IN FUNCTIONAL MOVEMENTS IN CROATIAN WOMEN'S PREMIER LEAGUE VOLLEYBALL PLAYERS

Tomislav Đurković[1], Maja Ban[2], Nenad Marelić[1]

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Abstract

The aim of this study was to determine if asymmetry is present in the range and quality of movements between in Croatian women's Premier league volleyball players. The testing was conducted on 31 women's Premier league volleyball players, all right-side dominant and members of HAOK Mladost Zagreb. Five bilateral tests were used, all parts of FMS screening tool protocol; Hurdle Step – HS, In-Line Lunge – ILL, Shoulder Mobility – SM, Active Straight Leg Raise – ASLR, Rotary stability – RS. The analysis revealed a significant difference in values in the two tests (SM and ASLR). The greater shoulder mobility (SM) of the dominant hand is probably caused by a smaller number of repetitions of smashes and serves than top level players. All the examinees daily performed corrective exercises that were focused on the dominant hand shoulder and this fact might be also a potential reason for the obtained results. Difference in test ASLR occurred, regardless of the prevention training programme that was implemented. That result might be caused with specific position of the feet during the take-off for the smash which generates extreme dynamic load in right-side dominant volleyball players.

Key words: *volleyball, asymmetry, imbalance, FMS*

Introduction

A poly-structural complex activity such as volleyball demands extremely high requirements from the players. As the training and competition load increases, the anatomic adaptation of the body also becomes stronger, more noticeable and easier to detect. Previous research that studied asymmetry in volleyball identified several specific kinematic samples which influence the mentioned asymmetries (Kugler et al., 1996; Wang & Cochrane, 2001; Salci et al., 2004; Tillman et al., 2004; Markou & Vagenas 2006; Lobietti et al., 2010; Cuckova & Suss, 2014; Zohreh & Ashraf, 2016). The mentioned samples primarily include attractive and "conspicuous" unilateral smashing and serving techniques, as well as less noticeable unilateral landings following smashes, jump serves and blocks. Another somewhat less visible phenomenon that can generate knee problems, and therefore also asymmetries in functional movements, is the take-off phase prior to a smash or a jump rotation serve (Khan & Bahr, 2003). According to Bahr (2003), top-level players perform up to 40000 smashes during a competitive season, which can result in a progressive injury of static and dynamic stabilisation structures which participate in all phases of this explosive movement. Among possible explanations for the occurrence of certain asymmetries are both aspects of player specialization for particular positions (Castanharo et al., 2011; Cuckova & Suss, 2014). One aspect includes the phenomenon of player specialization itself where the players are focused on the game only in particular parts (zones) of the field and on the performance of only certain volleyball techniques (e.g. the libero does not smash, serve or block; the opposite player does not receive serves; the setter does not smash, etc.), whereas the second aspect is the very often premature player specialization which can, combined with the previously mentioned specific loads and known kinematic stereotypes, cause certain asymmetries in relation to muscle imbalance and posture disorders. The methodology of collecting data in order to determine asymmetry includes video analysis, biomechanical research (kinetic, isokinetic and kinematic), standardized questionnaires for pain and mobility assessment, clinical orthopaedic testing and the FMS (Functional Movement Screen) screening tool. The FMS methodology consists of seven tests which enable diagnosing the limits in terms of mobility, stability and asymmetry of certain body parts (Cook, 2010). The mentioned methodology for collecting data is popular because of the possibility of obtaining valuable information in a relatively short duration of the tests, somewhat simpler interpretations of the results and the low cost of the testing, which accounts for choosing this method of testing. This methodology was also used for research in all team sports games: volleyball, basketball, soccer and handball (Cuckova & Suss, 2014; Shojaedin et al., 2014; Slodownik et al., 2014; Sprague et al., 2014). According to the research by Mokha et al. (2016), individual results in certain FMS tests are better predictors of potential injuries than the combined evaluation of the overall FMS screening which is a result of the assessments in all 7 tests. The aim of this research is to determine if asymmetry is present in the range and quality of movements between the left and right side of the body in Croatian women's Premier league volleyball players.

Methods

Sample of examinees: the testing was conducted on 31 women's Premier league volleyball players who are members of the first and second team at the Croatian academic volleyball club Mladost Zagreb. All the examinees are right-side dominant players. Sample of variables: for the purpose of this research, 5 bilateral tests were used that are part of the FMS screening tool protocol; Hurdle Step – HS, In-Line Lunge – ILL, Shoulder Mobility – SM, Active Straight Leg Raise – ASLR, Rotary stability – RS. The testing was conducted by educated personnel at the Faculty of Kinesiology, University of Zagreb. All the examinees signed an informed consent form for the implemented measurements.Data processing methods: the data processing was performed in accordance with the aim of this research so that it referred to establishing central and dispersive indicators of the measured variables, as well as to determining the significance of the differences in the measured variables on the left and right side of the body. The examination of the mentioned significance of the differences in the measured variables on both sides of the body was conducted by using the ***Wilcoxon Signed Rank Test*** for paired samples.

Results

Table 1. presents the results of descriptive statistics. The arithmetic mean, standard deviation and standard error were also calculated.

Table1: Descriptive statistical parameters

		M±SD	n	SEM
Hurdle Step – HS	Left (L)	2,06±,62	31	,11
	Right (R)	2,16±,52	31	,09
In-Line Lunge – ILL	L	2,13±,42	31	,07
	R	2,03±,60	31	,10
Shoulder Mobility – SM	L	2,45±,72	31	,13
	R	2,74±,44	31	,08
Active Straight Leg Raise – ASLR	L	2,55±,56	31	,10
	R	2,26±,68	31	,12
Rotary stability – RS	L	2,10±,47	31	,08
	R	1,94±,57	31	,10

M=arithmetic mean; n=number of examinees; SD= standard deviation; SEM= standard error

Table 2. shows the results of the Wilcoxon Signed Rank Test for the 5 measured variables.

Table 2: Wilcoxon signed rank results (differences between right and left side)

	HS_R HS_L	ILL_R ILL_L	MR_R MR_L	ASLR_R ASLR_L	RS_L RS_L
Z	-,90^{b}	-,90^{c}	-2,07^{b}	-2,49^{c}	-1,26^{c}
p	,37	,37	,04*	,01*	,21

Z – Z value, p – level of significance, *indicates statistical significance (p <0.05)

Discussion

The descriptive data in Table 1. indicate that larger numeric deviations in values of arithmetic means between the left and right side of can be registered in the Shoulder Mobility (SM) test (left 2.74, right 2.45) and the Active Straight Leg Raise (ASLR) test (left 2.55, right 2.26). Numeric deviations in values of arithmetic means between the left and right side were also recorded in the other measured variables, however, they were not as pronounced. The results of the Wilcoxon Signed Rank Test also demonstrated a statistically significant difference in values precisely in the two above-mentioned tests (SM and ASLR). The Wilcoxon Signed Rank Test registered a statistically significant difference in the values of the range and quality of movement in the right (dominant) shoulder joint (SM_R) in relation to the left one (SM_L), z=-2,07, p=0.04, and with the eta-squared value of 0.14 which, according to Cohen's criteria, indicates a great influence on the mentioned difference. There are two possible reasons for the significantly greater functional mobility of the right (dominant) shoulder. The first reason is in the fact that a regular physical conditioning and prevention programme, primarily focusing on the dominant shoulder, was implemented with the tested players during the competition season. The second cause for the better mobility might be a smaller number of repetitions than in highly professional players, as well as less power in smashes and serves performed at the playing level in which the tested players participate in. The Wilcoxon Signed Rank Test registered a statistically significant difference in the values of the range and quality of movement during the Active Straight Leg Raise of the left (ASLL_L) and right (ACLL_R) straight leg. The left side of the body demonstrated significantly better results, with the value of the test of z=-2,49, level of significance at p=0.04 and the eta-square value of 0.2 which, according to Cohen's criteria, indicates a great influence on the difference between the left and right side. The reason for such results can be a weaker functional flexibility of the muscles on the back of the thigh, insufficient hip mobility of the opposite leg and weaker stability and strength of the lower body in female volleyball players (Cook, 2010.). The weaker functional flexibility of the right leg can be the result of a specific motor stereotype which occurs during the take-off for the smash where the right leg performs an external rotation and under a higher flexion angle than the left leg, which then causes greater eccentric – concentric load on the right knee and muscle connective structures around the knee (Khan and Bahr, 2003).

Conclusion

Asymmetries in function movements have been determined in 2 out of the 5 performed bilateral tests. The greater shoulder mobility of the dominant hand is probably caused by a smaller number of repetitions of smashes and serves, i.e. specific motor stereotypes, than in players performing at the top professional level. It must be emphasized that the tested players daily performed corrective exercises that were focused on the dominant hand shoulder and how this fact is also a potential reason for the obtained results. The second test leads to the conclusion that the left side is better in relation to the range and quality of movements. Considering that the specificity of the position of the feet during the take-off for the smash in volleyball generates extreme dynamic load, (the identical motor stereotype also occurs during the take-off for the jump rotation serve and the jump float serve, however, with somewhat smaller load) in right-side dominant volleyball players (all tested players were right-side dominant), the conclusion can be made that it is precisely that motor stereotype which is the cause for the results obtained in this research, regardless of the prevention training programme that was implemented with the tested volleyball players.

References

1. Bahr, R. (2003). Injury prevention. In J., Reeser, & R. Bahr (Eds.), Handbook of sports medicine and science – Volleyball (pp. 94-106). Malden, MA: Blackwell Publishing.
2. Castanharo, R., Veras, M.I.O., Alcantra, C., Miana, A., Manoel, E.J., Proenca, J.E., Duarte, M., (2011). Asymmetries between lower limbs during jumping in female elite athletes from Brazilian national volleyball team. *Portuguese Journal of Sport Sciences,* suppl.11 (2), 53-56.
3. Cook, G. (2010). Movement: Functional Movement Systems: Screening, Assessment, and Corrective Strategies. Aptos, CA: On Target Publications.
4. Cuckova, T., & Suss, V. (2014). Muscle Imbalanceand Body Composition of Elite Junior Female Volleyball Players. Paripex *Indidan Journal of Research*. Vol:III, Issue:IV.
5. Fort-Vanmeerhaeghe, A., Gual, G., Romero-Rodriguez, D., Unnitha, V. (2016). Lower Limb Neuromuscular Asymmetry in Volleyball and Basketball Players. Journal of Human Kinetics 50(1), 135-143.
6. Hadzic, V., Sattler, T., Veselko, M., Markovic, G., Dervisevic, E. (2014). Strength asymmetry of the shoulders in elite volleyball players. J Athl Train, 49(3):338-344.
7. Khan, K., Bahr, R. (2003). Knee and ankle injuries in volleyball. In J., Reeser, & R. Bahr (Eds.), *Handbook of sports medicine and science – Volleyball* (pp. 130-140). Malden, MA: Blackwell Publishing.
8. Kiesel, K., Plisky, P. J., & Voight, M. L. (2007). Can Serious Injury in Professional Football be Predicted by a Preseason Functional Movement Screen? *North American Journal of Sports Physical Therapy, 2*(3), 147-158.
9. Kugler, A., Krüger-Franke, M., Reininger, S., Trouillier, H.H. and Rosemeyer, B. (1996) Muscular imbalance and shoulder pain in volleyball attackers. *British Journal of Sports Medicine*, 30(3), 256-259.
10. Lobietti R., Coleman S., Pizzichillo E., Merni F. (2010). Landing techniques in volleyball. J*ournal of Sports Sciences*, 28(13), 1469-1476.
11. Markou, S. & Vagenas, G. (2006). Multivariate isokinetic asymmetry of the knee and shoulder in elite volleyball players. *European Journal of Sport Science*, 6(1), 71-80.
12. Mokha, M., Sprague, P.A., Gatens, D.R. (2016). Predicting Musculoskeletal Injury in National Collegiate Athletic Association Division II Athletes From Asymmetries and Individual-Test Versus Composite Functional Movement Screen Scores. J Athl Train, 51(4), 276-282.
13. Reser, J. C. & Bahr, R. (2003). Handbook of Sport Medicine and Science Volleyball. Massachusetts: Blackwell Publishing company.
14. Salci, Y., Kentel, B.B., Heycan, C., Akin, S., Korkusuz., F. (2004). Comparison of landing maneuvers between male and female college volleyball players. *Clinical Biomechanics* 19 (6), 622-628.

15. Shojaedin, S., Letafatkar A, Hadadnezhad M, Shojaedin S, Mohamadi E. (2014). Relationship between functional movement screening score and history of injury. Int J Sports Phys Ther, 9(1):21-27.
16. Slodownik, R., Slodownik- Ogonowska, A., Morgulec- Adamowicz, N., Targosinski, P. (2014.) Fundamental movement patterns and potential risk on injuriesin 1st and 2nd division Polish handball players. *Trendsinsports*, 3 (21):147.
17. Sprague, P.A., Mokha, M., Gatens, D. (2014). Changes in Functional Movement Screen Scores Over a Season in Collegiate Soccer and Volleyball Athletes. Journal of Strength & Conditioning Research, 28(11), 3155-3163.
18. Tillman, M., Hass, C., Brunt, D. and Bennett, G. (2004) Jumping and landing techniques in elite women's volleyball. *Journal of Sports Science and Medicine* 3, 30-36.
19. Wang, H.K. & Cochrane T. (2001). Mobility impairment, muscle imbalance, muscle weakness, scapular asymmetry and shoulder injury in elite volleyball athletes. *J Sports Med Phys Fitness*, 41(3), 403-410.

THE EFFECT OF UNILATERAL TRAINING ON BILATERAL DEFICIT

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Abstract

The aim of this study was to determine the effect of a combined unilateral strength and balance training program to the bilateral deficit. The research included 27 subjects. They were randomly assigned to a control (6 men, 7 women) and an experimental (2 men, 12 women) group. Subjects were physically active students of the Faculty of Kinesiology, University of Zagreb. The maximal voluntary isometric contraction (MVIC) task was used to evaluate maximal and explosive strength of plantar and dorsal flexors of the feet. In a training period of five weeks, participants trained four time a weak, performing different tasks stressing maximal force production as well as postural adaptations. The main results shows an insufficient impact of the performed training protocol on the monitored variables. Based on previous results it may be speculated that the two training tasks (balance and strength) acted contradictorily on the subject`s muscle performance, leading to a “status quo” in the results. However, detailed future investigations about the influence of complex unilateral training protocols on bilateral deficit have to be conducted in order to elucidate more this research area.

Key words: *unilateral training, bilateral deficit, strenght training, balance training*

Introduction

Bilateral resistance training is included into resistance training programmes with the aim of increasing overall muscle strength, on both sides of the body, at the same time. This is advantageous as it allows muscle groups from opposite sides of the body to be worked in tandem (Kuruguanti et al., 2011). A phenomenon that is commonly observed is that maximal strength generating capacity is compromised when homologous limbs contract bilaterally. This is referred to as the bilateral deficit (BLD), and occurs when the maximal voluntary strength of simultaneous bilateral contraction is less than the sum of the strengths of right and left limbs when contracting alone (Howard and Enoka 1991; Jakobi and Chilibeck 2001; Kawakami et al., 1998). BLD is a well-known neurophysiological phenomenon characterized by a reductionin force generating capacity during synchronous bilateral contractions when compared to the sum of identical unilateral contractions (Beurskenset al., 2015). The BLD is attributed to modifications in neuromuscular and cortical control during unilateral and bilateral homonymous muscle contractions (Beurskenset al., 2015). BLD can be influenced by strength and balance training. Heavy-resistance strength training increases maximal isometric force (MIF) and reduces BLD after training due to its bilateral characteristics, while balance training increases unilateral MIF and BLD (Beurskens et al., 2015). This void in the literature is of particular interest because balance training, similar to resistance training, is known to positively affect MIF and especially rate of force development (RFD), as a measure that describes explosive force production, in young, middle-aged, and old adults (Beurskens et al., 2015). Due to the lack of scientific data to determine the potential of a combined balance and strength training, to influence bilateral deficit, the aim of this study was to determine the effect of combined strenght and balance exercise on the bilateral deficit of plantar and dorsal foot flexors.

Methods

Subjects

The research included 27 subjects. They were randomly assigned to a control (6 men, 7 women) and an experimental (2 men, 12 women) group. Subjects were physically active students of the Faculty of Kinesiology, University of Zagreb. After the risks and purpose of this study were explained to them, they signed a participation agreement letter. The exclusion criteria for their engagement in the study were previous acute injury or overuse syndrome of the lower leg and lumbar spine, as well as a history of neuromuscular disorder. During the study, they were not engaged in any additionally training procedure, besides the one performed for the purpose of this study.

Research protocol

Before the beginning of the study, subjects went through a standardized worm-up protocol, which consisted of 10 minute running with tasks and exercise for stretching the lower part of the body. The same protocol was used at the first and the last measurement (before and after the training protocol). The maximal voluntary isometric contraction (MVIC) task was used to evaluate maximal and explosive strength of plantar and dorsal foot flexors.

The subject alternated MVIC for plantar and dorsal feet flexors with an emphasis on explosive force production. A dynamometer that was installed underneath the pedal recorded the force production. The subjects task was to perform maximal plantar and then dorsal feet flexion, as fast and hard as possible. Three attempts of maximal isometric contraction of plantar and dorsal feet flexors were recorded. The average of the three results was calculated and taken for further analysis. For the measurement of the BLD, the task was performed with both legs simultaneously. The BLD was then calculated according to the formula introduced by Howard and Enoka:

$$BLD[\%] = \left(\left(\frac{MIF(BL)}{MIF(ULR) + MIF(ULL)}\right) - 1\right) x100$$

Training protocol

In a training period of five weeks, participants trained four time a weak, performing different tasks stressing maximal force production as well as postural adaptations. Participants in the experimental (training) group performed a combined unilateral strength and balance training. They trained with their left legs. The progression in balance tasks was assured by means of different platforms (balance boards, foam pads) and by different duration and complexity of the performed balance tasks. From the first to the fifth week of training, participants progressively performed one repetition lasting 30-50 seconds, 3-5 series of different tasks (standing still on one leg with open eyes, juggling tennis balls, bouncing the basket ball, catching and throwing tennis balls, touching the points on the border of balance, standing still with closed eyes, rotation of the head with closed eyes). The breaks between series lasted 30-60 seconds. During the five-week training period, subjects of the control group did not trained, they just continued with their usual activities.

Variables and data analysis

Two features were examined in this study: 1) unilateral explosive force production for plantar and dorsal foot flexors; 2) Bilateral deficit for plantar and dorsal foot flexors. The explosive force production was evaluated with the variable rate of force development in the first 30 ms from onset of action during the tasks of plantar and dorsal foot flexion, while BLD was calculated as mentioned above. The difference between the control and the experimental group, after the implementation of the training protocol, for the evaluated variables, was tested by means of a two-way analysis of covariance.

Results

The results presented in table 1 shows that there was no difference between the changes in the main variables, between the experimental and the control group. This result depicts the fact that the performed training protocol did not lead to any significant changes in the domain of explosive force production of plantar and dorsal foot flexors, as well as in bilateral deficit for the tasks of plantar and dorsal foot flexion.

	Control group		Experimental group		Ancova`s results	
	Initial measurement	Final measurement	Initial measurement	Final measurement	F	Sig
RFD_PF_R	14,27 ± 5,42	13,68 ± 6,11	11,95±4,46	12,56±2,86	,198	,661
RFD_DF_R	3,52 ± 1,46	3,49 ± 1,39	3,31 ± 1,27	3,25 ± 1,07	,101	,754
RFD_PF_L	12,33 ± 3,79	12,12 ± 4,87	10,39 ± 3,84	12,38 ± 2,45	3,819	,064
RFD_DF_L	3,49 ± 1,79	3,00 ± 1,99	3,32 ± 1,45	3,66 ± 1,27	3,200	,088
RFD_BLD_PF	-3,37 ± 8,08	-2,33 ± 11,22	-6,92 ± 14,46	-6,55 ± 10,19	,843	,369
RFD_BLD_PF	-8,66 ± 10,98	-7,65 ± 17,11	-18,06 ± 18,56	-11,45 ± 14,04	,535	,473

Legend: RFD_PF_R: rate of force development for plantar flexion of the right foot in the first 30 ms from onset of action; RFD_DF_R: rate of force development for dorsal flexion of the right foot in the first 30 ms from onset of action; RFD_PF_L: rate of force development for plantar flexion of the left foot in the first 30 ms from onset of action; RFD_DF_L: rate of force development for dorsal flexion of the left foot in the first 30 ms from onset of action; RFD_BLD_PF: bilateral deficit for plantar flexion; RFD_BLD_PF: bilateral deficit for dorsal flexion.

Discussion and conclusions

The main results of this study is reflected in an insufficient impact of the performed unilateral training protocol on the bilateral deficit, as well as on explosive force production of plantar and dorsal foot flexors. Two are the main reasons for what this may have happened: the first concerns the performed training protocol, and the second concerns the used variables. The performed unilateral protocol consisted of balance and strength training drills. It is well known that bilateral heavy-resistance strength training increases maximal isometric force and reduces BLD after training due to its bilateral characteristics, while balance training increases unilateral MIF and BLD (Beurkens et al., 2015). Here, the performed training was unilateral, and one would have expected unilateral training to enhance bilateral deficit. However, in this investigation, strength tasks were performed together with balance tasks . According to previous studies, balance training, similar to resistance training, is known to positively affect MIF and especially rate of force development (RFD), in young, middle-aged, and old adults (Beurskens et al.2015). Balance training may also alter bilateral deficit (Beurkens et al., 2015). The two training tasks performed in this investigation (balance and strength) may have acted differently on the subject`s muscle performance. Specifically it may be that the actions were contradictory in their nature. Based on previous results (Beurskens et al.2015), as well as based on the results obtained in this study, it may be speculated that the mechanisms of adaptation underlying balance and strength tasks are of contrary action, at least for what concerns bilateral deficit. The second reason why there was no difference between the changes in the main variables, between the experimental and the control group, may concerns the used variables. According to previous investigation it may be that the variables calculated on 30 ms from action onset may be not enough sensitive to capture the changes provoked by the performed training protocol (Kamoui et al., 2011). Since muscle action is very variable in its beginning, variables calculated in wider time window (i.e. 200 ms from onset of muscle contraction) may be more reliable. However, this remains an assumption, since no variables calculated in wider time windows were used in this investigation. Detailed future investigations about the influence of complex unilateral training protocols on bilateral deficit, using more variables, have to be conducted in order to elucidate more this research area.

References

1. Beurkens, R., Golhofer, A., Muehlbauer, T., Cardinale, M., Granacher, U. (2015).
2. Effects of Heavy-Resistance Strength and Balance Training on Unilateral and Bilateral Leg Strength Performance in Old Adults. Plosone 10(2): e0118535. doi:10.1371/journal.pone.0118535
3. Howard, J.D., Enoka, R.M. (1987). Interlimb interactions during maximal efforts. Medicine and Science in Sports and Exercise 19: S3.
4. Jacobi, J.M., Chilibeck, P.D. (2001). Bilateral and unilateral contractions: Possible differences in maximal voluntary force. Canadian Journal of Applied Phiysiology 26:12-33.
5. Kawakami, Y., Sale, D.G., MacDougall, J.D., Moroz, J.S. (1998). Bilateral deficit in plantar flexion: relation to knee joint position, muscle activation and reflex excitability. European Journal of Applied Physiology 77: 212-216.
6. Kuruganti, U., Murphy, T., Pardy, T. (2011). Bilateral deficit phenomenon and the role of antagonist muscle activity during maximal isometric knee extension in young, athletic men. European Journal of Applied Physiology, 111(7):1533-9.
7. Kamoui, A.V., Brown, L.E., Nguyen, D., Uribe, B.P., Coburn, J.W., Noffal, G.J., Tran, T. (2011). Relationship between force-time and velocity-time characteristics of dynamic and isometric muscle actions. Journal of Strength and Conditioning Research. 25(1):198-204.

PREVALENCE OF PODIATRIC CONDITIONS IN SPECIAL OLYMPICS ATHLETES: THE CZECH REPUBLIC WINTER GAMES FIT FEET SCREENING

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Abstract

Purpose: Podiatric conditions are frequently seen in persons with intellectual disabilities. However, the number of studies focusing on this topic is limited. Therefore the aim of this study is to estimate the prevalence of selected podiatric conditions among athletes with intellectual disabilities in the Czech Republic and to discuss these results with findings of USA athletes and international participants of Summer Special Olympic Games in Athens.

Methods: The Fit Feet screening findings of the Czech Republic Winter Games participants (n=46) were used for the analysis. The screening followed the standardized Fit Feet protocol.

Results: The prevalence of selected structural and gait conditions in our study population of Special Olympics skiers was similar to the findings of USA and international studies. The most common podiatric conditions found in this study included short Achilles tendon (56.52%), pes planus (36.96%), abducted gait (23.91%), restricted ankle joint range of motion (21.74%), pes cavus (17.39%), hallux abducto valgus (15.22%) and over-pronated gait (13.04%).

Conclusions: The high prevalence of selected podiatric conditions highlights the need for foot care promotion and prevention education among the athletes with intellectual disabilities. Furthermore, a greater knowledge of the podiatric findings prevalence in population with intellectual disabilities may provide for clinicians a more efficient management of their foot pathologies.

Key words: *Foot deformities, Gait, Intellectual disabilities, Skiers*

Background

Special Olympics is an international non-profit sports organization for people with intellectual disabilities, which is creating sports possibilities for more than 4.7 million athletes in 169 countries. Through sport training and competition individuals with intellectual disabilities improve their physical fitness and their abilities and skills. A lacking knowledge of the health prevention among athletes with intellectual disabilities was the reason why in 1997 Special Olympics introduced the Healthy Athletes Program, which provides a health screening in following areas: physical therapy and fitness, audiology, sports physical exam, vision, dentistry, health promotion and podiatry (www.specialolympics.org).

Physical activities for athletes with intellectual disabilities in the Czech Republic are provided by the Czech Special Olympics Movement and the Czech Association of Intellectually Disabled Athletes. The Czech Special Olympics Movement, which is part of the Special Olympics worldwide organization since 1990, connects 130 sports clubs providing the access to both all-year-long recreational and competitive physical activities to more than 2.500 athletes. Since 2002 Czech Special Olympics Movement has provided the physical therapy and fitness screening, since 2004 it has provided also the audiology, vision, dentistry and health promotion screening and since 2015 also the podiatry exam has been included into the Healthy Athlete screening in the Czech Republic (www.specialolympics.cz).

The podiatry examination, called Fit Feet exam, was launched in 2003 and focuses on the musculoskeletal, dermatological and gait conditions. Additionally, it provides education on foot care for the athletes and their coaches, family members or caregivers, as there is a higher prevalence of lower limb medical conditions and deformities among persons with intellectual disabilities compared to the general population. In a previous study by Jenkins et al. (2011) based on 1.580 Fit Feet screenings at United States competitions, a high prevalence of podiatric conditions associated with a ligamentous laxity such as pes planus or hallux abducto valgus was observed. Furthermore, the most common findings in gait biomechanics included an over-pronated gait, abducted gait and restriction in the ankle joint. From structural abnormalities, the most common ones were brachymetatarsia and metatarsus adductus (Jenkins et al., 2011). These musculoskeletal and functional conditions may influence the gait biomechanics of the athlete and have a negative impact on their sport performance. Therefore, the aim of this study is to estimate the prevalence of selected podiatric conditions among athletes with intellectual disabilities in the Czech Republic and to discuss these results with the Fit Feet examination findings of USA athletes and international participants of Summer Special Olympic Games in Athens, Greece, 2011 (Jenkins et al., 2011, Jenkins et al., 2015).

Methods

During National Winter Games 2017 in the Czech Republic Fit Feet screening by a Special Olympics clinical director and trained volunteers using a standardized Fit Feet protocol was available for the athletes. 46 athletes (25 males, 21 females) with the age range of 9 to 55 years and mean age of 29.17 years, competing in alpine skiing, snowboarding or cross-country skiing (50 m to 10 km distance) were examined. Intelligence quotient (IQ) of the skiers was below 75 points of IQ scale and indicated a moderate level of intellectual disability.

The Fit Feet screening includes many podiatric conditions categorized in the Healthy Athlete Software Form. For this study following conditions were selected: frontal plane motion in gait (normal, over-pronated, over-supinated), transverse plane of motion in gait (normal, adducted, abducted), knee (normal, valgus, varus), ankle joint range of motion (normal, restricted), Achilles tendon (normal, short), foot structure in stance (normal, pes planus, pes cavus), crossover toe (present or not), hammertoes (present or not), hallux abducto valgus (present or not). The screening was performed as the first thing in the morning before the preparation for ski competitions, to do not be influenced by a post-exercise lower-limb muscle fatigue. The final part of the screening consisted of a feedback for the skier, family member or coach and a recommendation for further treatment was provided when necessary.

Informed consent for Healthy Athletes examinations is a part of the Czech Special Olympics Movement registration procedure and was provided by the athletes and their caregivers prior to the screening.

Results

The prevalence of selected podiatric conditions is shown in Table 1. Differences between right and left limb were negligible.

Table 1: Selected podiatric conditions and their prevalence

		n	%
Frontal plane of motion in gait	over-pronated	6	13.04
	normal	39	86.96
	over-supinated	1	2.17
Transverse plane of motion in gait	adducted	1	2.17
	normal	34	73.92
	abducted	11	23.91
Knee	valgus	4	8.70
	normal	39	84.78
	varus	3	6.52
Ankle joint range of motion	normal	36	78.26
	restricted	10	21.74
Achilles tendon	normal	20	43.48
	short	26	56.52
Foot structure in stance	pes planus	17	36.96
	normal	21	45.95
	pes cavus	8	17.39
Crossover toe	present	2	4.35
	not present	44	95.65
Hammertoes	present	4	8.70
	not present	42	91.30
Hallux abducto valgus	present	7	15.22
	not present	39	84.78

Range of motion and gait

Restricted ankle joint range of motion was seen in 21.74% of athletes. Additionally, the prevalence of short Achilles tendon was 56.52%. The over-pronated and abducted gait were prevalent in 13.04% and 23.91% of athletes, respectively, and the prevalence of knee valgus and varus was 8.70% and 6.52%, respectively.

Structural conditions

The foot type screening showed that the prevalence of pes planus and pes cavus was 36.96% and 17.39%, respectively. Crossover toe was present in 4.35%, hammertoes were present in 8.70% and the prevalence of hallux abducto valgus reached 15.22%.

Discussion

The Fit Feet examination was part of the Healthy Athletes screening at the Czech Republic Winter Games 2017 as foot health is an essential element of any sports (Evans et al., 2011). From 215 participants, 46 athletes underwent the Fit Feet screening. Other Healthy Athlete screenings were also available at this event.

Two published studies of the prevalence of selected podiatric conditions in athletes with intellectual disabilities are known to the authors. The first data collection is from United States Athletes screening (n=1.580 athletes) and the second is from an international population participating in Special Olympics Word Summer games in Athens, Greece (n=2.096 athletes) (Jenkins et al., 2011; Jenkins et al., 2015). Therefore the results of this study will be discussed with their findings, when possible.

Range of motion and gait

Restricted ankle joint range of motion was seen in 21.74% of athletes in this study. In USA and Athens athletes a restricted ankle joint range of motion was present in 21,3% and 21.1%, respectively (Jenkins et al., 2011; Jenkins et al., 2015). Additionally, the short Achilles tendon prevalence was 56.52% in our study population. The overall prevalence of equinus, a restricted ankle joint sagittal plane of motion caused by short Achilles tendon, is 10.3% in the general population (Lawrence et al., 2002). Common foot problems associated with equinus include pes planus or hammertoes often seen in athletes with intellectual disabilities (Jenkins et al., 2011). The prevalence of knee valgus and varus was 8.70% and 6.52% in our study, respectively. In the population with Down syndrome the prevalence of knee valgus is higher, reaching 22% (Concolino et al., 2006). Over-pronated gait was prevalent in 13.04% and 46.9% of Czech and USA athletes, respectively. Whereas the over-supinated gait was prevalent in 2.17% and 5.3% of Czech and USA athletes, respectively. Finally, the adducted and abducted gait were prevalent in 2.17% and 23.91% of athletes participating in our study, respectively. The prevalence of adducted and abducted gait in USA athletes was 4.2% and 23.7% for the right foot, respectively. A difference in adduction and abduction during the gait between the left and right foot reported in USA athletes was not observed in our study (Jenkins et al., 2011).

Structural conditions

Structural condition screening revealed the prevalence of pes planus and pes cavus to be 36.96% and 17.39%, respectively. Similarly, the prevalence of pes planus was 38.1% and 39.9% in Athens and USA populations, respectively. Those numbers are in contrast to the prevalence of pes planus in the general population, which is approximately 16.2% and 11.7% for males and females, respectively (Tenenbaum et al., 2013). Nevertheless, pes planus has been associated previously with an increased body mass index and ligamentous laxity, which are commonly seen in athletes with intellectual disabilities. The prevalence of pes cavus was 6.2.% and 10.0% in Athens and USA populations, respectively. In the general population the prevalence of pes cavus is 4.5% (Jenkins et al., 2015). Furthermore, crossover toe was present in 4.35% of this study population. This podiatric condition is a result of metatarsophalangeal joint instability (Klinge et al., 2014). The prevalence of hammertoes in this study population was 8.70%. In the general population toes deformities are more common in women and their prevalence increase with advancing age, however, their exact prevalence is not known. The prevance of hallux abducto valgus reached 15.22% in our study. Whereas the prevalence of Athens and USA study was 5.4% and 12.8%, respectively. In the population with Down syndrome, the prevalence of hallux valgus is reaching 36.4% in contrast to the general population, where the prevalence of hallux valgus is 6.6%. Like the pes planus, this podiatric condition has been associated previously with a ligamentous laxity and connective tissue changes (Jenkins et al., 2011; Jenkins et al., 2015; Mansour et al., 2016).

The cause of the most common podiatric problems is the ligamentous laxity, abnormal gait and movement and ill-fitting footwear (Jenkins et al., 2011). Furthermore, the foot problems of Special Olympics athletes have been recognized to be related to certain intellectual disability syndromes. For example, Down syndrome has been associated with a higher prevalence of pes planus, metatarsus adductus, knee valgus, hallux abducto valgus, syndactily, clinodactyly and brachymatatarsia. Fragile X Syndrome has been associated with a joint hypermobility, excessive pronation and pes planus and Smith Magenis Syndrome has been associated with a pes planus, short toes, poor walking ability and increased risk of foot ulceration (Courtenay, Murray, 2015; Conenello, 2007). Therefore, the differences in particular foot conditions prevalence between Czech, Athens and USA cohorts may be caused by different proportion of athletes with specific syndromes associated with intellectual disabilities. Additionally, the difference in Czech, Athens and USA population findings may be caused by a small number of participants in our study, the difference between the winter and summer season or by a subjective assessment of foot, range of motion and gait observations by examiners (Jenkins et al., 2011), which are the limitations of this study. Future studies of the foot structure and gait biomechanics of skiers with intellectual disabilities comparing differences among alpine and cross country skiing would provide a more detailed insight into the specific foot conditions and sport performance relationship.

Conclusions

The Fit Feet screening at the Czech Republic Winter Games 2017 of 46 skiers with intellectual disabilities revealed the prevalence of the most common podiatric conditions including short Achilles tendon (56.52%), pes planus (36.96%), abducted gait (23.91%), restricted ankle joint range of motion (21.74%), pes cavus (17.39%), hallux abducto valgus (15.22%) and over-pronated gait (13.04%). The high prevalence of these podiatric conditions highlights the need for foot care promotion and prevention education among the athletes with intellectual disabilities. Furthermore, a greater knowledge of the podiatric findings prevalence in population with intellectual disabilities may provide for clinicians a more efficient management of their foot pathologies.

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References

1. Concolino, D., Pasquzzi, A., Capalbo, G., Sinopoli, S., Strisciuglio, P. (2006). Early detection of podiatric anomalies in children with Down syndrome. *Acta Paediatr*, 95, 17-20.
2. Conenello, R. (2007). Special Olympics Healthy Athletes, an Overview. http://www.aapsm.org/pdf/special-olympics-overview.pdf [available 10.1. 2017]
3. Courtenay, K., Murray, A. (2015). Foot Health and Mobility in People with Intellectual Disabilities. *Journal of Policy and Practice in Intellectual Disabilities*, 12 (1) pp. 42-46.
4. Evans, A., Reeve, M., Rundell, R., Ng, W. Q., Walton, D. (2011). Special Olympics IX National Games, Healthy Athletes Program: Fit Feet. Australian Podiatry Council Conference, *Journal of Foot and Ankle Research*, 4 (Suppl 1): 19.
5. Jenkins, D.W., Cooper, K., Heigh, E.G. (2015). Prevalence of podiatric conditions seen in Special Olympics athletes: A comparison of USA data to an international population. *The Foot*, 25, 5-11.
6. Jenkins, D.W., Cooper, K., O'Connor, R., Watanabe, L., Wills, Ch. (2011). Prevalence of podiatric conditions seen in Special Olympics athletes: Structural, biomechanical and dermatological findings. *The Foot*, 21, 15-25.
7. Klinge, S.A., McClure, P., Fellars, T., DiGiovanni, C.W. (2014). Modifcation of the Weil/Maceira metatarsal osteomy for coronal plate malalignment during crossover toe correction: case series. *Foot Ankle Int*., 35 (6), 584-591.
8. Lavery, L.A., Armstrong, D.G., Boulton, A.J.M. (2002). Ankle Equinus Deformity and Its Relationship to High Plantar Pressure in a Large Population with Diabetes Mellitus. *Journal of the American Podiatric Medical Association*, 92(9), 479-482.
9. Mansour, E., Yaacoub, J.J., Bakouny, Z., Assi, A., Ghanem, I (2016). A podoscopic and descriptive study of foot deformities in patients with Down syndrome. *Orthop Traumatol Surg Res*, doi: 10.1016/j.otsr.2016.10.001.
10. Special Olympics Czech Movement webpage: https://www.specialolympics.cz/zdravy-atlet [available 10.1. 2017]
11. Special Olympics webpage: https://www.specialolympics.org [available 10.1. 2017]
12. Tenenbaum, S., Hershkovich, O., Gordon, B., Bruck, N., Thein, R., Derazne, E., et al. (2013). Flexible pes planus in adolescents body mass index, body height, and gender – an epidemiological study. *Foot Ankle Int*, 34(6), 811-7.

EFFECTS OF NEUROFACILITATION TREATMENT ON ABILITY TO WALK IN INDIVIDUALS WITH AFTER STROKE HEMIPARESIS

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Introduction: One of the main cause of the stroke patients immobility is gait impairement. Gait disturbance presents clinically as balance problems, slower walking speed, reducing the step length and the gait cycle, and the asymmetrical gait pattern. They all reduce the patient's ability to perform everyday activities and result in the patient's dissatisfaction with the quality of their life.

Subjects and methods: The aim of this study is to determine the effect of the neurofacilitaton programme on balance and gait of 40 subjects diagnosed with stroke by magnetic resonance imaging andsuffering from hemiparesis, classified as level 3 according to the Medical Research Council paresis classification, at least 3 months after the stroke.

The STATISTICA for Windows ver. 10 StatSoft Inc. statistical software packet- ANOVA, the univariate analysis of variance - was used for data processing.

Results: Effects of the treatment programmes were compared by the Berg Balance Scale, the Timed Up and Go Test and goniometric measurements of active dorsiflexion of the foot, flexion and extension of the knee(Active Range of Motion - AROM). The study showed a statistically significant effect of the neurofacilitation treatment on all the variables (83.4% variables had statistically significant results, 15 out of 18), except on three variables (TUGT, BERG3 and BERG11) ($p>0.05$) relating to complex activities, such as getting up, walking, rotation, and sitting down.

Conclusion: Results obtained in this study showed a significant contribution of the neurofacilitation programme to almost all the variables of the static and dynamic balance as the basis of the gait function.

Key words: *stroke, neurofacilitation programme, balance, gait*

COMPARISON OF TWO DIFFERENT PNEUMATIC CUFF DESIGNS FOR RESTRICTING MUSCLE PERFUSION AT REST AND DURING ISOMETRIC MUSCLE CONTRACTION

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Purpose: Blood flow restricted resistance exercise (BFRRE) is used to gain muscle mass and strength. The most efficient technique of blood-flow restriction for muscle conditioning has not been identified as yet (1). During rest, width of tourniquet and limb circumference has been shown to substantially influence pressure distribution to the tissues (2). The aim of this study was to optimize tourniquet characteristics for restriction of limb muscles blood flow.

Methods: Newly designed tourniquet cuff with asymmetric pressure distribution (DCAP) and standard tourniquet cuff with symmetric pressure distribution (SCSP) were tested on 17 healthy volunteers (27.3±5.2 years) during rest. Thigh circumference and skinfold were determined for each leg. Efficiency of tourniquets was compared bilaterally on proximal thighs at four occlusion pressures (OP = 120, 160, 200 and 240 mmHg). Changes in hemoglobin kinetics in v. lateralis muscle (near-infrared spectroscopy), cardiovascular responses (ECG and ABP), isometric endurance, maximal voluntary isometric contraction (MIVC) torque and pain intensity (visual analogue scale, VAS) were analysed.

Results: Lean thigh circumference did not differ between legs (L= 57.3±3.7 cm, R=57.1±3.8 cm). VAS scores did not differ between tested tourniquets, but did significantly increase (p=0.03) at OP 200 mmHg and higher. Difference (p = 0.009) in slope of total hemoglobin concentration change ([tHbs]) was found between the tourniquets at OP 160 mmHg (DCAP=0.028μM/s, SCSP=0.056μM/s). Mean ABP was significantly increased (p= 0.02) at OP 120 mmHg compared to baseline values, whereas change in heart rate was detected. MIVC did not differ between legs (L= 230 ± 77 Nm, R= 233 ± 77 Nm). Shorter time to exhaustion (-11%; p=0,003) was found in ischemic condition compared to control condition, while no difference was found between tested tourniquets.

Conclusions: Based on differences in [tHbs], arterial occlusion was induced at OP ≥ 160 mmHg with DCAP, whereas OP ≥ 200 mmHg was required with SCSP. Given that higher pressure may cause damage to underlying tissues and increases discomfort, it is concluded that novel tourniquet design allows safer and more efficient blood flow restriction at a given tourniquet pressure and discomfort during rest. Whether the same is achieved during BFRRE, needs further investigation.

References

1. Kacin, A., Rosenblatt, B., Grapar žargi, T., Biswas, A. (2015). Safety considerations with blood flow restricted resistance training. Annales kinesiologiae, ISSN 2232-2620, vol. 6, no. 1, str. 3-26
2. Loenneke, J., Fahs, C., Rossow, L., Sherk, V., Thiebaud, R., Abe, T., et al. (2012). Effects of cuff width on arterial occlusion: implications for blood flow restricted exercise. [Article]. European Journal of Applied Physiology, 112(8), 2903-2912.

THE EFFECTS OF KINESIO TAPING ON LATERAL EPICONDYLE PAIN AND HANDGRIP MUSCLE STRENGTH DURING TENNIS TOURNAMENT

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Background: Lateral Epicondyle (LE) is a widespread type of overuse injury seen among tennis players. LE is often attributed to work related repetitive strain injuries but it is also a specific sports injury (Gellman, 1992). Pain over the lateral epicondyle, which is exacerbated by worker recreational activities that involve gripping actions of the hand, such as holding tools, shaking hands, and lifting a kettle, usually signals that the individual has a condition termed lateral epicondylalgia, epicondylitis, or what is more commonly known as tennis elbow. Its prevalence has been reported to be 3% in the general population, 15% in repetitive hand task occupations, and 50% in tennis players (Coombes, Bisset, & Vicenzino, 2009; Goel, Bathilaya, & Reddy, 2015). Handgrip strength (HGS) and pressure pain threshold (PPT) are outcome measures that are responsive to detect changes in LE (Shiri, Viikari-Juntura, Varonen, & Heliövaara, 2006).

Aim: To our knowledge, there are limited studies examining the effects of KT during a sport competition. Also, there are no studies investigating the effects of KT on HGS and PPT during tennis tournament. Based on data in the literature, showing that a prolonged tennis match could induce muscle fatigue, our hypothesis KT group would be less affected in HGS performance and PPT values than placebo taping and no taping group. Therefore, the purpose of this study is to evaluate the effects of KT application on elbow on pain, and functional handgrip strength performance during tennis tournament.

Methods: Participants were equally divided into three groups (the first group Kinesio Taping Group (KTG): 14 females and 15 males, the second group Placebo Taping Group (PTG): 15 females and 16 males, and the third group No Taping Group (NTG): 15 females and 14 males tennis players). Forty-three females and forty-six males volunteers (age 21.5 ± 3.7 years, body mass 69.7 ± 13.2 kg and height 167.8 ± 11.9 cm) were recruited to participate in this study.

Results: Pain pressure threshold values were significantly decreased after second, third, and fourth days of female tennis players (except KTG; p=0.076, p=0.029, p=0.018 respectively). Also, values of pain pressure threshold was significantly decreased second, third and fourth days of male tennis players (except KTG; p=0.128, p=0.023, p=0.001 respectively). Dominant handgrip strength values were significantly reduced after second, third, and fourth days of female tennis players (except KTG p=0.066, p=0.031, p=0.016 respectively). Besides, values of handgrip strength was significantly decreased second, third and fourth days of male tennis players (except KTG p=0.058, p=0.012, p=0.012 respectively).

Conclusion: The present study proved the application of KT effective in gaining long-term benefits in lateral epicondylalgia. This is the first study that a potential KT effect has been evaluated specifically on muscle strength and pain pressure threshold using an appropriate quantitative and objective methodology. Our findings indicated the application of KT on the wrist extensors, extensor carpi radialis brevis and longus muscles have effect on dominant muscle strength and pain pressure threshold without placebo effect.

***Key words**: Pain, kinesio taping, placebo, strength, tennis elbow*

References

1. Gellman, H. (1992). Tennis elbow (lateral epicondylitis). The *Orthopedic Clinics North America, 23*(1), 75-82.
2. Coombes, B.K., Bisset, L., & Vicenzino B. (2009). A new integrative model of lateral epicondylalgia. *British Journal of Sports Medicine, 43*(4), 252-258.
3. Goel, R., Balthilaya, G., & Reddy, R.S. (2015). Effect of kinesio taping versus athletic taping on pain and muscle performance in lateral epicondylalgia. *International Journal of Physiotherapy and Research, 3*(1), 839-844.
4. Shiri, R., Viikari-Juntura, E., Varonen, H. & Heliövaara, M. (2006). Prevalence and determinants of lateral and medial epicondylitis: A population study. *American Journal of Epidemiology, 164*(11), 1065-1074.

DIFFERENCES IN CERTAIN MOTOR ABILITIES BETWEEN CROATIAN AND GERMAN PUPILS WITH INTELLECTUAL DISABILITIES

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Abstract

The aim of this paper is to determine the significance of differences in motor skills between Croatian and German pupils with intellectual disabilities, taking into account as a criterion variable number of hours of physical education (PE) per week. We examined 188 participants from the Croatia and 788 participants from Germany who are in the school system and who have a mandatory 2 (Croatian) or 3 (German) hours of PE per week. All used tests are standardized by SOI (Special Olympics International. The following tests were conducted: partial sit-up test, time stand test and singe leg stance test eyes open left/right. The obtained results indicate a significant difference in all tests between populations. Croatian population achieved better statistical results in sit-up test and singe leg stance test eyes open left/right although it has only two hours of PE per week. In addition, German population achieved better results in time stand test as it was expected due to more hours of PE per week. One of the main reasons for such results could be specifics of researched population whose motor skills cannot develop to its full capacity, and in the normal population, expected results would be better in all tests for population who had more hours of PE per week.

Key words: *people with intellectual disabilities, Special Olympics, balance, sit up test, motor skills, physical education*

Introduction

There are not enough Research of people with intellectual disabilities to the available literature and it is related to a small sample of participants in a particular school or sports facilities. Mostly such surveys were conducted as a parallel comparison of school population of people with ID and healthy school population where the differences are expected were large (Peacock, 2014). Also studies were carried out generally through questionnaires which main goal were not motor or functional abilities, but only a subjective assessment of an individual or the examiner. This research is aimed at positioning the Croatian population with intellectual disabilities in relation to the German population to motor skills, taking into account as a criterion variable number of hours of PE per week. In Croatia, the number of PE hours is 2 hours per week, while in Germany the number of PE hours for people with intellectual disabilities is 3 hours per week. Expectations in the normal population in motor skills are positively correlated, the greater the number of PE hours gives better results in the tests and vice versa. The concept of this study is to prove that there will be no significant differences between populations with a larger number of PE hours in relation to the population with fewer PE hours considering their motor skills.

One of the main reasons for such results is the fact that the motor space of a population with ID cannot develop to its full capacity as in a normal population.)

Methods

The sample, which was tested in this study, involved 976 subjects. There were two groups of subjects, Croatian population with 188 participants and German population with 788 participants. Sample of variables consists of three tests of motor skills, repetitive power abdominal, lower body (leg) test, and balance test. The measurement was performed according to the prescribed Funn Fitness protocol. All subjects were healthy and not injured during the testing. Measurements were carried by verified timekeepers of Special Olympics, which have a minimum of 3 years' experience in the same program measurement. The variables that were measured are as follows:

Partial sit-up test: The test of the subject application to perform as many repetitions within one minute from the prone position. Design; the subject is placed in the supine position on the mattress. If the subject cannot be on the matters, the test can be performed on the table. Examinee's legs are bent at an angle of 90° in the hips and knees and placed on a chair. Subject is referred to lift their head and shoulder blades, and then descends to the original position. The duration of the test is 60 seconds. The goal is to make the subject partially lift the shoulder blades from the ground.

Time stand the test: subject must complete 10 rising up from sitting position as quickly as possible without helping hands. Design; The subject sits on a solid flat seat backrest. The feet must be entirely on the ground and knees bent at an angle of 90 degrees. After that, the subject performed 10 reps as quickly as possible, after the timekeeper gives permition to start. The time is measured until the subject fails to perform 10 repetitions. If the subject can't achieve 10 reps, it will be noted the number of repetitions in the measured time.

Single leg stance test eyes open left / right: the method used to measure the balance with the help of visual receptors. The test requires the subject to stand on one leg open eyes and to maintain balance as long as possible. Design; subject is standing on both feet and is located in front of the chair, which serves for safety. The test ends when the subject loses balance or step with the rised leg on the floor. The length of test is 120 seconds, if the subject losses balance before; the time of balance with one leg is noted.

Every test is carried out three times; rest between tests was two minutes. All the measured test results are analysed in statistical software package Statistica 5.0.

Results

Table 1: Descriptive statistic parameters (mean (Mean), minimum score (Min), maximum score (Max), range (Range) T-test value (p) for Croatian population

Test name	Parcijal_sit_up_test Mean (min-max)	Single_leg_stance_eyes_open_right Mean (min-max)	Single_leg_stance_eyes_open_left Mean (min-max)
CRO	35,31 (60-8)	37,01 (92-1)	35,71 (90-1)
GER	32,41 (73-5)	16,98 (60-1)	17,64 (60-2)
T-test (p)	**0,009**	**0,0002**	**0,0003**

Table 2: Descriptive statistic parameters (mean (Mean), minimum score (Min), maximum score (Max), range (Range) T-test value (p) for German population

Test name	Timed_stand_test Mean (min-max)
CRO	15,72 (76-7)
GER	17,28 (92-7)
T-test (p)	**0,026**

Statistical differences in the populations is also shown from the Tables, where the Croatian population *(Table 1.)* achieved better results in repetitive strength and balance while German population (*Table 2),* better results achieved in repetitive strength of the lower body (legs).

Discussion and conclusion

The expected results in this type of research, which imply motor skills can be easily, predict when it comes to the standard population. Generally, larger number of physical activity hours provides better results in the tested motor skills. The hypothesis that is set in this research has not been confirmed, and it was expected that there would not be significant differences in the population because the number of PE hours per week varies minimally. The obtained results is confusing because the differences in the population is statistically significant. The three test results are significant for a population that has fewer hours of physical activity per week while and only significant result in one test of population with more hours per week. People with intellectual disabilities can be difficult to fully develop their motor skills to the maximum level and when they do that, they are again in a worse position with respect to the standard population. The reason for such a result can be also other activities but we didn't have those informations for this research. Authors recommendations of this paper is to extend the research to other populations with ID from the region in order to get results that are more precise.

References

1. *American Association on Intellectual and Developmental Disabilities (2013). Definition of Intellectual Disability /on line/.* 15.11.2014.: http://aaidd.org/intellectual-disability/definition#.VBm42ZR_skI
2. American College of Sports Medicine (2012). *ACSM's Guidelines for exercise testing and prescription*. Champaign, IL: American College of Sports Medicine.
3. Durstine, J. R. (2009). *ACSM's Exercise management for persons with chronic diseases and disabilities*. Champaign, IL: American College of Sports Medicine.
4. Erin K.H., Barnes, T.L., McDermott, S., Mann, J.R., Clarkson, J., Meriwether, R.A. (2013). Availability of physical activity resources in the environment for adults with intellectual disabilities Disabil Health J. Jan 2012; 5(1): 41-48.
5. Izquierdo-Gomez, R. et all (2013). Are poor physical fitness and obesity two features of the adolescent with Down syndrome? *Nutricion hospitaralia*, 28(4), 1348-1351.
6. Oviedo, G.R. et all (2014). Effects of aerobic, resistance and balance training in adults with intellectual disabilities. *Research in developmental disabilities*, 35(11), 2624-2634.
7. Special Olympics.org (2011). *FUN fitness: Learn how to Organize, Promote and Present /on line/.* 17.10.2014.: http://resources.specialolympics.org/uploadedFiles/special-olympicsresources/Topics/Healthy_Athletes/FUNfitness_Manual_January2013_FINAL.pdf

DEVELOPMENT OF REPEATED SPRINT ABILITY IN LITHUANIAN DEAF BASKETBALL PLAYERS

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Abstract

The aim of this research is to assess the repeated sprint ability (RSA) of deaf elite basketball players in order to determine the evolution of the deaf players' muscle power during repeated-sprint exercise. Fourteen deaf male basketball players (28.3 ± 6.3 years) performed two RSA protocols consisting of 5 x 6 s cycling sprints with a 24 s rest interval between sprints. RSA was assessed by calculating absolute and relative peak power (PP), total work (TW) performed, fatigue index (FI), and work decrement (WD). The work decrement indices (7.1 ± 3.7%) for deaf players during the first trial were small and after 5-minute rest did not change significantly. The total work (332 ± 42 J) decreased by 6%. During the 5-minute passive rest, deaf basketball players' absolute peak power recovers about 95% of the initial levels. Therefore, we suggest that such interval of rest is sufficient for deaf basketball players so that they can continue the game showing good capacity potential. We also suggest that when deaf basketball players aim for even greater repeated sprint abilities, they need to reduce work decrement maintaining the capacity of all sprints.

Key words: *sprints, muscle power, work decrement, recovery*

Introduction

Deaf people are rather active in sports life and participation in basketball competitions is one of the ways for their self-expression. Lithuanian deaf athletes are the numerous prize winners in World, European Deaf Championships, as well as in Deaflympics Games. Recent significant achievement of Lithuanian deaf basketball players is becoming gold medallists in the XXII Deaflympics Games in 2013.

One of the most important criteria of fitness in training athletes in sports games is repeated sprint abilities (RSA) (Narazaki et al., 2009; Gabbett, 2010; Ruscello et al., 2013). At present, sports researchers are interested in the ability to carry out short work of maximum intensity with limited breaks for rest. Improving basketball game time-motion analysis has shown that non-intensive stages of the match, such as standing or walking, alternate with very intense running, sprinting, jumping intervals (Ben Abdelkrim et al., 2010; Conte et al., 2015). Depending on the game situation, the player's position, the course of the game and the rules, and the duration of intensive periods of exercise range from 1 to 10 seconds (Ben Abdelkrim et al., 2007).

Players need to repeat performance of highly intensive work for a particular time combining them with rest intervals. The biggest role is here played by the ability of the player's organism to recover fast. Such indicators as speed of recovery of energetic substances in muscles, functional power of circulatory and respiratory systems are among the most important indicators of basketball players' capacity (Spencer et al., 2005). We have established the functional capacity of deaf basketball players (Milašius et al., 2014). However, the RSA of deaf basketball players has not been extensively analysed. The research problem is not only how to assess the players' muscle power, but also to choose the optimum rest period for recovery after very intensive exercise intervals. The aim of this research is to assess the RSA of deaf elite basketball players in order to determine the evolution of the deaf players' muscle power during repeated-sprint exercise.

Methods

Participants

Fourteen male deaf basketball players (28.3 ± 6.3 years; 88.5 ± 8.2 kg; 189.9 ± 6.1 cm) voluntarily participated in this study during a preparatory period of Summer Deaflympic Games. The hearing loss of all participants exceeded 55 decibels. Prior to testing, all participants were fit, free from injury and provided written informed consent to engage in the study. Participants were familiarized with the research protocol and asked to refrain from vigorous exercise 24 hours prior to testing. Ethical approval was provided by the National Bioethics Committee.

Procedures

The laboratory based test session consisted of anthropometric measures, including body mass and stature, and the assessment of RSA on a mechanical braked cycle ergometer (Monark 894 E Ergomedic, Stockholm, Sweden) equipped with a computerized data acquisition program (Anaerobic Test Software 894E).

A RSA test was carried out in accordance with the Bishop et al. (2001) protocol in which all participants completed two trials of maximal cycling sprints. Participants performed 2 RSA protocols consisting of 5 x 6 s maximum cycling efforts with 24 s rest interval between each sprint. Before the test, the participants performed a 5 minute warm-up at a self-selected intensity interspersed with 4 submaximal sprints lasting 4 to 6 seconds on a cycle ergometer. During the test, a standard resistance of 10% of the subject's body weight was fixed on the cycle ergometer (Bar-Or, 1987). Each exercise period was started at a 45° pedal angle.

All five 6 s exercise periods were performed at maximum effort with a 24 s rest interval between work bouts. They had 2 trials which include 5 x 6 s cycle bouts, with a 5 minute rest between trials.

Repeated sprint ability was assessed by calculating absolute and relative peak muscle power, total work performed, fatigue index, and work decrement. Peak power (W) was recorded as the mean relative (W • kg-1) and the mean absolute (W) power for each 6 s exercise period. The mean absolute (J) and relative work (J•kg-1) was calculated as well.

Fatigue was estimated by calculating fatigue index ($FI_{1\text{-}5}$) and instantaneous fatigue ($FI_{1\text{-}2}$), using the following equations:

$$\text{Fatigue Index: } (FI_{1\text{-}5})\text{: FI } (\%) = 100 - \frac{5^{th}\ sprint \times 100}{1^{st}\ sprint}.$$

$$\text{Instantaneous fatigue: } (FI_{1\text{-}2})\text{: FI } (\%) = 100 - \frac{2^{th}\ sprint \times 100}{1^{st}\ sprint}.$$

Work decrement (WD%) was calculated to determine the change in the work capacity over the five sprints (Bishop et al., 2001):

$$\text{Work Decrement (WD\%)} = 100 - \frac{Total\ sprints \times 100}{Best\ score \times 5}.$$

Statistical Analysis

Results are presented as means ± standard deviations (SD). Data were analyzed for normality via the Kolmogorov–Smirnov test and parametric statistics were conducted. To determine significant differences in physiological variables following repeated sprints tests were compared using a one-way ANOVA with repeated measures. Results were considered significant at an alpha level of $p \leq 0.05$. Statistically significant changes and differences between trials were determined using SPSS (version 21.0; SPSS, Inc., Chicago, IL, USA).

Results

Table 1 presents all relative muscle power RSA test results. Within trials, there was a reduction in mean relative power by 8% in Trial 1, and 14% in Trial 2. This reduction in percentage of relative power between trials was due to the lower absolute peak power produced within each subsequent trial. Both relative and absolute PP reduced in trial II (2.9% and 5.5% respectively) compared to Trial I ($p > 0.05$). It is important to note that with each trial the dispersion of relative power (as observed by the SD values) consistently decreased suggesting that all participants responded in the similar way.

Calculations of $FI_{1\text{-}5}$ showed that fatigue during each test (Table 2). In the first trial it was 24.1 ± 12.0%, in the second one 20.8 ± 10.8% ($p > 0.05$). The calculation of $FI_{1\text{-}2}$ showed that fatigue in the second Trial decreased to by 1.9 ± 1.8%. High dispersion showed different functional capacity of deaf players' ATP - PC system. The absolute muscle power (W) was also measured. Its values are presented in Figure 1. The highest average value - 1149 W - was achieved in the Trial I. In the Trial II it was 890 W, the difference between the results was statistically significant ($p < 0.05$).

Table 1 presents the peak muscle power values. The results showed that the peak muscle power was achieved in the first trial - 1568 ± 318 W. In the second trial the peak value was 1482 ± 263W. The differences between the indices in all trials were not significant ($p > 0.05$).

Given the muscle power and its changes, the work done becomes a significant criterion. We see that in each trial the values did not significantly decrease. As the players' body mass was very different, it is important to know the average relative index of the work performed in each trial. The highest index was in the first trial 332 ± 42 J, and in the second trial was 11% lower ($p > 0.05$).

Discussion

Table 1: Relative muscle power performing 5 x 6 s cycle tests, Mean ± SD

Trials:	*I*	*II*
Sprint power (W·kg-1):		
1	12.5 ± 2.3	11.8 ± 1.8
2	12.4 ± 1.8	11.4 ± 2.0
3	11.7 ± 1.9	10.5 ± 1.7
4	11.7 ± 1.8	10.2 ± 2.0
5	11.5 ± 1.7	10.1 ± 1.3*
Peak power (W·kg-1):	17.4 ± 3.2	16.9 ± 2.8
Peak power (W):	1568 ± 318	1482 ± 263

Note: statistically significant difference at p < 0.05 between I-II*

RSA test results allow assessing what anaerobic muscle power of deaf basketball players is in different working intervals and how it decreases. The absolute power (Figure 1) and the relative muscle power indicators (Table 1) contribute to a better understanding of muscular functional capacities for basketball players of this group. Power loss in 5 x 6 s test can be associated with the ATP - PC stores in muscles. This has been confirmed by a number of previous studies (Jones et al., 1985; Medbø et al., 1999). In the first sprint, the ATP - PC is maximum, but 24 seconds of rest to recover the ATP - PC is not sufficient, thus the anaerobic glycolytic reactions begin to dominate (Spencer et al., 2005).

Our results provide an opportunity to assess the capacity of players. Hoffman (2006) presents basketball players' muscle peak power index in the Israel men's national basketball team – 14.4 ± 1.7 W•kg-1. The peak power index for Australian basketball players is 18.9 ± 1.8 W•kg-1 (Ellis et al., 2000). The peak power of our investigated deaf basketball players is 17.4 ± 3.2 W•kg-1.

Table 2: Fatigue and the work carried out, Mean ± SD

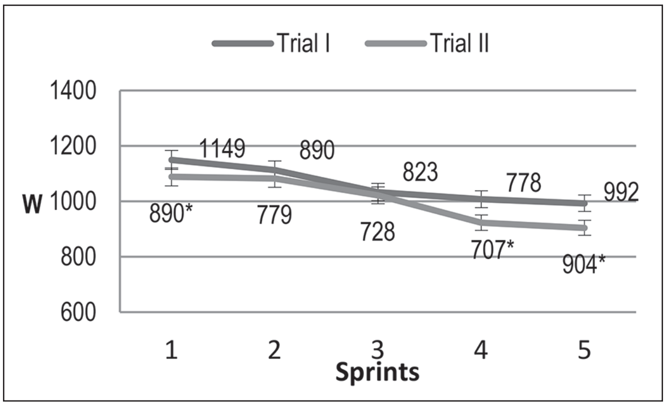
Trials:	*I*	*II*
FI1-5 (%):	24.1 ± 12.0	20.8±10.8
FI1-2 (%):	2.9 ± 2.6	1.9 ± 1.8
Total work (kJ):	27.1 ± 3.7	25.6 ± 4.0
Total work (J·kg-1):	332 ± 42	296 ± 46
Work decrement (%):	7.1 ± 3.7	5.2 ± 6.8

Note: statistically significant difference at p < 0.05 between I-II*

Reduction in power, i.e. fatigue index here is a very significant variable. In the investigation of RSA for basketball players, Castagna et al. (2007) found a negative correlation (r = -0.75, p = 0.01) between first-sprint time and FI. It means that basketball players demonstrating a greater PCr power showed had worse fatigue indicators. Calculating the fatigue index FI_{1-5}, we cannot make a detailed analysis of the decrease in our results. More information is provided by the work decrement (WD) index which it is provided with the work carried out. During the first sprint, the obtained WD index was 7.1 ± 3.7%, and the work carried out was 332 ± 42 J•kg^{-1}. Stapff (2001) suggests that the target WD of basketball players is < 7%, and the work carried out > 330 J•kg^{-1}. It can be assumed that performing RSA at low work decrement but high total work, alactic anaerobic muscle power potential for athletes in team sports is high.

According to our assumptions, 5 minutes of passive rest is sufficient for deaf basketball players to repeat physical work of the same extent and intensity. Signorile et al. (1993) investigated the effect of passive versus active recovery (cycling at 60W) on performance during eight, 6-second cycle sprints. They observed statistically significantly higher mean peak power and total work capacity using 30-second active rest breaks. Ahmaidi et al. (1996) also reported that active recovery (5 minutes at a workload corresponding to 32% of VO_2max) increased power outputs at high braking forces during repeated bouts of 6-second cycle sprints. Our study shows that after 5 minutes of passive rest, the second RSA test absolute mean peak power was lower by 5.5 % of the first test values.

It has been reported that the greater the PCr degradation, the greater the time that is required for full PCr repletion, as resynthesis must commence from a lower level (Dawson et al. 1997). Bogdanis et al. (1995) suggest that the half-time of PCr re-synthesis is reported to be between 21–57 seconds. In our research we discovered that after 5 minutes of rest, the work performed in the second RSA test was lower by 6% than in the first test. It should be noted that after the re-establishment of work decrement after 5 minutes of rest, the results did not differ significantly. These data suggest that 5-minute passive rest after RSA exercise is sufficient for the deaf basketball players to repeat high-intensity physical work.



Note: statisticaly significant diference at $p<0.05$ betveen 1st -2nd*trials

Figure 1: Absolute muscle power performing 5 x 6 s cycle tests

Conclusion

Our study showed that doing a Repeated Sprint Ability test two times with 5-minute rest, work decrement index does not change significantly: total work decreased by 6% after the recovery. During 5-minute passive recovery, deaf basketball players' peak power recovers about 95% of the initial level. Therefore, we suggest that such interval of rest is sufficient for deaf basketball players so that they can continue the game showing good capacity potential. We also suggest that when deaf basketball players aim for even greater repeated sprint abilities, they need to reduce work decrement maintaining the capacity of all sprints.

References

1. Ahmaidi, S., Granier, P., Taoutaou, Z., Mercier, J., Dubouchaud, H., & Prefaut C. (1996) Effects of active recovery on plasma lactate and anaerobic power following repeated intensive exercise. *Medicine and Science in Sport and Exercise, 28* (4), 450-456.
2. Bar-Or, O. (19870 The Wingate anaerobic test, an update on methodology, reliability and validity. *Sports Medicine, 6* (4), 381-394.
3. Ben Abdelkrim, N., Castagna, C., Jabri, I., Battikh, T., El Fazaa, S., & El Ati, J. (2010) Activity profile and physiological requirements of junior elite basketball players in relation to aerobic-anaerobic fitness. *Journal of Strength and Conditioning Research*, 24 (10), 2330-2342.
4. Ben Abdelkrim, N., El Fazaa, S., & El Ati J. (2007) Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British journal of sports medicine, 41* (2), 69-75.
5. Bishop, D., Spencer, M., Duffield, R., & Lawrence, S. (2001) The validity of a repeated sprint ability test. *Journal of Science and Medicine in Sport 4* (1), 19-29..
6. Bogdanis, G.C., Nevill, M.E., Boobis, L.H., Lakomy, H.K., & Nevill, AM. (1995) Recovery of power output and muscle metabolites following 30-s of maximal sprint cycling in man. *Journal of Physiology, 482* (2), 467-480.
7. Castagna, C., Manzi, V., D'Ottavio, S., Annino, G., Padua, E., & Bishop, D. (2007) Relation between maximal aerobic power and the ability to repeat sprints in young basketball players. *Journal of Strength and Conditioning Research*, *21* (4), 1172-1176.
8. Conte, D., Favero, T., Lupo, C., Francioni, F., Capranica, L, & Tessitore, A. (2015) Time-motion analysis of Italian elite women's basketball games: individual and team analyses. *Journal of Strength and Conditioning Research,* 29(1), 144-150
9. Dawson, B., Goodman, C., Lawrence, S., Preen, D., Polglaze, T., Fitzsimons, M., & Fournier, P. (1997) Muscle phosphocreatine repletion following single and repeated short sprint efforts. *Scandinavian journal of medicine and science in sports, 7* (4), 206-213.
10. Gabbett, TJ. The development of a test of repeated-sprint ability for elite women's soccer players. (2010) *Journal of Strength and Conditioning Research*, 24 (10), 1191-1204.
11. Hoffman, J. (2006) Norms for fitness, performance, and health. Champaign, IL: Human Kinetics.
12. Jones, N.L., McCartney, N., Graham, T., Spriet, L.L., Kowalchuk, J.M., Heigenhauser, G.J., & Sutton, JR. (1985) Muscle performance and metabolism in maximal isokinetic cycling at slow and fast speeds. *Journal of Applied Physiology, 59* (1), 132-136.
13. Milašius, K., Paulauskas, R., Dadelienė, R., Šatas, A. (2014) Body and functional capacity of Lithuanian deaf basketball team players and characteristics of game indices. *Baltic Journal of Sport and Health Sciences, 95* (4), 24-30.
14. Medbø, J.I., Gramvik, P., & Jebens, E. (1999) Aerobic and anaerobic energy release during 10 and 30 s bicycle sprints. *Acta Kinesiologiae Universitatis Tartuensis,* 4, 122-146.

15. Narazaki, K., Berg, K., Stergiou, N., & Chen, B. (2009) Physiological demands of competitive basketball. *Scandinavian Journal of Medicine and Science in Sports, 19* (2), 425-432.
16. Ruscello, B., Tozzo, N., Briotti, G., Padua, E., Ponzetti, F., & D'Ottavio, S. (2013) Influence of the number of trials and the exercise to rest ratio in repeated sprint ability, with changes of direction and orientation. *Journal of Strength and Conditioning Research, 27* (7), 1904- 1919.
17. Signorile, J.F., Ingalls, C., & Tremblay, L.M. (1993) The effects of active and passive recovery on short-term, high intensity power output. *Canadian journal of applied physiology, 18* (1), 31-42.
18. Spencer, M., Bishop, D., Dawson, B., & Goodman, C. (2005) Physiological and metabolic responses of repeated-sprint activities: specific to field-based team sports. *Sports medicine, 35* (12), 1025-1044.
19. Stapff, A. (2000) Protocols for the Physiological Assessment of Basketball players. *In Gore, C.J. (ed.) Physiological Tests for Elite Athletes. Australian Sports Commission.* Champaign, IL: Human Kinetics, 224-237.

KNEE INJURIES AND OVERUSE SYNDROMES IN EUROPEAN ELITE BADMINTON PLAYERS IS THERE A LINK BETWEEN INJURY AND TRAINING HOURS?

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Abstract

Background: Overuse syndromes and injuries of the knee are becoming increasingly common in badminton players, however, the specific nature of knee acute and overuse problems in junior badminton players is still not fully explained. The aim of this study was to evaluate the frequency of acute, overuse knee problems in elite European junior badminton players, and see whether there is a link between knee problems and the amount of training hours per week.

Methods: This retrospective epidemiological study was carried out on 150 elite junior badminton players who participated in European Junior Circuit tournaments during the competitive season 2014/15. Participants fulfilled a validated questionnaire, asking information about acute injuries as well as overuse syndromes of the knee. The questions covered variables like the frequency of injury and overuse syndromes in the last competitive season and also about the participant`s training load per week. The data were analysed using the SPSS statistic program. Mean number and percentages of knee injury and overuse syndromes were calculated. The statistical significance of differences in weekly training load between injured and non-injured players, were tested by means of a paired t-test for independent samples. The level of statistical significance was set at $p < 0.05$.

Results: The results showed a high frequency of knee injury and overuse syndromes in the tested junior badminton players. 30% of the participants reported at least one problem with the knee. The weekly training load was significantly lower for the injured players, compared to the ones who did not report knee problems.

Conclusions: Future research must be done to elucidate the link between knee injuries in junior badminton players and their weekly training load. A higher number of training hours per week may be protective in nature, if spent in preventive training measures. Effective preventive training programs for junior badminton players should aim at prepare the standing leg for specific and repeating loads in badminton.

Key words: *badminton, knee, injury prevention*

Introduction

Badminton is an individual, non-contact sport requiring jumps, lunges, quick changes of direction and rapid arm movements from a wide variety of postural positions (Phomsoupha and Laffaye, 2015). It is a high-speed sport played on relatively small court, with high variety of court movement and racket strokes. The opponent try to force the player out off balance or out from central position, so badminton player need to be able to move and react quickly on the court. For all this, it requires the player to bending knees in starting position and with a split step start to move in every direction on the court. According to the Badminton World federation, it is one of the most popular sports in the World; with about 150 million people playing the game worldwide. The physical demands of badminton suggest that acute injuries or overuse syndromes to the lower limbs may be a frequent occurrence (Yung et al., 2007). This is especially important in consideration to junior badminton players, because at this point of the athlete’s career the training and competition demands increases substantially. On a technical movements on the court the lunges is one of the elements that is regularly used in badminton play and puts high physical demands on lower limbs. It can be perform at the net, in the mid-court and in the rear court. Kuntze et al. confirmed the relative high frequency of lunging, 15% of all movements in competitive single games. This movement puts lots of muscular demands and especially on the knee joint. The most common injury mechanism at the knee joint were on single leg landing after overhead stroke, and the second one side stepping and backward stepping (type of lunging). About one third of the injuries occurred in the lower limb especially the knees (Goh at al., 2013).

Based on the above mentioned, one may conclude that overuse syndromes and injuries of the knee are becoming increasingly common in badminton players, however, the specific nature of knee acute and overuse problems in junior badminton players is still not fully explained. To plan effective preventive training for young badminton players, their specific epidemiology of injuries must be taken in consideration. The aim of this study was to evaluate the frequency of acute, overuse knee problems in elite European junior badminton players, and see whether there is a link between knee problems and the amount of training hours per week. The obtained results may facilitate future planning of specific preventive measures for young badminton players.

Methods

This retrospective epidemiology study was carried out on a sample of 150 junior badminton players during selected tournaments in European Junior Circuit 2014. /15. (Polish Junior, Hungarian Junior, Italian Junior, Dutch Junior). Junior badminton players with age ranging from 14 to 18 years old, 167.1 (±24.5) cm heights, and 66.5 (±13.28) kg weights were included in the study. All the players were from Europe (total of 12 European countries) and have played tournaments of European Junior Circle across Europe. As players were under the age of 18, we firstly contacted coaches from each country for the permission to include their players in this study about badminton injuries. All participants gave their written consent before participating in the investigation. According to a previously published protocol (Trošt Bobić, Petrinović, Bobić, 2017), participants fulfilled a validated questionnaire, covering the information about their past acute injuries and overuse syndromes. For the purpose of this study, questions about the frequency of knee acute injuries and the subjective perception of knee pain in the last competitive season were highlighted. Data covering variables like pain conditions, site of the pain, as well as general data about the participant's activity (i.e. hours of training per week), dominant arm and preferred leg were also gathered.

The data were analysed using the SPSS statistic program. Mean number and percentages of knee injury and overuse syndromes were calculated. The statistical significance of differences in weekly training load between injured and non-injured and between the players who felt pain and those who did not, were tested by means of a paired t-test for independent samples. The level of statistical significance was set at $p < 0.05$. The graphs were prepared in Microsoft Excel.

Results

A total of 45 players (30% of all 150 participants) reported some kind of problems with their knees in the last competitive season. Among them, 18 (40%) complained about knee overuse syndromes, 15 (33.3%) reported about acute knee injury, while 12 of them (26.6%) reported both, acute injury and overuse syndrome (Figure 1). Since a many of the players reported symptoms in both knees, the sum of 71 knee problems was collected in 45 players (45 players with 71 injuries: 31 acute injuries and 41 overuse syndromes), and 33.3% (n = 15) of them had problems with both (right and left) knees. When the problem was unilateral, in 83.3% of the cases (n = 25 out of 30) it affected the standing leg, meaning the leg on the side of the dominant hand.

The average number of training session per week differ significantly between the players without knee problems and the sum of the players who reported only overuse syndromes, only acute injury and both (Figure 2). Precisely, the healthy players had significantly more trainings per week than the injured ones, regardless the nature of the problem. T-test for independent variables similarly showed significance in the difference between the number of training sessions per week, for each individual subgroup of players who reported some kind of knee problems (only overuse, only acute, or overuse and acute together), compared to the group of healthy players (Table 1).

The average number of training hours per week showed the same trend, but the differences where even bigger. T-test for independent samples showed statistically significant difference in the amount of training hours per week between the players without knee problems and the sum of the players who reported only overuse syndromes, only acute injury and both (Figure 3). In addition, the healthy players had significantly more training hours per week than the injured ones. T-test for independent variables showed significance in the difference between the number of training hours per week, for each individual subgroup of players who reported some kind of knee problems (only overuse, only acute, or overuse and acute together), compared to the group of healthy players (Table 2).

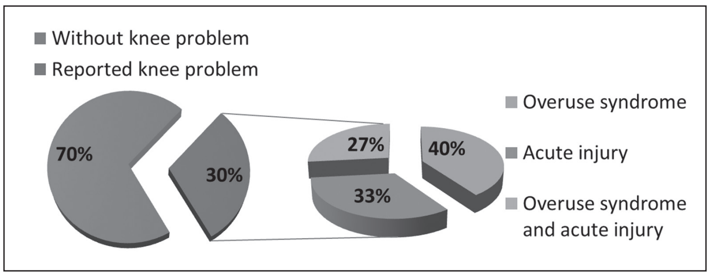

Figure 1: Percentage distribution of different knee problems.

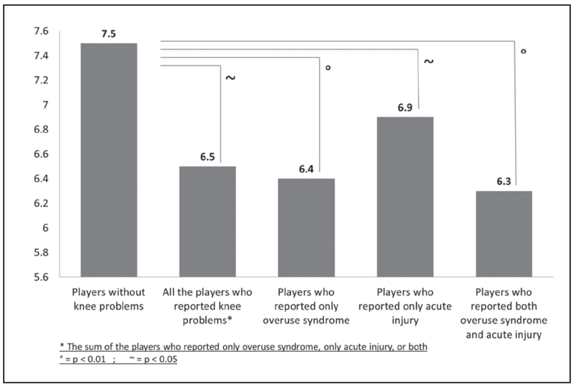

Figure 2: Differences between the number of training sessions per weak for the healthy players and the players who reported different kinds of knee problems.

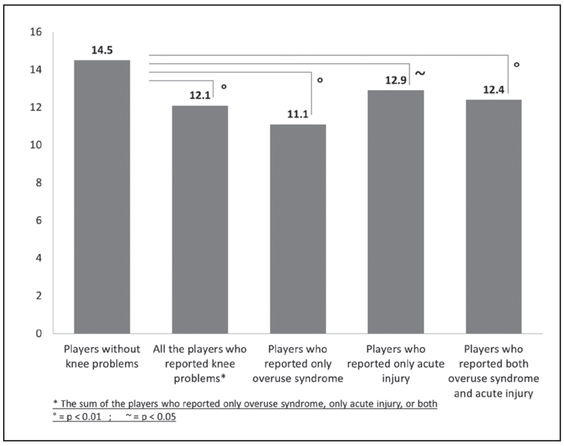

Figure 3: Differences between the number of training hours per week for the healthy players and the players who reported different kinds of knee problems.

Table 1: Difference in the number of training sessions per week, between the players without knee problems and the other subgroups, tested by means of T-test for independent samples

	Players without knee problems	All the players who reported knee problems	Players who reported only overuse syndrome	Players who reported only acute injury	Players who reported both overuse syndrome and acute injury
Average number of training session per weak	7.5	6.5	6.4	6.9	6.3
Difference between the players without knee problems and the other subgroups (p values)	-	**0.015**	**0.003**	**0.038**	**0.0003**

Table 2: Difference in the number of training hours per week, between players without knee problems and the other subgroups, tested by means of T-test for independent samples

	Players without knee problems	All the players who reported knee problems	Players who reported only overuse syndrome	Players who reported only acute injury	Players who reported both overuse syndrome and acute injury
Average number of training hours per weak	14.5	12.1	11.1	12.9	12.4
Difference between the players without knee problems and the other subgroups (p values)	-	**0.009**	**0.0001**	**0.041**	**0.004**

Discussion and conclusions

The main finding of this study is the relatively high frequency of knee problems in elite European junior badminton players and the significantly higher training load (measured in training sessions and training hours per week) in the healthy ones. A total of 71 knee injuries were collected. Almost one third of the tested players reported some kind of problems with their knees in the competitive season preceding this study. Among them, 40% complained about knee overuse syndromes, 33.3% reported acute knee injury, while 26.6% reported both. One third of the affected players had problems with both knees, while two thirds of them complained about unilateral knee problems. The majority of the unilateral knee problems were located on the side of the standing leg, meaning the leg on the side of the dominant hand.

The relatively high incidence of knee injury found in this study confirms previous knowledge (Miyake et al., 2016; Shariff, George, Ramlan, 2009; Yung et al., 2007). The knee has been reported as a frequent injury location in Hong Kong elite badminton players, with the further explanation that senior players were prone to re-injury, while juniors had a higher incidence rate of new injuries (Yung et al., 2007). The fact that an early injury (sustained by a young badminton player), may lead to recurrent injury situations in later stages of the athletes career, points out the need to lower the injury risk in young junior badminton players. The knee was the mostly injured site of the body even according to the results of a retrospective case notes review study conducted on Malaysian badminton players (Sharif et al., 2009). Investigating the pattern of 469 musculoskeletal injuries Sharif et al. (2009) also found out that, the majority of injuries (91.5%) were categorized as mild overuse injury and that approximately 60% of the injuries occurred in players younger than 20 years of age. This partially confirms the finding of our study, conducted only on junior badminton players, who reported a significant number of knee problems, and where 67% of the injured athletes reported knee overuse syndrome or both, acute and overuse problems. Overuse injuries are characterised by specific tissue damage, due to repetitive stress, without allowing time for the body to heal. Consequences of overuse injuries include loss of playing time, reduced function, psychological exhaustion, and significant pain (Hootman, Dick and Agel, 2007). Young athletes may have an increased risk for overuse syndromes because growing bones are less resistant to stress (Hootman, Dick and Agel, 2007). The obtained results and the results of previous investigations points out to the urgent need to plan and conduct specific preventive strategies aimed at diminish the growing burden of knee injury and overuse syndrome in young badminton players.

The fact that knee problems dominated on the side of the racquet hand, found in this study represent an important information and it supports the fact that preventive training protocols should focus on preparing the standing leg for specific and repeating loads in badminton. However, since specific mechanisms of ACL injuries in both legs has been described (Kimura et al., 2010), basic principles of movement functionality, stability and mobility of the whole body should not be ignored.

Another important finding is the statistically lower number of training sessions and training hours per week in the group of injured athletes. Interestingly, a similar result was found out when shoulder injury was examined on same participants (Trošt Bobić, Petrinović, Bobić, 2017). Likewise, Šeme and Kondrič found that elite Slovenian badminton players who sustained shoulder injuries trained 1.37 times less than their uninjured colleagues (652.1 hours/ year vs. 891.8 hours/year) (Šeme and Kondrič, 2013). Such result may be surprising if the training process is seen just as an intense and exhausting process. However, the quantity of training, does not entirely describe its quality. A clear limit of this study is the shortage of information about the training content. It seems that in the subjects included in this study, an addition of the training volume was protective for knee injuries. However, there is a lack of detailed training session's description (e.g. type of exercises, worm-up and recovery techniques…). Although future research must be done to elucidate the link between knee injuries in junior badminton players and their weekly training load, it seems that a higher number of training hours per week, if properly planned, may lower the risk of knee injury in junior badminton players.

In conclusion, knee overuse syndromes and injuries are becoming increasingly common in badminton players. Overuse syndromes often affects the knee on the side of the racquet hand and increased training volume, if properly planned, may be injury-protective in nature. The obtained results may be used as guidelines in planning prevention strategies, especially when working with the youngest.

References

1. Goh, S.; Mokhtar, A.H.; Ali, M.R. (2013). Badminton injuries in youth competitive players. Journal of Sports Medicine and Physical Fitness. 53(1): 65.
2. Hootman, J.M., Dick, R., Agel, J. (2007). Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. Journal of Athletic Training, 42(2):311-319.
3. Kimura, Y., Ishibashi, Y., Tsuda, E., Yamamoto, Y., Tsukada, H., Toh, S. (2010). Mechanisms for anterior cruciate ligament injuries in badminton. British Journal of Sports Medicine. 44(15):1124-7.
4. Kuntze, G.; Mansfield, N.; Sellers, W. (2010). A biomechanical analysis of common lunge tasks in badminton. Journal of Sports Sciences. 28 (2): 183.
5. Miyake et al. (2016). A Prospective Epidemiological Study of Injuries in Japanese National Tournament-Level Badminton Players From Junior High School to University. Icine, Asian Journal of Sports Medicine, Mar 1;7(1):e29637.
6. Phomsoupha, M., Laffaye, G. (2015). The science of badminton: game characteristics, anthropometry, physiology, visual fitness and biomechanics. Sports Medicine. 45: 473-495.
7. Šeme, T. i Kondrič, M. (2013). Retrospective analysis of sports injuries among Slovenian badminton players. Kinesiologia Slovenica, 19(3), 60-67.
8. Shariff, A.H., George, J., Ramlan, A.A. (2009). Musculoskeletal injuries among Malaysian badminton players. Singapore Medical Journal. 50(11):1095-7.
9. Trošt Bobić, T., Petrinović, L. and Bobić, G. (2017). Učestalost pojave bolnog ramena kod europskih juniorskih igrača badminton – implicacije za prevenciju [Frequency of shoulder overuse syndromes in European junior badminton players – implications for prevention] (in Croatian). In(ed), Zbornik radova 15. Međunarodne konferencije kondicijska priprema sportaša 2017. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
10. Yung, P.S., Chan, R.H., Wong, F.C., Cheuk, P.W., Fong, D.T. (2007). Epidemiology of injuries in Hong Kong elite badminton athletes. Research in Sports Medicine. 15(2):133-46.

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EFFECTIVENESS OF ABDOMINAL CIRCUMFERENCE ON BODY FROM INJURY POSTURE/BALANCE CONTROL AMONG SOCCER PLAYERS UNDER 21 YR.

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Abstract

Background: This study centred on Lumbar pain (LBP) as a most common musculoskeletal symptoms report by healthcare employees, according to (Alireza Choobineh, Hadi Daneshmandi, Seyed Kazem Saraj Zadeh Fard, Seyed Hamidreza Tabatabaee, 2016), due to abnormal posture, bending, twisting, gardening, and lack of exercise according tophysical sports studies. Founded on this notion, the current study was expected to determine the consequence of mechanical effects of intra-abdominal with posture/balance control among soccer players under 21 yr.

Methods: For the suggested, a total of 163 male soccer players under 21 years from the Algerian football championship involved in the current study. Their average age19,56±1.22 years, distributed into homogeneous groups, depending on their waist abdominal circumference. Controlled in Anthropometrics (Body Fat Percentage (BFP) -abdominal circumference (WC)) and Physical test -Abdominal test (Abdo) - Modified Bass Test of Dynamic Balance (DB) and standing balance (SB)).

Results: Founded on the data test and analyze statistics, we confirm:

a. The increase of Intra-Abdominal Fat accumulated in abdominal circumference (WC) represents big risk excess abdominal fat associated with limitation of their levels of physical mobility and ability.
b. Over abdominal fat record in abdominal circumference decrease,abdominal musclestrength, endurance, flexibility and balance related to Pelvic belt reinforcement levelscorrelateswith body fat exists leading to thereducedphysical performance capabilities early and to pathology posture at later.

Conclusions: Founded on the variances acquired by the search team, we climax the abdominal fat impulses conducted to the constant structural misalignment, which allows a disproportionate amount of weight and muscle traction to fall on certain parts. However, sports participation cannot guarantee physiological body mass and body composition. From the above, we commend the evaluation of abdominal string as a part of body management corresponding to Pelvic belt reinforcement related to mobility and ability of spine health and performance.

Key words: *Intra-abdominal fat, posture/balance control, players under 21 yr.*

Introduction

LBP is one of the highest commonness medical practitioners than any other musculoskeletal symptoms (Mohammad Almalki, Mohammed H Alkhudhayri, Ahmad A Batarfi, Shorowk K Alrumaihi, Shaker H Alshehri, Sami I Aleissa, Nader S Alkenani, 2016). Reported the case of sports studies as (27%)in college football players (50%) artistic gymnasts and (86%) rhythmic gymnasts (Laura Purcell, Lyle Micheli, 2009). Whileto express bad posture as one of the biggest causes of back pain (Leslie S Treas, Judith M Wilkinson, 2013), we referee to the literature which revealon one hand that the limited of body alignment function associatedwith extended periods of time jobs asfixed positions frequently (Shrawan Kumar, 2003) is at big risk for those present. Where inanother in the footballer's world, the low back injury was the most common,according to (Marianne S Gengenbach, Thomas E Hyde, 2007). Founded onthe above and the health problems indication (Morsi, Yosry S, 2015), which reports that injury of lifestyleexperience can affectthe neck and back pain (Teen-Hang Meen, Stephen Prior, Artde Donald Kin-Tak Lam, 2013), resulting in musculoskeletal disorders (Suzanne C. Martin, Mary Kessler, 2007). Confirmed byprevalence studies in significant musculoskeletal pain related to the quality of lifestyle (Jeffrey I. Mechanick, Robert F. Kushner, 2016).

The case of contact sports, repetitive flexion, extension, and torsion, whichis the most injury of low back pain in the sports practice.Although similarity sports studies show that strength, balance, and coordination appeared to be key factors in maintaining an upright posture connected to the level of athletic fitness as a protection (Marianne S Gengenbach; Thomas E Hyde, 2007). Through this View this review of the literature, the present study was envisioned to examine the impact of size abdominal circumference (WC) on musculoskeletal posture/balance control. Where our hypotheses based on similarity, which confirmed, that sports participation could not guarantee to establish the effect of physiological body mass and body composition (Pantelis Theodoros Nikolaidis, 2012), reported down to 5%BF the case of athletes to maintain or improve performance (Sharon Plowman, Denise Smith, 2008). Which request the coach to control the change in body weight growth interrelated to anthropometric measurements and their correlation with performance (Zerf Mohammed, Houar Abelatif, Mime Mokhtar, Bengoua Ali, 2016). Approves by similar studies in preserving of ideal and healthy competition body weight, subordinate to assessment programs (Vijender Sharma, 2011).

Appreciated that low back pain requires a specific program of evaluation and training.Ourscomes in this present study based on medicalperspective that to avoid the back problems (Christine Felstead, 2014), we request to prevent the excess body fat. Evidence, which requests the development of strength in the abdominal and back muscles that support the hips and spine Moreover, the aims of the actual study are to examine the significance of mechanical effects of intra-abdominal on Musculoskeletal posture/balance control among soccer players. In order to provide baseline information for future analytical studies.

Materials and methods

Study Protocol and Subjects

Protocol

This studygrounded on the indicationthat low back pain is associations with body fatness, fat distribution, and height(K. S. Clifford Chao, Smith Apisarnthanarax, Gokhan Ozyigit, 2005). Where athletes are at greater risk of sustaining a lumbar (lower) spine injury due to levels of physical activity (University of Maryland Medical Center (UMMC), 2016) injuryaslots of stress undergoes to the spine, well the absorption of pressure, twisting, turning, and even the bodily impact among the football players. Therefore, sports participation cannot guarantee physiological body mass and body composition, and it is necessary to prescribe an exercise targeting body mass and fat control according to (Pantelis Theodoros Nikolaidis, 2012).

Subjects

The subjects were 163 male soccer players under 21 years of the Algerian football championship participated in the present study. Their average age 19, 56±1.22 years distributed into homogeneous groups, according to them, abdominal circumference size WC≈≤80 and ≤80 (cm). Tested by saving tests (Body Fat Percentage-Abdominal circumference - Modified Bass Test of Dynamic Balance and standing balance). To exclude the effect of sex on data, all subjects are male. None of the subjects had historically of inscrutable visual defects, vertigo, motor paresis or sensory deficits. Participation in this study was voluntary to attend experience. Informed consent was obtained, and coaches signed a document.

Testing Protocol

Our choice is based on the indication that generally having poor posture and mechanics. The abnormal posture becomes apparent. Whereas examining posture in a static position allows an unobstructed view of all postures elements. Where the correct posture minimizes stress on muscles, bones, and joints while incorrect posture places abnormal stress on these structures (Sandra J. Shultz, PhD, ATC, CSCS, FNATA, Peggy A. Houglum, PhD, ATC, PT, and David H. Perrin, PhD, ATC., 2015).

- ✓ **Measurements of standing balance (SB)**
- • Objective

To monitor the development of the pupil’s ability to maintain a state of equilibrium (balance) in a static position. See fig 1. Shows standing balance (SB).

- **Required Resources**

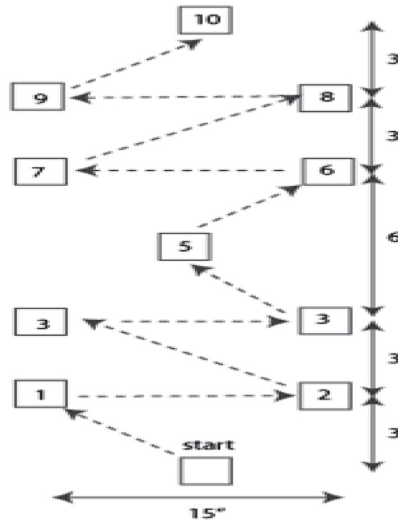
To undertake this test, you will require Warm dry location – gym, Stopwatch,and an assistant.

To conduct the test:

- The player stands comfortably on both feet with their hands on their hips.
- The player lifts the right leg, places the sole of the right foot against the side of the left kneecap and closed both eyes.
- The assistant gives the command "GO", starts the stopwatch and the player raises the heel of the left foot to stand on their toes. The player is to hold this position for as long as possible.
- The assistant stops the stopwatch when the player's left heel touches the ground or the right foot moves away from the left knee. The assistance records the time.

✓ **Modified Bass Test of Dynamic Balance (DB)**

This multiple hop test requires that 1-inch (2.5 cm) tape squares be laid out in a course as showed in figure 1. The subject is required to jump from square to square, in a numbered sequence, using only one leg. The hands should remain on the hips. On landing, the subject remains to look face straight ahead, without moving the support leg, for five seconds before jumping to the next square. See fig. 2. Shows Dynamic Balance (DB).



- Scoring: the result is recorded as either a success or failure. A successful performance consists of hopping to each tape mark without touching the floor with the heel or any other part of the body and holding a static position on each tape mark for five seconds without exposing the tape mark.

✓ **Body Fat Percentage (BFP)**

Body fat can be estimated from body mass index (BMI) in the current study. We used the formula for children: Adult Body Fat % = (1.20 x BMI) + (0.23 x Age) – (10.8 x gender) – 5.4

Using gender male= 1, female= 0. (Janjic Jelena, Baltic ZM, Glisic Milica, Ivanovic Jelena, Boskovic Marija, Popovic Milka and Lovrenovic Mirjana, 2016)(Zerf Mohammed, Houar Abelatif, Mime Mokhtar and Bengoua Ali, 2016).

✓ **Waist or Abdominal Girth**

To measure abdominal circumference, locate the upper hipbone and the top of the right iliac crest. Place a measuring tape in a horizontal plane around the abdomen at the level of the iliac crest. Before reading the tape measure, ensure that the tape is snug, but does not compress the skin, and is paral-lel to the floor. The measurement is made at the end of a normal expiration (Cheryle Hart, Mary Kay Grossman, 2008). Where waist circumference >30 inches or 76,5 cm. General: central obesity, BMI, dysmorphism (Paula J. Adams Hillard, Paula Adams Hillard, 2008).

✓ **Abdominal tests (Abdo)**

The abdominal test measures the muscular strength and endurance of the abdominal muscles and hip flexors for 1 min recording the number of repetitions practiced by the athlete (Dr. C. Ashok, 2008)(Sanjay Parashar, 2015).

Statistical Analyses

Data tests got shows, that our soccer players are distributed into two groups, according to them WC size as protocol. The total sample accepts the normal distribution and homogeneityof all variables chosen to study. Presented as a means ± standard deviation, Shapiro-Wilk and Levene test. The T-independent sample t-test was conducted to combine the results obtained from the two groups see Table 1. The relationship between the two groups was analyzed by Pearson correlations.

Results

Table 1: Shows the baseline characteristics of the sample

Variables		N	Mean±SD	Levite's	Sig.	T	P≤ 0,05
Weight (Kg)	WC≤80	94	62,73±4,68	1,47	0,72	-6,23	0,00
	WC≥80	69	68,20±6,41				
	Total	163	65,05±6,14				
Height (Cm)	WC≤80	94	177,99±4,01	1,16	0,26	6,10	0,00
	WC≥80	69	173,86±4,37				
	Total	163	176,69±4,53				
BFP (%)	WC≤80	94	11,62±1,77	0,59	0,12	-11,06	0,00
	WC≥80	69	14,94 ±2,04				
	Total	163	13,03±2,50				
WC (Cm)	WC≤80	94	77,66±1,42	1,43	0,56	-10,21	0,00
	WC≥80	69	82,84±2,37				
	Total	163	80,90±1,25				
BMI	WC≤80	94	19,86±1,52	1,22	0,22	-9,95	
	WC≥80	69	22,51±1,79				
	Total	163	20,98±2,10				
DB (sec)	WC≤80	94	4,67±0,95	1,33	0,62	11,04	0,00
	WC≥80	69	3,16±0,71				
	Total	163	4,03±1,13				
SB (Min)	WC≤80	94	2,67±0,19	1,28	0,95	12,03	0,00
	WC≥80	69	2,02±0,32				
	Total	163	2,42±0,43				
Abdo (number)	WC≤80	94	38,26±6,34	1,61	0.08	4,42	0,00
	WC≥80	69	34,05±5,50				
	Total	163	36,48±6,33				

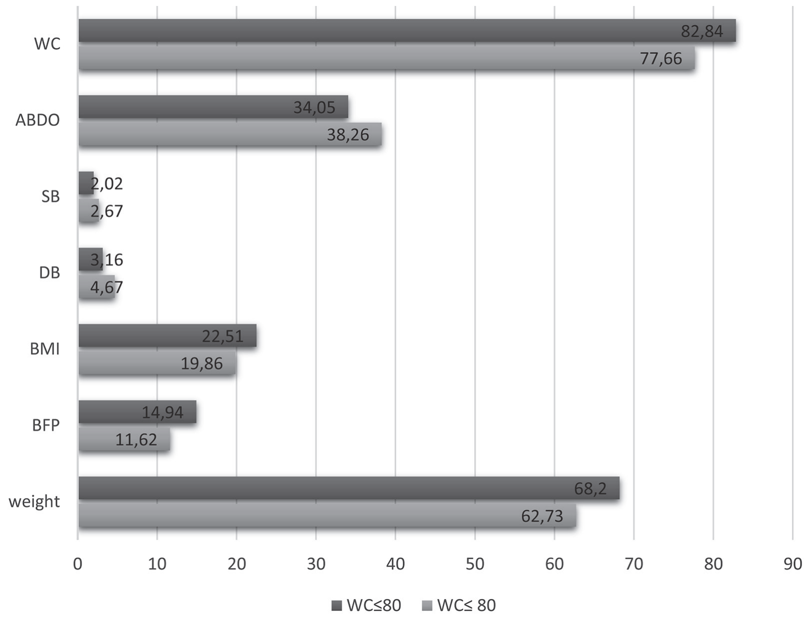
All. Independent T sample t-test analyzedpracticed are significant at $P \leq 0.05$. While in Table 2. All correlations between physical test used (both Balance tests and abdominal) and WC are a strong negative, in the opposite of anthropometrics variables and (weight-BFP-BMI) with WC. Since that we agree, that posture is the regular and balanced arrangement of skeletal componentsto maintain the body's support structures against injuries and progressive deformation (Fabris de Souza SA, Faintuch J, Valezi AC, Sant'Anna AF, Gama-Rodrigues JJ, de Batista Fonseca IC, de Melo RD, 2005). However, the function of the spine is divided between the anterior (static) and posterior (dy-namic)(David G. Borenstein, Sam W. Wiesel, Scott D. Boden, 2004), that mechanically required the intermediate of intrinsic skeletal muscles to protect the spinal column (Michael P. Burke, 2011). While the minimal muscle, strength in altered posture necessitates the dorsal muscles to improve more ef-fort to maintain the balanced position (Andersson GB, Ortengren R, Herberts P, 1977). Leading to fatigue, skeletal asymmetry, and pain corresponding to nociceptive stimuli related to extreme muscle strain to maintain posture. Long established among the literature in the significant relationship between muscle shortness, waist, thigh circumferences, and postural balance type (Ragıba Zagyapan, Cihan Iyem, Ayla Kurkcuoglu, Can Pelin, Mustafa AgahTekindal, 2012). Appropriate by the American College of Sports Medicine as strategies for Weight Loss and Prevention of Weight Regain for Adults (I-Min Lee, 2009).

Table 2: Shows the correlations between the variables and balance string lambposture

R: P≤ 0,05	BMI	BFP	WC	SB	DB	Abdo
WC	0,91**	0,82**	1	-0,88**	-0,66**	-0,51**

**. The correlation is significant at the 0.01 level (bilateral).

Discussion



Our result thought fig 1 shows that all means calculate are in the benefit of less WC according to the protocol used. Confirmed in the case of BFP according to the normsintricate by American Council on Exercise (ACE) to express the Ideal Body Fat Percentages (Lauren Jawno, Fran Schumer, 2012). Where our simple ranked between Athletes and Fitness, normal and overweight agreeing to BMI. While all comparison practiced, shows thatthe SB, DB and ABDO are in the benefits of less waist con-firmed by Independent T-test, in less BFP, BMI relative to Weight and WC correlate with achievementsof physical performance (both balance & strength abdominal).Seen these results, we agree that:

a. The increase of Intra-Abdominal Fat accumulated in abdominal circumference (WC) represents big risk posture/balance control; due to a decrease of the buttocks musclestrength which negatively affects habitually body posture and habitually locomotion according to (Luka Tunjic, 2005).

b. Over abdominal fat record in abdominal circumference leads to a reduction of physical per-formance capabilities early and to pathology later. Our results confirm thatwaist circumference and abdominal fat are associated with an increased body weight gain as arisk associated with poor balance at a higher risk of lower limb injuries (Haff, G. Gregory, Triplett , N. Travis, 2016). Record in the actual study as inverse negative correlation with aPhysical fitness test, due to upper WCcorrelate with body composition and fitness (Clemens Drenowatz, Ronald P. Steiner, Susanne Brandstetter, Jochen Klenk, Martin Wabitsch, Jürgen M. Steinacker, 2013). Revealed by World Health Organization (WHO) in the prevention of overweight and obesity (Ruth S.M Chan, Jean Woo, 2010). For that, we agree, that an upright posture (Charles B Higgins, Albert de Roos, Ovid Technologies, Inc., 2006), request control of the Body gain accumulates in abnormalities posture, which its upper leads to the decrease of muscle coordination, control of movement, balance, and awareness of body position (Sandy Fritz, 2013). Reported in present study in the case of Soccer players with a maximum body fat and a wide waist circumference are likely carrying excess abdominal fat in their abdomenassociated with limitation of their levels physical mobility and ability (Ronald Ross Watson, 2014) (Paul Insel, Don Ross, Kimberley McMahon, 2016). Whereas to prevent the phenomena of overweight/obesity in soccer players, we requestfrom coaches and fitness trainersto monitor the weight changes related to fitness and health levels (Nikolaïdis PT, 2012).

While helpingathletes'to recognizethe effect of body fatness (Melinda M. Manore, 2015) on physical fitness. We recommend, our coaches tocontrol the weight changes relative to the improvementof abdominal musclestrength, endurance, flexibility,and balance related to decreasing of body fat (Jerrold S. Greenberg, George B. Dintiman, Barbee Myers Oakes, 2004). As well asthe need of exercise ab-dominal,back and pelvicmuscles at least 30 minutes daily training program sessions, without forgetting the weight control programs.

Conclusions

Our findings support our hypothesis, that intra-abdominal is a fat body fat gain relative to large WC conducted to fatness confirmed by medical Algerian studiesamong our general population (George A. Bray, Claude Bouchard, 2014). While the current study reports, that Pelvic belt reinforcement request the measurements of intra-abdominal pressure and muscular activity. Where the increase of waist size due to Intra-abdominal fataccumulated in abdominal circumference, influence movement ability, pos-tural control capacity, conducting to weakly posture, fatigue, painful muscular tension and poor muscle tone.In conclusion, our results validate the evidence, that practice of football requires the follow-up on the progress of the players by an evaluation program, which tracks the change of the weight respectfully to levels of physical performance. Therefore, the amount of BFP related to the large WC size leads to poor posture due to Pelvic belt reinforcement fragility as well as the weakness of musculoskeletal and balance related toabdominal muscles levels strength, endurance, flexibility, and balance related to Intra-abdominal fat accumulated in abdominal circumference.

References

1. Alireza Choobineh, Hadi Daneshmandi, Seyed Kazem Saraj Zadeh Fard, Seyed Hamidreza Tabatabaee. (2016). Prevalence of work-related musculoskeletal symptoms among Iranian workforce and job groups. *Int J Prev Med, 7*, 130. Retrieved from http://www.ijpvmjournal.net/text.asp?2016/7/1/130/195851
2. Andersson GB, Ortengren R, Herberts P. (1977). Quantitative electromyographic studies of back muscle activity relatated to posture and loading. *Orthop Clin North Am, 8*(1), 85-96.
3. Charles B Higgins, Albert de Roos, Ovid Technologies, Inc. (2006). *MRI and CT of the cardiovascular system*. Philadelphia: Lippincott Williams & Wilkins.
4. Cheryle Hart, Mary Kay Grossman. (2008). *The insulin-resistance diet : how to turn off your body's fat-making machine*. New York: McGraw-Hill.
5. Christine Felstead. (2014). *Yoga for runners*. Champaign, IL: Human Kinetics.
6. Clemens Drenowatz, Ronald P. Steiner, Susanne Brandstetter, Jochen Klenk, Martin Wabitsch, Jürgen M. Steinacker. (2013). Organized Sports, Overweight, and Physical Fitness in Primary School Children in Germany. *J Obes*, 935245. doi:10.1155/2013/935245
7. David G. Borenstein, Sam W. Wiesel, Scott D. Boden. (2004). *Low Back and Neck Pain: Comprehensive Diagnosis and Management*. Philadelphia : Saunders.
8. Dr. C. Ashok. (2008). *Test your physical fitness*. Delhi : Kalpaz Publications.
9. Fabris de Souza SA, Faintuch J, Valezi AC, Sant'Anna AF, Gama-Rodrigues JJ, de Batista Fonseca IC, de Melo RD. (2005). Postural changes in morbidly obese patients. *Obes Surg, 15*(7), 1013-6.
10. George A. Bray, Claude Bouchard. (2014). *Handbook of Obesity* -- *Volume 1: Epidemiology, Etiology, and Physiopathology, Third Edition*. US: CRC Press.
11. Haff , G. Gregory, Triplett, N. Travis. (2016). *Essentials of strength training and conditioning*. Champaign, IL: Human Kinetics.
12. I-Min Lee. (2009). *Epidemiologic Methods in Physical Activity Studies*.Oxford; New York: Oxford University Press.
13. Janjic Jelena, Baltic ZM, Glisic Milica, Ivanovic Jelena, Boskovic Marija, Popovic Milka and Lovrenovic Mirjana. (2016). Relationship between Body Mass Index and Body Fat Percentage among Adolescents from Serbian Republic. *Journal of Childhood Obesity, 1*(2:10), 1-5.
14. Jeffrey I. Mechanick, Robert F. Kushner. (2016). *Lifestyle Medicine: A Manual for Clinical Practice*. UK: Springer Shop.
15. Jerrold S. Greenberg, George B. Dintiman, Barbee Myers Oakes. (2004). *Physical Fitness and Wellness: Changing the Way You Look, Feel, and Perform*. UK: Human Kinetics.
16. K. S. Clifford Chao, Smith Apisarnthanarax, Gokhan Ozyigit. (2005). *Practical essentials of intensity modulated radiation therapy*. Philadelphia: Lippincott Williams.
17. Laura Purcell, Lyle Micheli. (2009). Low Back Pain in Young Athletes. *Sports Health, 1*(3), 212-222. doi:10.1177/1941738109334212
18. Lauren Jawno, Fran Schumer. (2012). *Change4good : ten essentials for food, fitness and the good life*. Bloomington: Authorhouse.
19. Leslie S Treas, Judith M Wilkinson. (2013). *Basic Nursing: Concepts, Skills, & Reasoning*. USA: F.A. Davis.
20. Luka Tunjic. (2005). *Obesity, Gravity, Strength and Balance*. US: Lulu Enterprises Inc.
21. Marianne S Gengenbach, Thomas E Hyde. (2007). *Conservative management of sports injuries*. Sudbury , Toronto: Jones and Bartlett Publishers.
22. Marianne S Gengenbach; Thomas E Hyde. (2007). *Conservative Management of Sports Injuries*.Sudbury ; Toronto: Jones and Bartlett Publishers.
23. Melinda M. Manore. (2015). Weight Management for Athletes and Active Individuals: A Brief Review. *Sports Med, 45(Suppl 1)*, 83-92. doi:10.1007/s40279-015-0401-0

24. Michael P. Burke. (2011). *Forensic Pathology of Fractures and Mechanisms of Injury: Postmortem CT Scanning.* US: CRC Press.
25. Mohammad Almalki, Mohammed H Alkhudhayri, Ahmad A Batarfi, Shorowk K Alrumaihi, Shaker H Alshehri, Sami I Aleissa, Nader S Alkenani. (2016). Prevalence of low back pain among medical practitioners in a tertiary care hospital in Riyadh. *Saudi J Sports Med, 16*, 205-9. doi:http://www.sjosm.org/text.asp?2016/16/3/205/187556
26. Morsi, Yosry S. (2015). *Optimizing Assistive Technologies for Aging Populations*. USA: IGI Global.
27. Nikolaïdis PT. (2012, Nov-Dec). Physical fitness is inversely related with body mass index and body fat percentage in soccer players aged 16-18 years. *Med Pregl, 65*(11-12), 470-5. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/23297612
28. Pantelis Theodoros Nikolaidis. (2012). Elevated Body Mass Index and Body Fat Percentage Are Associated with Decreased Physical Fitness in Soccer Players Aged 12–14 Years. *3*(3), 168-174. doi:PMCID: PMC3445644
29. Paul Insel, Don Ross, Kimberley McMahon. (2016). *Nutrition*. Sudbury: Jones & Bartlett Learning.
30. Paula J. Adams Hillard, Paula Adams Hillard. (2008). *The 5-minute Obstetrics and Gynecology Consult*. Philadelphia: Lippincott Williams & Wilkins.
31. Ragıba Zagyapan, Cihan Iyem, Ayla Kurkcuoglu, Can Pelin, Mustafa Agah Tekindal. (2012). The Relationship between Balance, Muscles, and Anthropomorphic Features in Young Adults. *Anat Res Int*, 146063. doi:10.1155/2012/146063
32. Ronald Ross Watson. (2014). *Nutrition in the prevention and treatment of abdominal obesity.* Burlington: Elsevier Science.
33. Ruth S.M Chan, Jean Woo. (2010). Prevention of Overweight and Obesity: How Effective is the Current Public Health Approach. *Int J Environ Res Public Health, 7*(3), 765-783. doi:10.3390/ijerph7030765
34. Sandra J. Shultz, PhD, ATC, CSCS, FNATA, Peggy A. Houglum, PhD, ATC, PT, and David H. Perrin, PhD, ATC. (2015). *Excerpts the Correctly examine posture*.http://www.humankinetics.com/excerpts/excerpts/correctly-examine-posture: Human Kinetics.
35. Sandy Fritz. (2013). *Sports & exercise massage : comprehensive care in athletics, fitness & rehabilitation*. St. Louis, Mo: Elsevier Mosby.
36. Sanjay Parashar. (2015). *Art of Abdominal Contouring: Advanced Liposuction*. Place of publication not identified: Jaypee Brothers Medical P.
37. Sharon Plowman, Denise Smith. (2008). *Exercise Physiology for Health, Fitness, and Performance*. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins.
38. Shrawan Kumar. (2003). *Advances In Industrial Ergonomics And Safety IV.* USA: CRC Press.
39. Suzanne C. Martin, Mary Kessler. (2007). *Neurologic Interventions for Physical Therapy.* Edinburgh: Elsevier Saunders.
40. Teen-Hang Meen, Stephen Prior, Artde Donald Kin-Tak Lam. (2013). *Innovation, Communication and Engineering.* USA: CRC Press.
41. University of Maryland Medical Center (UMMC). (2016). *Low Back Pain in Athletes*. Maryland: University of Maryland Medical Center. Retrieved from http://umm.edu/programs/spine/health/guides/low-back-pain-in-athletes
42. Vijender Sharma. (2011). *Principles and Methods of Teaching.* UK: Sports Publications.
43. Zerf Mohammed, Houar Abelatif, Mime Mokhtar and Bengoua Ali. (2016). Height versus Weight which Cassel Parameter Determine Pulmonary Functions Fitness among the Algerians Soccer Players. *J Pulm Respir Med, 6*, 353. doi:10.4172/2161-105X.1000353
44. Zerf Mohammed, Houar Abelatif, Mime Mokhtar, Bengoua Ali. (2016). Traditional versus scientific method: the differences exist between selecting players. *JPES, 16 Supplement*(1), 673 - 678. doi:10.7752/jpes.2016.s1108

SENIOR FITNESS TEST BEFORE INTENSIVE DANCE-EXERCISE INTERVENTION FOR HEALTHY SENIORS AND PATIENTS WITH MILD COGNITIVE IMPAIRMENT

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Purpose: Alzheimer's disease (AD) is the major cause of dementia in seniors. Pharmacological disease-modifying treatment is not available, and increasing attention is thus being given to non-pharmacological approaches.

Methods: The aim was to compare the input information of two test groups using Senior Fitness Test – healthy seniors (HS) and patients with mild cognitive impairment (MCI) in AD. The intention of the project is to develop a structured dance-exercise protocol for healthy and evaluate its effect of motor abilities in these populations. Study was performed in 19 subjects. Half of each group will undergo a 6-month dance-exercise intervention (a total of 50 training units, each lasting for 60 min, with innovative dance choreography); the second half will be a control (life as usual) group.

Results: The difference between MCI group and HS group was not significant. Both groups achieved similar results in three senior fitness tests.

Conclusion: results confirmed the similarity of the two groups before the planned intervention program. References: References: Rikli, R. E., and C. J. Jones, 2013, Senior Fitness Test Manual, Human Kinetics. Rektorová I (2012a) Nová klinická kritéria pro diagnostiku Alzheimerovy nemoci po 27 letech. Neurologie pro praxi 13: 68-71. Keogh JW, Kilding A, Pidgeon P, et al. (2009) Physical benefits of dancing for health older adults: a review. J Aging Phys Act 17:479-500.

***Key words**: Alzheimer's disease, healthy senior, Senior Fitness Test, dance*

THE POSSIBILITIES OF MOVEMENT THERAPY WITH ONCOLOGICAL PATIENTS

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Abstract

A growing number of studies confirm the benefits of regular movement for oncological patients. Regular and long term physical activity improves not just their physical condition, it also raises the ration of muscular matter, enhances the resistance to stress, and it positively lowers the occurrence of fatigue syndrome, which is in the studies of oncological patients stated to be present in 70 – 100% cases in the course of treatment (Radbruch, et. al., 2008). The objective of our article is to submit our experience with creating movement intervention program (MIP) and using it as the movement therapy for hemato-oncological patients and patients with breast cancer. We have been applying the movement therapy with these patients for the last 4 and 3 years respectively. In this article, we will submit our experience with the methodics of MIP and we will describe the specification of the physical activities (PA), which are suitable and which are not suitable for these patients. We are continuing with this program and we are searching for the possibilities of cooperation with insurance companies, who could support the movement therapy of oncological patients after their treatment.

Key words: *movement intervention program, hemato-oncological patients, breast cancer, PA specification, PA methodics*

Introduction

A growing number of studies confirm the benefits of regular movement for oncological patients. Regular and long term physical activity improves not just their physical condition but it also raises the ratio of muscular mass of the body. Furthermore, it also enhances the resistance to stress, and it positively lowers the occurrence of fatigue syndrome, which is in the studies of oncological patients stated to be present in 70 – 100% cases in the course of treatment and 30 – 75% for months and years after finishing the therapy (Radbruch L., et. al., 2008). Practically, it is possible to use regular PA mostly as a supplement therapeutic method. The advantage of physical exercise is, that if the parameters are well indicated and chosen, it has a positive influence to the disease and its treatment consequences to the organism, and at the same time it can lead to saving costs of further treatment. The objective of our article is to submit some recommendations for creating the MIP for hemato-oncological patients and the patients with breast cancer. We will be looking at the specification of the individual PA in the lesson in detail.

The intervention program for the hemato-oncological patients has been realized for the last four years, in cooperation between the Faculty of Sports Studies of Masaryk University and the Hemato-oncological Department of the Brno Faculty Hospital. The program for the breast cancer patients has also been continuing at the Faculty of Sports Studies for the last three years in cooperation with the Masaryk Oncological Institution in Brno.

Excursion into the Theory

With the recently growing interest for rehabilitation treatment following cancer therapy, some authors are using the condition training as a part of the preventive measures for the indicated patients already during their chemotherapy (Dimeo et al., 1997). According to the NCCN Fatigue Practice Guidelines the patient should start regular exercising already during the time of starting the cancer treatment. The benefits of aerobic exercise to the quality of life of the patient, with the elimination of the fatigue syndrome, have been proved in the clinical practice mostly with the adult population (Davies N. & Thomas R., 2007). The benefits of the physical activity were verified and confirmed with patients with breast cancer not only after finishing their treatment within the framework of rehabilitation, but also already in the course of the treatment itself (Knols et al., 2005). What can also be of benefit for these patients is including a moderate aerobic exercise program already in the early phases of their treatment. It improves their physical, functional and social comfort, it lowers the symptom of anxiety and it improves their perception of the fatigue syndrom. (Knols et al., 2005). The advantages for the quality of life and longevity coming out from raising the physical activity can change with respect to the type and stage of cancer, medical treatment, and the current lifestyle of the patient. The influence of the physical exercise was researched even during high dosages of chemotherapy, radiotherapy and bone marrow transplant (BMT), during the chemotherapy after the transplant of the stem cells of the peripheral bone (PBSCT) and immediately after a bone marrow transplant. There were positive results recorded in the body composition (the overall weight, the body mass index, the weight of fat, amount of water in the body, overall energy output, muscle power, functional speed of eliminating creatinine, neutropenia, haemoglobin) (Knols et al., 2005). Also Hayden et al., (2006) point out physical activity in connection with the colorectal carcinoma, where the studies showed a smaller risk of about 40-50% compared to patients who lead a sedentary way of life.

In adult oncological patients, physical activity (PA) and fitness have been repeatedly shown to correlate with and improve many mental and physical measures, including decreased cancer recurrence and mortality. At baseline and after 6 months, we measured aerobic fitness by cardio-pulmonary exercise testing; body composition and bone density and health-related quality of life (Azar et al., 2013).

The Objective

The main objective of the movement intervention program is the stabilization and rising of the level of physical fitness, stopping the loss of muscle mass, the development of individual physical skills, and the resocialization of the individual as a consequence of the disease and treatment of the patients diagnosed with cancer. At the same time, the physical program is focused on the psycho-social part of the physical activity, where the exercises chosen are introduced in such a way, that there is an improvement in the quality of life and self-conception of the people, their self-confidence grows and they are creating positive mental aspects towards movement.

The Methodics of Creating a Movement Intervention Program

Before starting the MIP we first find out through group and individual interviews, what are people's expectations and their self-conception and attitude to the program. Most of them speak about the feeling of weariness, fear of the unknown and the reaction of their organism to the physical exercise; however they simultaneously speak of great willingness to get actively involved in the program (Svobodova et al., 2014). The intervention movement program for oncological patients is worked out and realized based on medical recommendations obtained about the oncological patients and on the individual lecturer's experience. In our intervention program are involved mostly clients after treatment, or those who are undergoing less radical medical procedures. All the clients have gone through a stress test before being involved in the program, and they went through the analyses of their body composition with the aid of the In Body machine. This measurement is always repeated after 3-6 months of the intervention program for verifying the influence of the physical activities. One exercise unit takes 60 minutes and the instructors keep a detailed record of the progress of the exercise unit. We observe the level of physical exertion from the point of view of heart rate, which is recorded by personal sport testers (ST polar RS 100, RS 300X) and also obtained from questioning the subjective perceived exertion according to the Borg scale. We select the PA in such a way that they are beneficial for the organism and not an unnecessary overload. The objective is raising the heart and pulmonary activity, for which it is necessary to include a sufficiently high intensity of exercise – heart rate during the exercise has to move between 60-90% of the maximum heart rate. We also recommend the patients to do outdoor activities such as walking, mountaineering, cross-country skiing, fartlek running, cycling, rowing, walking up the steps, swimming and some other activities as additional forms of exercise.

The MIP exercise lesson structure – We put the exercise lessons together according to general and usual rules, so that it always contains the introductory, main and the final parts. These three parts should always be kept no matter what exercise program it is (Svobodova et.al, 2014).

In the **introductory** part we always set and check the heart rate recording machine and we introduce them to the objective and the structure of the lesson. We devote a sufficient amount of attention to this part so that we motivate the patients; we include warming up activities and dynamic warming up exercise. In the **main** part we include mostly aerobic physical activities for improving the physical condition, which is the main objective of the IP. The intensity of the physical exercise usually has the character of interval training, and it depends on the current level of fitness of the individual. The **final** part is about a gradual calming down, relaxing the neuromuscular tension and relaxing the fascial network. We are using compensation, breathing and relaxation techniques.

Specification of the physical activities – the cardio training – for our program we chose the *SPINNING* exercise program as the major aerobic exercise for the cardio training. During a demanding ride, the body metabolism starts working in an anaerobic way, and the HR raises. In our case, the patients get to such situations very rarely, thanks to the checking of their sport testers, which are set up for everyone in a tailor made way by a doctor, who did the entrance exam. All of them have the minimum and maximum level of intensity of HR set. In the cardio zone we also use the *CROSSTRAINER* which simulates walking, *STEPPER* which simulates walking up the steps, *TREADMILL* – a running simulator and *ROWING* – a rowing simulator.

Outdoor walking – hiking up to 20 km. We chose the routes not only according to their length, but also according to the degree of incline which we have in this route. **Fartlek** – is one of the methods of a runner`s training, which we include in our MIP. **Circuit training** – it is an interval training, where we are selecting the alternation of the muscle groups used at the various stations, which are organized in a circle. The transitions between the stations are done dynamically and continuously. We use various tools for exercising at the stations such as weights, expanders, overballs, medicine balls, steps, bosu, fitballs and skipping ropes. **Tabata** – is an interval cardiovascular training, which proved to improve the performance in a very short time – 14 minutes. **Dancing, Zumba, Movida** – we include simple dancing elements focused on different types of natural movement to music. The objective is to gradually develop skills of movement in harmony with the music, for the people to become aware of their body and feelings. **Shaking** – is according to Svobodova et.al. (2014) a simple alternative to a cardio exercise in a faster rhythm. It involves the shaking movement of the whole body or some parts of the body. The patients reach their recommended HR in a relatively short time. **Body styling** – is another activity that we can include in a simple choreography. It is a combination of aerobic and bodybuilding focused on forming muscle groups of the whole body. **Bosu** – is a balancing tool (BOSU® Balance Trainer) specifically designed to help you reach better muscle balance more quickly, safely and in a more complex way than with any other training tool of its kind.

The specification of the physical activities – slow forms. Body and mind – is about correct breathing and including the whole body while moving. During these lessons we use mostly slow forms of exercise such as yoga, balance training, stabilization and relaxation exercises, where it is possible to concentrate on a conscious experience from the movement, and the mutual influence of the movement and the mental level. **Spiral stabilization** – also surely belongs to this category. It is an original method designed for functional stabilization and mobilization of the spine. It involves exercises with an elastic rope, where if you do the exercise well, the muscle spiral chains are activated, and by that the stability of the spine is optimized. This method also has a positive influence on the function of the inner organs. (Smíšek, 2009). This activity is suitable for patients with breast cancer, if you set up a minimum rope tension. **Balance exercise** – is focused at connecting balance and mobilization exercises and proper body posture. We gradually include balance exercises while standing, sitting and lying on various balancing tools (BOSU®, other balancing pads, foam rollers, overballs and fitballs). **Pilates** – an exercise program for the deep muscle system of the core of the body, healthy spine, joints and perfect coordination. **Yoga** – focused to the harmonization of the movement system and mind, relaxing stiff muscles and joints, lowering stress and mental tensions. **Compensation exercises –** ***stretching exercises*** – we include static stretching (passive stretching) and the methods of post-isometric relaxation (PIR) while keeping necessary didactic rules. **Relaxing and breathing exercises** – using the methods of local and overall relaxation and the auto massage of arms using simulation balls and massage hedgehogs.

The specification of the physical activity for the hemato-oncological patients and the patients with breast cancer

Apart from the above mentioned PA we also include sport games such as volleyball and badminton for the **hemato-oncologial patients.** Badminton is popular because it is simple, as well as table tennis. After handling the basic playing activities, everyone can get involved in the game. We recommend including sport games – badminton, table tennis and volleyball – into the physical program for these patients in the phase of developing their condition. When choosing the sport, it is also necessary to assess the person`s technical playing skills. Taking part in the sport games definitely contributes to having a different experience of movement, it brings the feeling of belonging to a group, it supports creating closer relationships among the participants and therefore it raises the feeling of trust in the group. For the hemato-oncologial patients we do not recommend physical activities in water, because of the danger of getting too cold and the danger of bacterial infection.

We have to carefully select the physical activities in the framework of the rehabilitation for the **patients with breast cancer**. In these cases, the lymphatic glands are usually removed. When choosing the exercises, we have to take into consideration some specifics, so that the arms are not loaded in an unsuitable way, and that it does not cause a lymphatic edema (lymphoma). The objective of the MIP with this group of patients is not just raising their physical condition, but also the prevention of the lymphoma of the arms and the syndrome of a frozen shoulder. Based on our lecturer`s practice we do not recommend the basic positions such as kneeling on all fours, the push up position; and from the exercises it is the push-ups and lifting weights above your head which is not recommended. We recommend swimming and AQUA Fitness in water for the water massage of the lymphatic system and the movement with the elevation in the water, which has a positive influence on the return to the original physical and mental condition. We do not recommend sport games such as table tennis, badminton, volleyball, etc. for this diagnosis, because of the overload of the arms.

Conclusion

In our MIP we put emphasis on the succession, both in quantity and quality, of the selection of the PAs. At the beginning we look for an optimum load and we observe especially the parameters oriented at aerobic fitness, the growth of muscles and the overall flexibility. It is necessary to differentiate the structure of the exercise unit and the structure of the physical activity according to the individual diagnosis of the patient, the age, sex, current health state and mental condition. The objective of each exercise unit is to adapt the individual to the physical load and to make him perceive the mental and social aspects of the movement. We also consider as very beneficial the socio-psychological influence of the lessons to the patients and their subjective experience. Their quality of life is improving. First as a result of the movement itself, and secondly because of their feelings that they are getting better, which they can see on the increased load, raising the number of repetitions or in a more complex choreography. A great benefit is coming from being together with people with a similar diagnosis, but not in a hospital environment. Regular physical activity clearly enhances their positive thinking in the fight with the insidious disease.

We are continuing with this program and we are searching for ways of cooperation with the insurance companies, who could support the movement therapy of oncological patients after their treatment.

References

1. Azar, M., Reuveny, R., Yalon, M., Koren, A., &Constantini, N. (2013).*The Effect of Physical Activity on the Mental and Physical Health of Childhood Cancer Survivors*. British Journal of Sports Medicine, 47(10).
2. Davies. N, Thomas, R. (2007). *Lifestyle During and After Cancer Treatment*. Clinical Oncology; 19:616-627.
3. Dimeo, F. C., Tilmann, M. H., Bertz, H., Kanz, L., Mertelsmann, R., & Keul, J. (1997). *Aerobic Exercise in the Rehabilitation of Oncological Patients after High Dose Chemotherapy and Autologous Peripheral Stem Cell Transplantation*. Cancer, 79(9), 1717-1722.
4. Haydon, A. M., MacInnis, R. J., English, D. R., & Giles, G. G. (2006).*TheEffect of Physical Activity and Body Size on Survival after Diagnosis with Colorectal Cancer*. Gut, 55(1), 62-67.
5. Knols R., & Aaronson K. L., &Uebelhart D., &Fransen J. &Aufdemkampe G. (2005). *Physical Exercise in Oncological Patients During and After Medical Treatment: A Systematic Review of Randomized and Controlled Clinical Trials*. Journal of Clinical Oncology, vol. 23 (no. 16).doi: 10.1200/JCO.2005.02.148
6. Radbruch, L., Strasser, F., Elsberg, F.et. al.(2008). *Fatigue in Palliative Care Patients – an EAPC Approach*. Paliative Medicine: 22:13-32.
7. Smíšek, R., Smíšková, K., &Smíšková, Z. (2009).*Spiral Stabilization of the 12 Basic Exercises: Treatment and Prevention of Back Pain Using the SM-System: Functional Stabilization and Mobilization of the Spine*. R. Smíšek.
8. Svobodova, Z., Malá, A., Adámková, R., Dovrtělová, L., Hrouzek, M., Janíková, A., & Vodička, T. (2014*). Physical Activities Program Suitable for Hemato-oncological Patiens – A Pilot Study*. At the 7th International Scientific Conference on Kinesiology (p. 107).
9. Pokorná, A., Střeštíková R.. Intervention Exercise Program for Oncological Patients with Breast Cancer. *Clinical oncology*, Ambit Media a.s., 2016, Year 29/2016, No. 6, s. 461-462. ISSN 0862-495X

THE EFFECT OF LIGHT EXERCISE ON THE CEREBRAL HAEMODYNAMICS AND COGNITIVE PERFORMANCE OF INDIVIDUALS AFFECTED BY A STROKE

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Purpose

While there is evidence of differences in cerebral haemodynamics and cognitive performance between stroke patients and both elderly and young healthy individuals, no research have examined changes in cerebral haemodynamics and cognitive performance during exercisein stroke patients. This study aimed to determine whether light intensity exercise has similar effects on the cerebral oxygenation and cognitive task performance of stroke patients and healthy age-matched individuals.

Methods

Thirty two men and women (52 to 85 years), of which 14 were stroke patients and 18 were healthy age-matched controls, volunteered for this study. The post-event period for the stroke patients was 14.8 $\pm$ 6 months and 11 of the 14 patients had left hemisphere damage. Each participant was required to attend one testing session where measurements of cerebral haemodynamics were obtained via near-infrared spectroscopy (NIRS). NIRS monitoring was done at rest, while the participant performed the modified Stroop Task and during a six minute walk test (6MWT). Cohen's effect sizes (d) were calculated to compare the magnitude of difference between groups.

Results

A decrease in O_2Hb levels was observed after exercise in the experimental group during both the simple and complex tasks (-15.4 $\pm$ 0.6 vs -8.33 $\pm$ 0.5µMol), while the control group had higher oxygenation levels during both tasks (2.78 $\pm$ 0.3 vs 16.7 $\pm$ 0.5µMol). Practically significant lower O_2Hb values were observed in the left prefrontal cortex of the stroke patients compared with the controls (ES = 0.4). After exercise, reaction (RT) on the simple cognitive task improved in both groups from resting levels (1.37 $\pm$ 0.2s vs 0.96 $\pm$ 0.1s; ES = 0.4), while performance was worse on the complex task in stroke patients, but not controls (-0.81 $\pm$ 0.1s vs 1.27 $\pm$ 0.2s; ES = 0.6).

Conclusions

Cerebral oxygenation was dependent on the complexity of the cognitive task and was blunted in stroke patients. While light exercise had a positive effect on cognitive task performance in both groups, it had a negative effect on the stroke patients during the complex task; this finding may suggest neural fatigue because of a delayed haemodynamic response or a reduction in regional cerebral blood flow.

LOW BACK PAIN IN FEMALE VOLLEYBALL PLAYERS OF THE FIRST CROATIAN NATIONAL LEAGUE

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Abstract

Backgroud: Recent investigations pointed out that overuse syndromes are becoming increasingly common in volleyball players, however, the specific epidemiology of overuse syndromes especially of low back pain in volleyball players remains poorly understood. The aim of this study was to estimate the frequency of low back pain in Croatian elite female volleyball players and to relate these findings with their specific playing role on the court.

Methods: The study was carried out on a sample of 75 female volleyball players competing in nine clubs of the first Croatian national league. The players were tested during competitive seasons 2011/2012 and 2012/2013. Participants fulfilled a previously validated questionnaire, covering the information about their low back pain. Mean number and percentages of low back pain were calculated. The significance of differences in the total number of lumbar pain problems between five playing roles was tested by means of a Chi-square test.

Results: The results showed that 48% of the tested players had felt pain in the lumbar spine in the last two competing seasons, and this pain was strong enough to interfere with their volleyball routine in 50% of them. Despite the wide number of low back pain complains registered in the receiver/attackers subgroup, the total amount of back problems did not differ significantly between players with different court specialties.

Conclusions: Specific training strategies, aiming at strengthening the lumbar stabilizing muscles as well as at acquiring a good spiking technique, should be implemented in order to prevent low back pain in elite female volleyball players.

Key words: *overuse syndromes, volleyball, low back pain*

Introduction

Volleyball is the most widespread team sport in the world and this fact is demonstrated by the highest number of national federations (221). Likewise, it is one of the most popular sports in Croatia, especially in female competitions. With regard to the specificity of volleyball (high number of repetitions of certain explosive and dynamic structures), it seems logical that there is a certain number of injuries which are caused by the mentioned activities (Janković et al., 2009.). In terms of injury incidence, volleyball is a rather safe sport when compared with other team sports. This was confirmed by the research data published on the incidence of injuries in different sports during the Olympic games in Athens in 2004, Beijing in 2008 and London in 2012 where volleyball demonstrated the lowest injury incidence out of all team sports (Jung et al., 2006 and 2008, Engebretsen et al., 2012). The highest number of injuries in volleyball takes place during landings, whereas up to 70% of injuries occurs during blocks and smashes (Watkins and Green, 1992), two technical-tactical elements which are typical in volleyball and represent outperforming the opponents in order to score a point over the net. According to Pećina et al. (2004), chronic damage of the locomotor system resulting from sports and recreation are the result of long-term and repeated micro traumas which lead to tissue overstraining. One of the three most common chronic injuries in volleyball is lower back damage. Specializing for separate playing positions within a volleyball team also includes special tasks for each of those positions. As these special tasks are specific for each position, the assumption can be made that injuries can also be specific (Briner & Benjamin, 1999). Volleyball theory and practice distinguish 5 playing positions. The SETTER (team “playmaker”) is in charge of precise and tactically reasonable ball distribution for the hitters. OUTSIDE HITTERS (primarily offensive players) are most often the best and most versatile players who get the most passes. The OPPOSITE has a double role which integrates both defensive (serve reception and defence) and offensive (smashes and counterattacks) tasks during the game. The MIDDLE BLOCKER has the primary task to block hits in the middle of the net in zone 3 and assist in blocks to the right and left with the sideline blockers; he attacks the opponents with fast set balls (“first tempo”). The LIBERO is a player specialized for defensive tasks - serve reception and defence. He most often takes the place of the central players who are substituted from the game after a serve and a lost point; this player is not allowed to smash, block or serve. However, the frequency and location of low back pain in elite female volleyball players remains poorly understood. To plan effective preventive training for female volleyball players, their specific epidemiology of injuries must be taken in consideration. The aim of this study was to estimate the frequency of low back pain in Croatian elite female volleyball players and to relate these findings with their specific playing role on the court. The obtained results may facilitate future planning of preventive strategies and lower the rate of low back pain in elite volleyball players.

Methods

This retrospective epidemiology study was carried out on a sample of 75 female volleyball players competing in nine clubs of the first Croatian national league. The players were tested during competitive seasons 2011/2012 and 2012/2013. Their average age was 21 years, with the youngest being 15, and the oldest being 33. Their average high was 179.85 cm (min. 164 cm – max 193 cm), while their average weight was 68.4 kg (min. 52 kg – max 85 kg). Participants fulfilled a previously validated questionnaire, covering the information about their overuse syndromes in the lower back. The questions covered variables like frequency of the symptoms in the last month. Questions covering variables like graduated pain condition (1-5) and difficulties to perform specific volleyball techniques (1 to 5) was also asked. General data about the participant's activity (i.e. hours of training per week), dominant arm and preferred leg was also gathered. All participants gave their written consent before participating in the investigation. Mean number and percentages of low back pain were calculated. The significance of differences in the total number of low back pain between five playing roles was tested by means of a Chi-square test. The graphs were prepared in Microsoft Excel.

Results

The tested female volleyball players where all playing the highest Croatian National league, with an average volleyball experience of 9.29 years (SD ±3.87 years). They had an average of 5.53 training sessions (SD ±1.69 training), and an average of 10.74 training hours per week (SD±4.18 hours). Their average number of played competitions in the two seasons of the study was 51.57 games (SD ±24.99 games). During the two seasons of this study, they had an average of 60000 training hours and 4566 competing hours. The results showed that in the testing period, 48% (a total of 36 out of 75 players) of the players had felt pain in the lumbar spine, and this pain was strong enough to interfere with their volleyball routine. The affected players complained that their back pain hampered them in several volleyball elements. They mostly complained about back pain symptoms during spiking (22 players) and overhead passing (13 players), while the complains during blocking, defence, underhand passing and serving where less frequent (8, 7, 6 and 3 player`s complains respectively). Percentages values are presented in Figure 1. It is important to point out how half of the players who reported low back pain were forced to pause from training for a short period of time, because of the exacerbating symptoms.

For what concerns the playing roles, the most affected players where the receiver/attackers (14/26 – 58%), followed by the middle blockers and the setters (8 and 6 players respectively). Only four diagonal players and libero complained about back pain. Despite the wide number of low back pain complains registered in the receiver/attackers subgroup, the total amount of back problems did not differ significantly between players with different playing specialties (Figure 2 and Table 1).

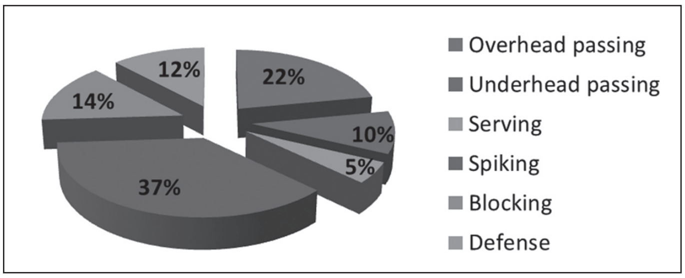

Figure 1: Percentage of player`s low back pain complains per specific volleyball techniques.

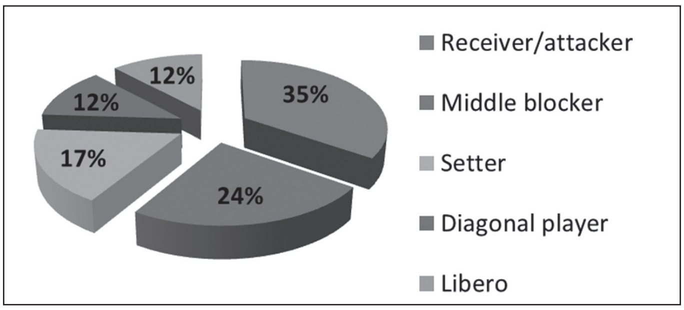

Figure 2: Percentage of low back pain according to the player's volleyball roles.

Table 1: Differences between the total numbers of low back pain between five playing roles, tested by means of a Chi-square test.

Playing role		Low back pain		
		Yes	No	Total
Setter (n=13)		6	7	13
	% of LBP	46.2%	53.8%	100%
Diagonal player (n= 9)		4	5	9
	% of LBP	44.4%	55.6%	100%
Middle player (n=18)		8	10	18
	% of LBP	44.4%	55.6%	100%
Receiver/attacker (n=26)		14	12	26
	% of LBP	53.8%	46.2%	100%
Libero (n=9)		4	5	9
	% of LBP	44.4%	55.6%	100%
Total (n=75)		36	39	75
	% of LBP among all the players	48.0%	52.0%	100%
Pearson Chi-Square	**.556**	**4**	**.97**	
Nominal by Nominal	**Phi**	**.09**	**.97**	
	Cramer`s V	**.09**	**.97**	
LBP: low back pain				

Discussion and conclusions

This retrospective epidemiology study showed a relatively high frequency of low back pain in Croatian elite female volleyball players. Low back pain pain was registered in 48% of the tested players. The relatively high frequency of lumbar pain found in this study confirms the results of previous studies done on university students participating in volleyball as well as on elite beach volleyball players (Noormohammadpour et al., 2016; Külling et al., 2014). Recently, Noormohammadpour et al. (2016), in their retrospective study, registered a one year prevalence of 40% of low back pain on a sample of 114 female volleyball players participating in the National Sports Olympiad of Female University Students in Shahrekord, Iran. Külling et al. (2014), in their MRI investigation of the lumbar spine of 29 professional beach volleyball players (mean age of 28 years old), found a high 79% of disc degeneration, and 21% of spondylolysis, which was up to three times higher compared with the age-matched control population. However, in their study MRI findings did not correlate with subjective perception of low back pain, suggesting that MRIs findings in athletes have to be interpreted with caution. In our investigation, the players who mostly complained about low back pain were the receiver/attackers, followed by the middle blockers and the setters, while only few diagonal players and libero complained about it. The most likely cause of reported pain in the lower back of the receiver/attackers is lying in the frequent jumps and landings and in specific movements of the trunk that are characteristic for the preparatory phase during spiking and jump serving (Mroczek et al., 2014). This player's tasks often integrate serve receptions and smashes. After taking a middle or low-to-the-floor volleyball stance in which he receives the serve, this player then transitions into the spike momentum. Then follows the take-off, preparation “bow and arrow” position where trunk extension and lateroflexion together with trunk rotation occurs for what concerns the lumbar spine mobility and stability systems (Noormohammadpour et al., 2016). To perform a spike, an athlete need a coordinated action of the paravertebral muscles and the large trunk muscles in order to protect the lumbar vertebrae and discus from repeated exceeding loads, that may cause back pain (Külling et al., 2014). A high number of landings (often on one foot only), as well as quick and explosive falls after receiving serves and playing defence can also contribute to this chronic problem. Acquiring a proper playing technique since the early days of practicing volleyball, may lead to an optimal load distribution through the whole body, and remove the excessive load of the lumbar spine while performing specific volleyball techniques (Warren, Smith and Chimera, 2015). Despite the wide number of low back pain complains registered in the receiver/attackers subgroup, the total amount of back problems did not differ significantly between players with different specialties. Such result may partly be explained by the relatively low number of subjects included in this study. However, although statistically low, a group of 75 elite female players represent a significant number of Croatian volleyball players engaged in the highest level of competition. Therefore, the obtained results are an important indicator of the burden of low back pain in top Croatian volleyball players. The relatively high predominance of low back problems in this group is an important indicator that specific preventive measures should be implemented in the everyday training routine, in order to alleviate such problems and ameliorate the player's health as well as their sport efficiency. Balance training programs (Oliver & DiBrezzo, 2009), or specific worm-up routine (Green, Grenier and McGill, 2002) may help in resolving the registered low back problems. Participants also complained that their low back pain hampered them in several volleyball techniques. They mostly complained about low back pain symptoms during spiking and overhead passing, while complains during blocking, defense, underhead passing and serving where less frequent. Taken all together, the results obtained in this study point out the need to introduce two main strategies for the prevention of low back pain in elite female volleyball players: first specific elements such as spiking and overhead passing should be properly trained, learned and automatized from the early beginnings, and second, specific work-out routine aiming at developing a good lumbar spine stability and mobility should be regularly implemented in everyday work. Such training strategy may help in diminishing the marked loading of the lumbar spine in female volleyball players. By doing so, it may prevent the relatively high frequency of low back pain in elite volleyball players found in this study. Despite lowering the number of low back pain cases, it may also help alleviate symptoms and reduce the period of time spent off the court, because of the exacerbating symptoms. However, additional studies are needed to establish why female volleyball players are at high risk for low back pain. Future investigations should aim at identify the best practices for prevention and rehabilitation of low back pain in this specific population.

References

1. Briner, W.W., Benjamin, H.J. (1999). Volleyball injuries. Managing acute and overuse disorders. Physician Sportsmed, 27(3): 48-60.
2. Engebretsen, L., Soligard, T., Steffen., K., Alonso, J.M., Aubry, M., Budgett, R., Dvorak, J., Jegathesan, M., Meeuwisse, W.H., Mountjoy, M., Palmer-Green, D., Vanhegan, I., Renström, P.A. (2012). Sports injuries and illnesses during the London Summer Olympic Games 2012. *Br J Sports Med 2013;47:*407-414
3. Green, J.P., Grenier, S.G., McGill, S.M. (2002). Low-back stiffness is altered with warm-up and bench rest: implications for athletes. Medicine and Science in Sports and Exercise. 34(7):1076-81.
4. Junge, A., Langevoort, G., Pipe, A., Peytavin, A., Wong, F., Mountjoy, M.L., Beltrami, G., Terrell, R., Holzgraefe, M., Charles, R., Dvorak, J. (2006). Injuries in team sport tournaments during the 2004 Olympic Games. Am J Sports Med. 2006; 34(4):565-76.
5. Junge, A., Engebretsen L. Mountjoy, M.L., Alonso, J.M., Renström, P.A., Aubry, M.J., Dvorak, J. (2009). Sports Injuries during the Summer Olympic Games 2008. Am J Sports Med. 2009; 37(11):2165-72.
6. Külling, F.A. Florianz, H., Reepschläger, B., Gasser, J., Jost, B., Lajtai, G. (2014). High Prevalence of Disc Degeneration and Spondylolysis in the Lumbar Spine of Professional Beach Volleyball Players. Orthopaedic Journal of Sports Medicine.9;2(4):2325967114528862
7. Mroczek, D., Januszkiewicz, A., Kawczyński, A.S., Borysiuk, Z., Chmura, J. (2014). Analysis of male volleyball players' motor activities during a top level match. Journal of Strength and Conditioning Research. 28(8):2297-305.
8. Noormohammadpour, P., Rostami, M., Mansournia, M.A., Farahbakhsh, F., Pourgharib Shahi, M.H., Kordi, R. (2016). Low back pain status of female university students in relation to different sport activities. European Spine Journal. 25(4):1196-203.
9. Oliver, G.D., Di Brezzo, R. (2009). Functional balance training in collegiate women athletes. Journal of Strength and Conditioning Research. 23(7):2124-9.
10. Pećina, M. i suradnici.(2004) Ortopedija. Naklada Ljevak.
11. Warren, M., Smith, C.A., Chimera, N.J. (2015). Association of the Functional Movement Screen with injuries in division I athletes. Journal of Sports Rehabilitation. 24(2):163-70.
12. Watkins J., Green B.N. (1992) Volleyball injuries: A survey of injuries of Scottish national league male players. British Journal of Sports Medicine 26;135-137

SPORTS-ANAMNESIS PROFILE OF DEAF ELITE ATHLETES IN CROATIA

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Abstract

The aim of this research was to determine, for the first time, sports and medical history profile of top elite deaf athletes in the Republic of Croatia, also to collect information about the athlete's hearing status, sports initiation, competitive status, and preferences for coaches and integrated or segregated competitions. The study was conducted on a sample of 31 top deaf athletes from seven sports. For the purpose of this investigation a questionnaire was used (Kurkova, Valkova & Scheetz, 2011). During competitions on national level all respondents participated with normal hearing peers' athletes what does an important role to their integration into the hearing community. Results of this study indicate deaf athletes desire for greater opportunities to participate in the chosen sport, so are mostly forced to integrate into a standard system of sport. The findings confirm positive parent's role in supporting and developing the child's desire to participate in sports. Period of sports initiation of top Croatian deaf athletes, is on average, at the start of attending higher grades of elementary school, so it is necessary to promote greater importance, as well as to inform parents, health professionals and educational institutions about the possibilities for including children with hearing loss in both regular and in deaf sport system at the early age.

Key words: *integrated competition, separate competitions, hearing status, sports initiation*

Introduction

The term deaf athlete refers to an athlete with hearing impairment, that is to say a deaf, hard of hearing and an athlete who has a cochlear implant. The only restriction is related to meeting the criterion of minimum damage of 55 dB on a better ear, the average speech frequencies of 500, 1000 and 2000 Hz, in order to have the right to participate in the international elite competitions for deaf athletes, where it is forbidden to use a hearing aid or external part of the cochlear implant during the competition (ICSD, 2016).

The international elite competitions for deaf athletes includes major sports events such as the Deaflympics, previously called World *Games for the Deaf*, World Deaf Championships and Continental Deaf Championships (European and other championships) in Olympic and non-Olympic sports.

A review of current professional and scientific literature with the aim of describing the participation of top deaf athletes revealed the lack of research in Croatia. Also the are limited number of this type of studies in other countries, too. Stewart, Robinson & McCarthy 1991 did the research on 21 deaf athletes who participated in the World Games for the Deaf in New Zealand Christchurch in 1989. Research was conducted with the aim to describe the bio-demographic characteristics and socialization processes that led to the initiation of these athletes in the sport of deaf. Another study on the 53 top European deaf athletes gave an insight into the factors that influence their participation in sports (Kurkova, et al., 2011).

Above mentioned research papers gave fundamental basis for the caring out this research which aim was to establish, for the first time, sports and medical history profile of elite deaf athletes in Croatia, and to collect information about the athlete's hearing status, sports initiation, competitive status, preferences for coaches and integrated/segregated competitions.

Methods

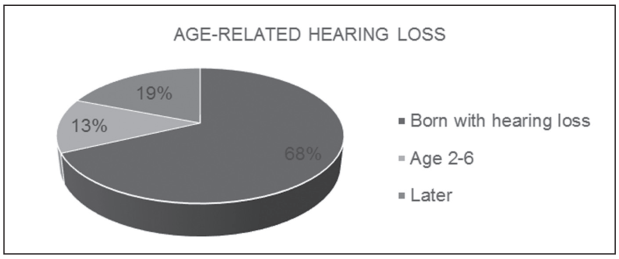
The research sample included a total of 31 athletes (20 male athletes and 11 female athletes) from seven sports altogether (athletics, bowling, chess, curling, handball, shooting and table tennis). The average respondents chronological age was 34.5, ranging from 16-77 years. This study involved athletes who meet the following four criteria: (1) a minimum of bilateral hearing loss of 55 dB for the better ear (the average speech frequencies of 500, 1000 and 2000 Hz), (2) a member of the Croatian Deaf Sports Association, (3) an active member of the Croatian national team nominated for participation in the elite international competitions, and (4) medal won or achieved significant result at elite international competitions in the last two years from the time of conducting the survey. The total population of deaf athletes is 53 athletes from eight sports (athletics, bowling, chess, curling, handball, shooting, skiing and table tennis), what means 58.5% of the entire population of Croatian top deaf athletes were included in this study.

For the purpose of this research, a questionnaire was used to investigate participation of top deaf athletes in the sport (Kurkova, et al., 2011), which includes several structured units. Analysis of this survey included few survey scopes: athlete's hearing status, the use of hearing aids and communication, as and history of participation in sports competitions.

The study was conducted with the approval of the Croatian Deaf Sports Association, who also made initial selection of its members, who met the criteria for participation.

Results

Research results for athletes hearing status (Figure 1) show that the largest share of athletes were born deaf or became deaf during their first two years of life (67.7%) and majority of them (51,6%) has a deep hearing loss or hearing loss greater than 90%.



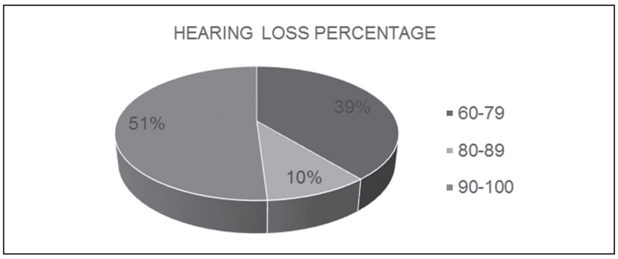
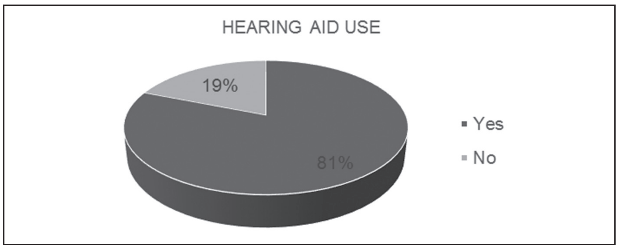


Figure 1: Graphic age-related and the percentage of hearing loss

Most of the elite deaf athletes using a hearing aid (80.6%) as shown in Figure 2, where ten of them uses one hearing aid, nine two hearing aids, while six has built a cochlear implant. More than half of surveyed deaf athletes combines the use of sign language, spoken speech, speech and lip reading and written text (61.3%), respectively as primary communication mode are using total communication (Figure 2).



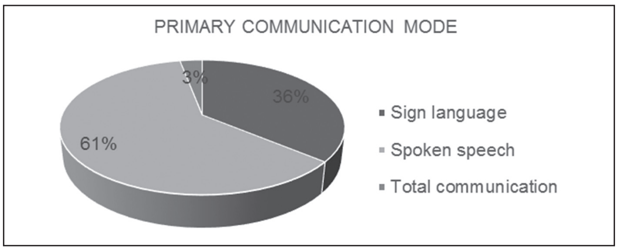
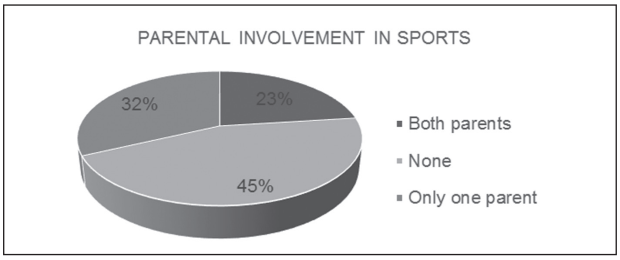


Figure 2: Graphic hearing aid use and primary communication mode

Results for parental involvement in the sport within elite Croatian deaf athletes reveals 45.1% of parents have not participated in any sports, elite nor at the recreational level as seen in Figure 3. In most cases, deaf athletes involved in sport by themselves (54.7%) or were encouraged by parents (32.3%). Almost half of them (47.1%) was driven to the sport by their parents of whom at least one parent participated in sport (54.9%).



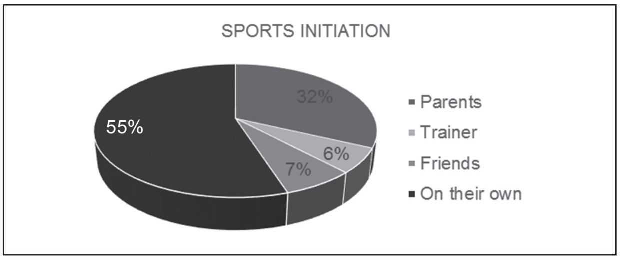
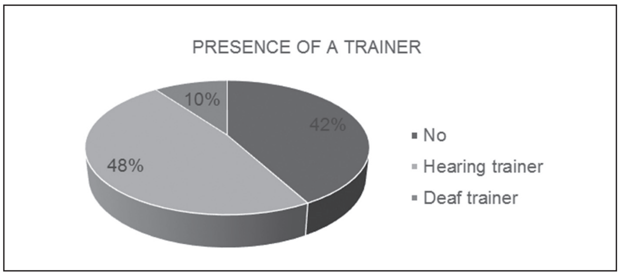


Figure 3: Graphic parental involvement in sports and sports initiation

Croatian elite deaf athletes in average got involved in an organized sport activities system in age of 10.5 (range 6-27 years), and in age 18.6, in average (range 7-40 years), they got involved in their current sport where they have elite athlete status.

Most of the them have trainers or coaches (58.1%), where mostly one is normal hearing person as shown in Figure 4. Most deaf athletes don't have a preference towards a particular type of trainers (67,7%) whether trainer is the hearing or deaf person. As an ideal coaching features athletes frequently mentioned their expertise, understanding and care for the athlete, awareness and knowledge how to communicate with deaf person and certain qualities and values as sacrifice, dedication, integrity, perseverance and motivation).



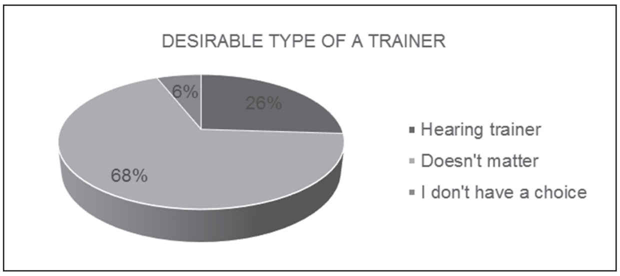


Figure 4: Graphic presence of a trainer and desirable type of a trainer

All surveyed deaf athletes participated in the mainstream competition system with normal hearing athletes in Croatia. 51.6% of them reported how preference for a separate competition system it is not important to them, respectively they don't have preference either towards integrated nor to separate competition system as shown in Figure 5. Nine respondents would like a separate type of competition where they would compete with only deaf athletes, because they believe all athletes there have same fair conditions (55,6) and better communication with other participants during the competition (44.4%).

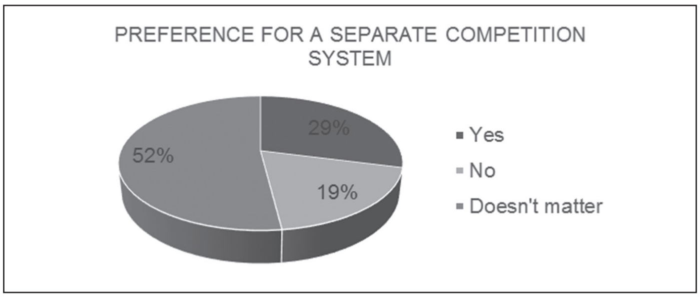


Figure 5: Graphic preference for a separate competition system

Discussion

When we talk about elite Croatian deaf athletes, among most of them, hearing impairment results from birth or developed in the first two years of life. Given the high frequency of hearing aids use, most deaf athletes relies on the ability to communicate through the use of total communication. The above is highlighted by the fact that deaf athletes who use sign language also rely on their ability to communicate through spoken speech, speech and lip reading, and finger spelling, which is consistent with previous studies (Scheetz, 2004; Kurkova, et al., 2011).

The primary communication mode is associated with the degree of hearing loss, timely diagnosis, quality of rehabilitation, the type of school and socio-cultural environment of education (Kurkova, 2001; Scheetz, 2004). It is assumed that these factors have an impact on the preferences of deaf athletes for the type of competition they would get involved in and on their sense of understanding and interest which hearing community shows for the forms of communication among deaf people (Kurkova, et al., 2011). During sports events there seem to be a common misunderstanding about the communication needs of deaf people (Kurkova, 2005), and one of the causes may be that a deaf person often does not inform hearing society of his/her communication problems and consequently remains in isolation. For example, when a deaf person needs somebody to repeat some information, the hearing person can experience this request as a lack of understanding or a lack of attention (Martin & Bat-Chava, 2003).

The results of this study confirm the positive role of parents in supporting and developing the child's desire to participate in sports. Children with sports active parents are six times more likely to show similar active life style than children with sedentary parents. Parents' attitudes to kinesiological activity strongly influence physical activity habits in their own children, and the same was confirmed for children with hearing impairment (Kurkova & Sigmund, 2010; Ellis, Lieberman & Dummer, 2014).

It is believed that the deaf person owns feeling of comfort in the hearing community may later affect the preference for participation in an integrated or separate sports system, but also in the choice of the trainer or the coach (Kurkova, et al., 2011). In this study, the majority of deaf athletes, who have trainer, actually have hearing trainer and one seems to be a crucial factor in helping deaf athletes for integration into the mainstream sport system. Croatian elite deaf athletes suggested how auditory status of trainers is not important to them, as it is their professional competence, understanding and concern which they show for the athlete, as well as, the awareness and knowledge of how to communicate with them.

One of the reasons why all of the respondents are competing in the regular system of competition with hearing competitors may be because there are not enough domestic sport competitions for only deaf athletes. Integration of deaf athletes in the system of training and mainstream competition with normal hearing athletes helps them to raise their quality of training and preparation for national and international competitions of deaf, but also allows them to evaluate their current achievements with others throughout the season. Several athletes have indicated its preference to a separate system of competition, what could be consequence of previous negative socialization, and it is also in accordance with the above research (Kurkova et al., 2011). They believe conditions are better in a segregated system of competition regard to communication, and fair conditions for all. As long as deaf athletes are not limited by their physical disabilities, as long as vestibular system is not damaged, they have option to choose competition system as they prefer. Although deaf athletes had rather compete with athletes similar to themselves because of socialization and communication options, they still appreciate opportunity to participate in mainstream competitions what gives them possibility of their sports performance evaluation, promotion and wider recognition of deaf athletes.

Conclusion

This research was conducted with the aim of creating a sports anamnestic profile of elite Croatian deaf athletes. All deaf athlete respondents participate in national regular system competitions, what does an important role in their integration into the hearing community. The integration of deaf athletes helps them to raise the quality of training and prepare themselves for the upcoming national and international events of the deaf, but also allows them to evaluate current achievements with others throughout the season.

The results of this study confirm parent's positive role in supporting and developing child's desire to participate in sports. However, as the majority of respondents' have involved individually in the sport, and in average time of their sport initiation have begun while attending higher grades of elementary school, it is needed greater promotion of the importance for including the children with hearing impairment in physical activity and sport from earliest age.

References

1. Ellis, M.K., Lieberman, L.J., & Dummer, G.M. (2014). Parent influences on physical activity participation and physical fitness. *The Journal of Deaf Studies and Deaf Education*, 19(2), 270-281.
2. ICSD (2016). *Eligibility* /on-line/. Retrieved June 20, 2016 from www.deaflympics.com/athletes.asp?eligibility
3. Kurkova, P. (2001). Analysis of the biographies of skiers with a hearing impairment from the perspective of integration. In J. Pavlik (Ed.), *The role of physical education and sport in the transition countries of central Europe* (pp. 234-236). Brno, Czech Republic: Masaryk University.
4. Kurkova, P. (2005). Sport as a means to the inclusion of people with hearing disability into an integrated environment/society. In D. Milanović, & F. Prot (Eds.), *4th International Scientific Conference on Kinesiology: ''Science and Profession – A Challenge for the Future''* (pp. 789-791). Zagreb: University of Zagreb.
5. Kurkova, P., & Sigmund, E. (2010). Physical activity preferences of students who are deaf or hard of hearing (Abstract). *Acta Universitatis Palackianae Olomucensis, Gymnica, Book of abstracts*, 40(3), 76.
6. Kurkova, P., Valkova, H., & Scheetz, N. (2011). Factors impacting participation of European elite deaf athletes in sport. *Journal of Sports Sciences*, 29(6), 607-618.
7. Martin, D., & Bat-Chava, Y. (2003). Negotiating deaf–hearing friendships: Coping strategies of deaf boys and girls in mainstream schools. *Child: Care, Health and Development*, 29, 511-521.
8. Scheetz, N.A. (2004). *Psychosocial aspect of deafness*. Boston, MA: Pearson Education.
9. Stewart, D.A., Robinson, J.A., & McCarthy, D. (1991). Participation in Deaf sport: Characteristics of elite Deaf athletes. *Adapted Physical Activity Quarterly*, 8, 136-145.

CARDIAC REHABILITATION TRAINING PROGRAM FOR INDIVIDUALS AFTER AORTIC VALVE REPLACEMENT

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Aim: The aim of this study is to assess an impact of aerobic-resistance exercise on cardiorespiratory indicators in patients after aortic valve replacement (AVR), and evaluate monitored parameters as a result of a positive influence of a physical activity level.

Methods: The study was conducted between years 2005-2015 on a group of 65 patients of an average age of 60,5±10 years, with left ventricular ejection fraction of 56,5±6 percent. All patients were after AVR. All these patients were included in a cardiac rehabilitation training program (CR). CR included a three-month aerobic-resistance training with a frequency of three times a week. The length of a training unit was set to 80 minutes (out of which 50 minutes were allocated to individual aerobic training). The control group consisted of 20 patients after AVR who did not exercise systematically (but they exercised on an individual basis, supervised by their attending cardiologist). Both groups were assessed by exercise echocardiography and spiroergometry as well as clinically, before and after CR.

Results: Completing the interventional training program led to a significant increase of exercise tolerance (1,5±0,3 vs. 1,8±0,3 W/kg; $p<0.0001$) and of peak oxygen consumption (19,2±0,9 vs. 23,5±1 ml/kg/min., $p<0.0001$). Decreased values of resting heart rate and resting systolic and diastolic blood pressures were observed in subjects after completing CR. However, the measured changes did not reach a statistical significance. In the control group, the improvement in functional and aerobic capacity also occurred but did not achieve statistical significance.

Conclusion: The study showed some important connections that can be utilized for practical application of aerobic-resistance training prescription for patients after AVR. Significant improvement in cardiorespiratory indicators and indicators of exercise tolerance after completing CR reinforces the crucial role of physical activity.

Cardiac rehabilitation training program after AVR allows an exact evaluation of the outcome of the surgery and also an adjustment of pharmacologic therapy, particularly the anticoagulant therapy. The influence of regular exercise on long-term prognosis is not yet clear and will require long-term trials in larger numbers of patients. Outpatient rehabilitation after AVR correction is a safe treatment method.

Key words: *Cardiac rehabilitation, prevention, aerobic training, resistance training, aerobic capacity, aortic valve replacement, cardiosurgery intervention*

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HOW DOES EXERCISE SUPPORT DIETARY APPROACHES TO WEIGHT LOSS AND BETTER HEALTH

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Developed societies have globally been experiencing rising rates of obesity and associated morbidities including coronary heart disease, cancer, arthritis, and in particular type 2 diabetes.

It is accepted that this outcome is a result of increased food intake, inappropriate diet, and high levels of inactivity. It is of individual and public health interest to examine why human physiological mechanisms do not prevent obesity and morbidities, and how changes in dietary and exercise habits may prevent or minimize this damage and improve human health and lifespan. The problem of living in industrialized and technologically advanced societies is that our physiology was not designed for this lifestyle. Our hunter gatherer ancestors had to forage and hunt, and physical activity was a large component of life during pre-industrial agrarian period both as observed in small social enclaves to this day. Urban living, on the other hand, has removed the need for physical exertion through mechanized assistance of most living activities and even work. In addition, our physiological inability to track calories eaten or expended, and the commercial pressure to make highly palatable, energy dense food conveniently available, makes it easy to overeat and store calories as body fat. To counteract these environmental forces leading to inactivity and overeating, it is important to use exercise and diet strategically. It is instructive to understand the physiology and pathology caused by inactivity in order to provide a strong incentive to engage in necessary levels of physical activity in the form of sport and deliberate physical recreation. While the amount of energy expenditure in produced by typical patterns of aerobic training is insufficient to produce a significant weight loss, regardless of the form or modality of isocaloric exercise, such physical activity produces beneficial changes in the form of increased insulin sensitivity and aerobic fitness even in the absence, or with a modest degree, of weight loss. While attempts to lose weight from any level of overweight or obesity, is met with strong physiological resistance in the form of reduced metabolic rate and hormonally induced increased hunger which prevent a maintenance of weight loss, exercise training combined with different dieting strategies supports sustained diet-induced weight loss. Obesity-associated insulin resistance and glucose intolerance can also be reduced by altering the prevalent nutrient composition of the diet and by adjusting the timing of meals and exercise. Human mortality is maximized by increasing aerobic fitness, and skeletal health is optimized with sports involving joint-reaction and ground reaction loading. Striking a balance between sensitivity to satiety signals triggered by exercise that prevent overeating, and the levels of exercise that do not overtax the heart, the capacity of which declines with advancing age, represent the best strategy for long and healthy life.

STRENGTH TRAINING IS MEDICINE IN ELDERLY POPULATION: AN UPDATE

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Abstract

Over the past several decades skeletal muscle atrophy has been found to be debilitating and life threatening condition in older persons. In adittion, there has been increasing interest in the role of different interventions to treat *sarcopenia*, the age-related loss of muscle or lean mass, in curtailing active and healthy aging. There is strong body of evidence nowdays to suggest that lack of strength and power, or *dynapenia*, is a more constant factor in compromised wellbeing in old age with qonsequent interest in specific resistance training protocols to counteract these deficits. Seminal studies published in the early 1990's by Fiatarone and colleagues in the high-impact journals highlighted the role that strength training can have on increasing muscle strength, muscle size and functional capacity in older adults. Since than, strength training has been proved to reduce the risk of osteoporosis, depression, signs and symptoms of numerous chronic diseases such as heart disease, arthtritis, type 2 diabetes, cognitive abilities and self-esteem. Recently, emerging evidence suggests that muscle power (the product of force time velocity or the rate of performing work) is highly effective to elicit substantial improvements in maximal mechanical muscle function, functional performance and mobility limitations in old and very old population. It seems that muscle power is novel health-related physical attribute in elderly people which should be regularly targeted with high-velocity resistance training.

Key words: *exercise, sarcopenia, muscle power, dynapenia*

AUTOPHAGY IN MUSCLES AND EXERCISE CAPACITY OF MIDDLE AGED RATS FOLLOWING DIFFERENT AEROBIC EXERCISE PROTOCOLS

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Purpose: The aim of this study was to compare the extent of muscle cell autophagy and exercise capacity following the high intensity interval training (HIIT) versus moderate intensity continuous training.

Methods: 9 months old, male Wistar rats were randomly divided into 3 groups. Every group comprised of 8 rats. The control group, the experimental moderate training group (50-min moderate intensity continuous running at 60% VO2max), and the experimental HIIT group (6 bouts ×3 min running at 80% VO2max interspersed with 6 bouts ×3min active recovery at 50% VO2max with a 7-min warm-up and cool down at 60% VO2max). After 12 weeks of exercise, the rats were tested for VO2max and running endurance. In three rats of each group, the soleus muscle and myocardium tissue samples were collected in order to perform an electron microscopy.

Results: The quantification of autophagosomes per cellular cross-section performed by transmission electron microscopy (TEM) showed that both, moderate training group and HIIT group had a significantly higher autophagy level in the soleus muscle than the control group (1.6±0.1 vs. 1.72±0.18 vs. 1.15±0.21 respectively). The same was found in myocardium samples (1.32±0.18 vs. 1.57±0.16 vs. 1.16±0.18 respectively). Additionally, the HIIT group had a significantly higher autophagy level than the moderate training group in the myocardium (P=0.04). Regarding the aerobic capacity, both moderate training group and HIIT group, performed significantly better than the control group (VO2max was 3074.47±357.89 vs. 3632.18±457.96 vs. 2218.58±444.2 ml/kg/h; running endurance was 325.65±88.28 vs. 349.11±75.3 vs. 170.5±37.25 m). Between the two experimental groups, the HIIT group had a significantly better aerobic capacity (VO2max) than the moderate training group (P=0.000).

Conclusion: These results point to the better effects on improving autophagy level of the myocardium, as well as VO2max, by high intensity interval training versus moderate intensity continuous training. The improvement of the autophagy level of the soleus muscle and the myocardium by both aerobic training types might enhance the exercise capacity of middle-aged rats to some extent, but the underlying mechanisms should be further researched in future.

Reference

1. Nybo l Sundstrup-E-Jakobsen-MD-et-al. High – intensity training versus traditional exercise interventions for promoting health. [J]. Med Sci Sports Exerc, 2010, 42(10): 1951-1958.
2. Giessing j Eichmann-B-Steele-J-Fisher-J. A comparison of low volume 'high-intensity-training' and high volume traditional resistance training methods on muscular performance, body composition, and subjective assessments of training. [J]. Biol Sport, 2016, 33(3): 241-249.

THE EFFECTS OF A SOCCER MATCH ON INDICATORS OF MUSCLE DAMAGE AND INFLAMMATION

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Purpose: Soccer match players perform a substantial number of explosive activities such as jumps, duels, shots and dribbling, accelerations, decelerations, changes of direction and sprints during the match. It is precisely such repetitive eccentric contractions that are related to muscle damage (*exercise-induced muscle damage*) and inflammation. That is clinically presented as muscle soreness usually developed 24 or 48 hours after the match. The aim of this research was to identify the changes in biomarkers of muscle damage and inflammation in young players after a soccer game.

Methods: The sample of examinees was composed of 43 soccer players (16.8 ± 1.06 years) who were divided into two groups according to their age (22 cadets aged 15.86 ± 0.35 and 21 U19 players aged 17.76 ± 0.54) and they played two soccer games which lasted 90 minutes each. Right before and immediately after the match, venous blood samples were taken in order to determine the markers of muscle damage and inflammation. All statistical analyses were conducted by using the SPSS software.

Results: The examinees of our research, in keeping with what was expected as markers of muscle damage demonstrated significantly higher values of myoglobin (the arithmetic mean of the differences =-158,79; CI=-198,05 - -119,52) and creatine kinase (the arithmetic mean of the differences =-154,08; CI=-206,83 - -101,32) as well as total number of leukocytes (the arithmetic mean of the differences =-3,15; CI=-3,84 - -2,46) and concentration of C-reactive protein (the arithmetic mean of the differences =0,01; CI=-0,02 – 0,05) as indicators of inflammation.

Conclusions: The conclusion can be made that the results of this research showed that, as the muscle protein concentration is increased and an inflammatory reaction also occurred, soccer matches caused muscle damage in young players.

INFLUENCE OF PHYSICAL ACTIVITY ON SELECTED PHYSIOLOGICAL VARIABLES IN A PATIENT AFTER BONE MARROW TRANSPLANTATION – A CASE STUDY

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Abstract

Haemato-oncological diseases and their treatment are associated with many side-effects. The most common is an enormous level of fatigue. This fatigue is a multidimensional, subjective and objective physiological condition characterised by a persisting and extreme exhaustion. Effective way to eliminate fatigue is inclusion of physical activity into the daily habits. The paper is presenting case study - a patient with Hodgkin lymphoma and following secondary Acute Myeloid Leukaemia treated by bone marrow transplantation. Who was undergoing two years lasting physical activity intervention. The positive impact of PA was verified on selected physiological variables. The Bioelectrical impedance analysis, maximal oxygen consumption, maximal performance, spectral analysis of heart rate variability and haemoglobin concentration was chosen. Despite persisting anaemia, throughout the whole course of exercise intervention, the level of physical fitness and activity of autonomic nervous system has been gradually increasing. The patient has shown a significant improvement in all observed parameters.

Key words: *Cancer treatment, acute myeloid leukaemia, physical activity, bioelectrical impedance analysis, maximal oxygen consumption, maximal performance*

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Introduction

Haemato-oncological diseases and their treatment are associated with many side-effects. The most common is an enormous level of fatigue. This fatigue is a multidimensional, subjective and objective physiological condition characterised by a persisting and extreme exhaustion, a reduced capacity to work both physically and mentally (patients are often unable to carry out basic habitual daily activities, there is a resulting loss of self-sufficiency, that leads to demoralisation, pessimism, anxiety, etc.), and an inability to rest or sleep (Courneya & Friedenreich 2011). It is more apparent that the fatigue associated with a malignant disease is negatively linked to the overall activity of the autonomic nervous system (ANS), particularly to the vagus nerve activity (Dupont, Bower & Ganz 2012). This imbalance can be compensated by suitable prescription of physical activity (PA) (Janikova, Hrncirikova, Dovrtelova, Zvonar, Hrouzek, & Vodicka 2014). The main problem in PA application as a method complementing cancer treatments after chemotherapy is a temporary decline in the number of blood cells (cytopenia). Critical values are generally considered the values of neutrophils below 1,0x109/L, haemoglobin below 80g/L and platelets below 50x109/L, that is when physicians recommend abstaining from any exercise due to a high risk of bleeding, infection, injury, etc. According to the results of some studies it seems that a tailor-made prescription of physical activity adapted to the disease stage, planned treatment and a current health-related fitness and patient’s preferences may be applied safely and with a measurable effect (Elter, Stipanov, Heuser, Bergwelt-Baildon, Bloch, Hallek & Baumann 2009), (Baumann, Zopf, Nykamp, Kraut, Schule & Bloch 2011). Even though PA in malignant diseases is generally recommended, there is no clear and scientifically-based recommendation for PA prescription in haemato-oncological diseases in terms of intensity, duration, frequency or content. Despite PA being safe and feasible in these patients, initial load tests are recommended due to a medium to high risk of complications. American College of Sports Medicine (ACSM) guidelines recommend that general cancer patients should exercise for about 150 minutes a week at moderate load intensity (Whaley, Brubaker, Otto, & Armstrong 2006). According to other research studies including patients with carcinomas at an early (non-metastatic) phase the aerobic load could have an intensity of 55-75% of maximal heart rate, corresponding to a perceived effort according to Borg (RPE) of 11-12 points, it should last for 10-90 minutes and be done 3-7 times per week (Mustian, Morrow, Carroll, Figueroa-Mosley, Jean-Pierre & Williams, 2007). An intermittent PA (3 times 10 minutes) which gradually changed to a continual exercise was also effective to reduce fatigue in association with carcinoma. Moreover, resistance training performed 3 times a week at medium to high load intensity (60–90% of 1-RM) was also suitable. Low load intensity is safe and well-tolerated in patients with metastatic diseases (Segal, Reid, Courneya, Malone, Parliament & Wells 2003), (Segal, Reid, Courneya, Sigal, Kenny

& Prud'Homme, 2009). However, it is more appropriate to strongly recommend patients with a malignant disease to avoid excessive load which would act negatively on their immune system and interfere with therapy and the subsequent recovery. The only large randomised study on patients with lymphoma demonstrated that aerobic exercise implemented during chemotherapy had a significant positive impact on the reduction of fatigue, on quality of life and body fitness. Simultaneously, exercise did not influence the treatment protocol and had no negative effect on the treatment response. (Courneya, Sellar, Stevinson, McNeely, Peddle & Reiman, 2009).

Methods

Participant's history

The patient was an active sportsman with no health problems until 26 years of age. He was engaged in acrobatic rock-and-roll at a performance level. His physical fitness corresponded to the performance load; he preferred an active way of life. He was a non-smoker. In October 2009, the first health problems occurred in the form of repeated and then even continual pyrexia with unknown cause. The patient was examined for lymphadenopathy and splenomegaly via Positron Emission Tomography (PET) which confirmed glucose hypermetabolism in enlarged lymph nodes. In April 2010, a diagnosis of Hodgkin's lymphoma was confirmed.

The patient was treated with 8 cycles of chemotherapy. Escalated BEACOPP is divided into four stages. Chemotherapy was ceased with a significant anaemia and pancytopenia. The patient continued to be observed. In March 2013, Acute Myeloid Leukaemia (AML) was detected as part of a follow-up assessment. This type of leukaemia is linked to the consequences of chemotherapy BEACOPP as confirmed in this patient too. In April 2013, a request for an allogeneic donor was sent to the National Registry of Bone Marrow Donors and in June 2013 and allogeneic bone marrow transplantation from a non-related donor was conducted. On the 23rd day following the transplantation the bone marrow started producing within the granulocyte line.

Study design

The physical activity intervention started fourteen months after the bone marrow transplantation. The patient's decision to undergo physical activity was based on his desire to return back to the physical fitness and performance and to reduce levels of overall fatigue. The intervention design was based on ACSM general recommendations (Armstrong 2006), the patient's current health status and the results of spiroergometric load test which showed no cardiovascular pathology that would contraindicate the physical activity. The patient was informed about the intervention process and he gave an informed consent. The intervention programme lasted 24 months (September 2014 – September 2016); it was implemented 3 times a week for 60-90 minutes in the form of individual exercises. Every six months the patient underwent follow-up measurements for all selected parameters. The patient's heart rate was monitored throughout the training unit using a monitor of heart rate combined with the Borg scale which evaluates a perceived intensity of difficulty of the given load. The exercise plan design was based primarily on the current health status and level of physical fitness. The intervention factor always contained an aerobic part within the heart rate zone set during the spiroergometry, compensatory exercises including those to maintain physiological length of postural muscle groups, resistance training in the form of functional circle training to increase fat-free body mass and a specific form of training based on the patient's request (elements of acrobatic rock-and-roll).

Assessments:

Bioelectrical impedance analysis (BIA) of body composition:

The estimation of body composition was carried out by a non-invasive bioelectrical impedance (apparatus InBody 230). The BIA is a method for determination of the fat-free body mass. It is based on measurement of the resistance of body tissues to alternate current.

Spiroergometry in conditions vita maxima:

Endurance was assessed using an Lode Excalibur sport ergometer and twelve lead ECG, Custo Cardio 100 BT. Maximal oxygen consumption (VO_2 max), carbon dioxide production, and pulmonary ventilation (VE) were continuously determined breath by breath using an Metalyzer®3b, Cortex.

Maximal performance (W max)

The initial load was set at 1W.kg^{-1}. Then, in each next step, the load was increased after 1 minute by 0,3 W.kg-1.

For this study the protocol to voluntary maximum termination was used.

Haemoglobin concentration:

Was determined in the laboratory during the follow-up checks by the attending physician.

Spectral Analysis of Heart Rate Variability (SA HRV):

SA HRV is a non-invasive method used to assess the functional state of the autonomic nervous system. The high-frequency component (HF) of fluctuations of R-R intervals (0.15-0.80Hz) in assessment of short-term SA HRV is considered an index of activity of the PSNS (parasympathetic nervous system). The low-frequency component (LF) of SA HRV and its ratio to HF provide an opportunity to assess balance of both divisions of autonomic nerve system. For the purposes of research, better interpretation of results, easier orientation and clear-cut identification of less significant changes of the performance spectrum, the methodology of Stejskal et al. (Stejskal, Šlachta, Elfmark, Salinger & Gaul-Aláčová 2002) was selected. The relation of total score to the age of patient is known as the functional age, ANS. The evaluation of the spectral analysis of heart rate variability was carried out using DiANS PF 8 apparatus.

Results

Bioelectrical impedance analysis (BIA) of body composition

As is apparent from table 1. The improvement in individual values in the first year of intervention was continuously ascending. During the second year, the individual values rather stagnate. Nevertheless, during 24-month intervention the patient has gained 11.7 kg with the gain of almost 5kg of fat-free body mass and fat tissue of 6.7kg.

Spiroergometry

The exact progress of all spiroergometric parameters is shown in table 1. Very low values of maximal oxygen consumption (VO2 max) and workload (W/kg) at the beginning of intervention despite persistent anaemia gradually was increasing to the minimal level of values of healthy, untrained population of the relevant age (Novotný, Sebera, Novnotná, Hrazdira & Chaloupecká 2003).

Haemoglobin

Even three years after the bone marrow transplantation, the patient still does not reach normal, minimal (138 mmol/l) levels of haemoglobin (table 1). However, the output measurement of this parameter shows a positive trend.

Table 1: Changes of physiological variables during intervention

	24.7.2014	24.6.2015	9.12.2015	9.9.2016
weight (kg)	65,9	75,8	77,6	77,6
Fat-free body mass (kg)	33,1	38,1	38	38
haemoglobin (mmol/l)	87	99	113	127
VO2 max (ml·kg^{-1}·min^{-1})	25,1	30,5	32,66	35,8
workload (W/kg)	2,27	2,38	3,22	3,6

Spectral Analysis of Heart Rate Variability (SA HRV)

Changes in total spectral performance of the autonomic nervous system are shown in table 2. Throughout the whole course of intervention, the increases in vagal activity and total spectral performance can be observed. The difference between the functional and the calendar age of the patient decreased from 9.6 to 1.5 years. This positive shift is considered to be absolutely essential for further prognosis of the patient.

Table 2: Changes of performance of the autonomic nervous system

	24.7.2014	24.6.2015	9.12.2015	9.9.2016
biological age (years)	30,83	31,75	32,25	33
Functional age (years)	40,5	34,9	34,9	34,4
total score SA HRV	-2,5	-0,86	-0,74	-0,4

Discussion

Our case study has proven that physical activity has a positive influence on changes of selected physiological parameters in the patient after bone marrow transplantation. Throughout the whole course of intervention, all measured parameters were continuously increasing. The values of body weight, and fat-free body mass was after first year of intervention stabilized at a level which presumably corresponded to the activity of the patient and promoted the increasing level of the monitored physiological parameters. But we can discus whether to include in the second half of the intervention program larger volumes of resistant training for its anabolic effect and also because of its protective impact on the systolic blood pressure that is even higher than aerobic exercising (Struhár, Dovrtělová, & Kumstát 2014).

The patient was raising the intensity and frequency of the load during the second year of intervention, according to his subjective feelings. It is impossible to say exactly how the treatment and better condition of the patient were influenced. There is a high probability that the concentration of haemoglobin in the blood would be increasing even without the intervention. This parameter is associated with receipt of the bone marrow from the allogeneic donor and the perception of the treatment by the patient. The rate of increase of haemoglobin concentration in the blood is highly individual. The question remains, to what extent it is possible to boost haematopoiesis, e.g. by hypoxic training, which according to Wang, & Weng, (2011) promotes the activity of natural killer cells.

One of the important factors in the successful completion of the interventional program is to maintain the patient's motivation and full cooperation. The motivation can also be increased by individual guidance during physical activities. For patients after oncological therapy, this individual approach is very important. It can be provided in the form of individual or group sessions. In the group sessions, a possibility to share experiences and feelings about the illness with other patients plays a highly positive role. Strong bonds inside the group of exercisers or between exercisers and fitness specialist are formed. And this is another - social - dimension of the interventional program.

Our patient perceived the interventional program positively. He considers it one of the key factors for his return to ordinary life.

Conclusion

Despite persisting anaemia, throughout the whole course of exercise intervention, the level of physical fitness and activity of ANS has been gradually increasing. The patient has shown a significant improvement in all observed parameters. After two years of intervention, he is capable of full-scale training at the level of an average recreational athlete. Also, levels of all observed parameters correspond to those of an average recreational athlete.

Bibliography

1. Baumann FT, Zopf EM, Nykamp E, Kraut L, Schule K, Elter T, Fauser AA, Bloch W. (2011). Physical aktivity for patiens undergoing an allogeneic hematopoietic stem cell transplantation: benefits of a moderate exercise intervention: *Eur J Haematol*; 87(2), 148-56.
2. Courneya KS, Sellar CM, Stevinson C, McNeely ML, Peddle CJ, Friedenreich CHM, Tankel K, Basi S, Chua N, Mazurek A, Reiman T. (2009). Randomized Controlled Trial of the Effects of aerobic exercise on Physical functioning and quality of life in lymphoma patients: *J Clin Oncol*; 27, 4605-4612.
3. Courneya KS, Friedenreich CM. (2011). Physical activity and cancer: an introduction. In*: Physical activity and Cancer.* Springer Verlag Berlin Heidelberg.
4. Dupont A, Bower JE, Ganz PA. (2012). Lower heart rate variability is associated with cancer-related fatigue in breast cancer survivors: *European Journal of Psychotraumatology*; 3.
5. Elter T, Stipanov M, Heuser E, Bergwelt-Baildon M, Bloch W, Hallek M & Baumann F (2009). Is physical exercise possible in patients with critcal cytopenia undergoing intensive chemotherapy for acute leukaemia or aggressive lymphoma?: *Int J hematol*; 90(2), 199-204.
6. Janikova, A., Hrncirikova, I., Dovrtelova, L., Zvonar, M., Hrouzek, M., Vodicka, T., & Zackova, D. (2014). Autonomic dysfunction is augmented during therapy, but can be improved by physical exercise in patients with hematological malignancy. Results of a pilot trial: *Haematologica*, 99, 785-785.
7. Mustian KM, Morrow GR, Carroll JK, Figueroa-Moseley CD, Jean-Pierre P, Williams GC. (2007). Integrative nonpharmacologic behavioral interventions for the management of cancer-related fatigue: *The Oncologist*; 12(Supplement 1):52-67.
8. Novotný, J., Sebera, M., Novotná, M., Hrazdira, L., & Chaloupecká, A. (2003). In: *Kapitoly sportovní medicíny.* Brno: MU Brno.
9. Segal RJ, Reid RD, Courneya KS, Malone SC, Parliament MB, Scott CG, Venner PM, Quinney HA, Jones LW, Slovinec D Angelo ME, Wells GA. (2003). Resistance exercise in men receiving androgen deprivation therapy for prostate cancer: *Journal of Clinical Oncology*; 21(9),1653-1659.
10. Struhár I, Dovrtělová L, a Kumstát M. (2014). Resistance Training as a Powerful Tool in the Prevention and Treatment of Cardiovascular Diseases: *International Journal of Medical, Health, Pharmaceutical and Biomedical Engineering*, 8 (7), 373-376.
11. Segal RJ, Reid RD, Courneya KS, Sigal RJ, Kenny GP, Prud'Homme DG, Malone SC, Wells GA, Scott CG, Slovinec D Angelo ME. (2009). Randomized controlled trial of resistance or aerobic exercise in men receiving radiation therapy for prostate cancer: *Journal of clinical oncology*; 27(3), 344-351.
12. Stejskal P, Šlachta R, Elfmark M, Salinger J, Gaul-Aláčová P.(2002). Spectral analysis of heart rate variability: New evaluation method: *Acta Universitatis Palackianae Olomucensis. Gymnica*, 32(2),13-18.
13. Wang, J.S., Weng, TP. (2011). Hypoxic exercise training promotes antitumour cytotoxicity of natural killer cells in young men: *Clinical Science*, *121*(8), 343-353.
14. Whaley M, Brubaker PH, Otto RM, & Armstrong LE. (2006) In: *ACSM's guidelines for exercise testing and prescription*. American College of Sports Medicine: Lippincott Williams & Wilkins, Philadelphia.

ANAEROBIC THRESHOLD IMPROVEMENT IN A 75-YEAR-OLD CYCLIST: A CASE STUDY

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Background: Many opportunities exist for seniors to pursue general fitness and moderate to highly competitive athletic pursuits in “master” categories. There is a need to better understand the health and fitness parameters of master’s athletes specifically those competing in several competitions yearly. Last year a case study was performed on a 101-year-old cyclist who broke the 1-hour cycling distance record (24.25 km) for the centenarian age group (1). The purpose of this study was to add to the expanding literature on elderly athletes and provide a case report on the physiology of a remarkable 75-year-old cyclist.

Methods: The lone male cyclist (75 years, BMI 24.42, 15.5% BF.) was part of a larger project on track and field athletes in the master category, who were recruited for a 9-month long study that evaluated their training knowledge, physiology, nutrition and health characteristics. The athlete of interest began cycling at aged 60 and was often competitive in one age group below his own age. He did not have a coach and his best result was a silver at the world masters’ road race in the 70+ category. He completed a health fitness test battery (CPAFLA) and an incremental test on a cycling ergometer pre and post of the master’s competition season.

Results: His health and fitness results from a standardized protocol (CPAFLA) for grip strength, push-ups, partial curls, flexibility, back strength, and leg power were all above the very good category. His pre-post results showed improvement particularly with anaerobic threshold (AnT) improving 71% (26.6 ml/kg/min; 200 watts, pedalling 70 rpm) to 75% (32.2 ml/kg/min; 225 watts) of his VO2max (37.9 ml/kg/min, 274 watts, 90 rpms, MHR 165 bts/min, ventilation 101.61 L/mim, RER 1.18). This athlete’s AnT was quite high at the study start and therefore a further improvement was somewhat surprising as he had only been cycling for 15 years.

Conclusions: In conclusion, it appears that age can be irrelevant when it comes to fitness levels since it was possible to increase performance and maintain power output related to anaerobic threshold in this older male cyclist.

References

1. Billat VL, Dhonneur G, Mille-Hamard L, et al. Case Studies in Physiology: Maximal Oxygen Consumption and Performance in a Centenarian Cyclist. *J Appl Physiol*. 2016.

FEMALE ATHLETE TRIAD- PROBABLE BUT DIFFICULT TO CONFIRM IN ELITE FEMALE ICE HOCKEY PLAYERS

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Background: Athletes, coaches, and sport physiologists are aware that the menstrual cycle can impact athletic performance, positively and negatively. Researchers know that the combination of energy deficiency, ovulatory disturbances and bone loss (osteoporosis) or bone weakening (osteopenia) known as the Female Athlete 'Triad' can impact future bone health. Elite female hockey players have high energy expenditure particularly when preparing for international competitions. It is possible that these athletes over time may enter a state of negative energy balance without noticeable body weight change.

Purpose: The study investigated menstrual cycle length (CL) luteal phase length (LP), energy balance (EB), and BMD in female ice hockey players (HP) compare to non-athlete controls (C). Descriptive data is reported as means and standard deviations (±SD). Twelve players (age 21.1 ± 3.4 yrs. HT. 165.9 ± 4.6 cm, Wt. 64.7± 8.1 kg, %BF 22.8 ± 3.8%) and 12 controls (age 21.4 ± 2.8 yrs., HT. 169.5 ± 5.5 cm, Wt. 65.4 ± 5.4 kg, %BF 20.0 ± 3.1%) completed the study. The menstrual cycle length was measured using basal body temperature (BBT).

Results: Mean CL for the HP (35.8 ± 11.2 days) was longer than the C (29.8 ± 4.3 days). Mean LP length for the C was slightly less than that of the HP (HP = 10.1 ± 2.1 days; C = 9.6 ± 2.8 days). Anovulation occurred in 50.0% of HP and 39.2% of C cycles. There were no significant differences in mean lumbar spine (p = 0.9), hip (p = 0.5), and radial (p = 0.7) BMD between HP and C subjects. Mean EB for HP and C was negative (HP =-1026.52 ± 450.1 kcal.day^{-1}; C = -780.00 ± 310.19kcal.day^{-1}). No significant dwithin-group differences were found in mean Wt. (HP p = 0.7; C p = 0.8), % BF (HP p = 0.97; C p = 0.6), or FFM (HP p = 0.6; C p = 0.98) in either group from time 1 to time 2.

Limitations: The BBT method coupled with keeping a menstrual cycle diary was too time intensive for the HP with only a 28% completion rate versus 70% with the C.

Discussion: Our data suggest that although both HP and C were in a chronic state of negative energy balance, they did not exhibit a loss of body weight or percent body fat, commonly associated with disordered eating practices and the Triad. This data supports the hypothesis that female athletes are experiencing menstrual disturbances despite their body composition and may not be deriving the bone trophic effects associated with weight bearing activity.

NEUROANATOMICAL AND FUNCTIONAL CHANGES IN RESPONSE TO ONE MONTH OF INTENSIVE BALANCE TRAINING

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Purpose: : Training of balance and posture is important for many activities in everyday life and prevention of falls. Previous studies on animals and humans have established a dependency of the system for spatial nav-igation, located in medial temporal lobe, on the input from vestibular system [1]. However, it is unknown if training aimed on improvements in vestibular system function can lead to enhancement of spatial navigation skills. The aim of this study is to determine if one month of intensive slackline training can improve spatial orientation capabilities together with balancing skills and cause corresponding neuroanatomical changes.

Methods: Fifty healthy young subjects (mean age = 23.8 years; SD = 2.7 years; 24 females) were recruited for this study. The subjects were divided into training (n = 25, mean age = 23.2 years; SD = 2.5 years; 12 females) and control group (n = 25, mean age = 24.4 years; SD = 2.8 years; 11 females). Professional instructor taught training group to slackline over four consecutive weeks with three 60-minute-trainings in each week. Data acquisition was performed at two time points: 1) baseline, 2) after the training

Applied tests [2]: Clinical balance tests (CBT); Orientation test - triangle completion task (OT); Structural MRI.

Results: Significant interaction effects: 1) CBT-closed eyes (1.64±0.46 vs. -0.07±0.64, p=0.02) and 2) OT-wheelchair (21.29±5.95 vs. 1.09±8.33); Corresponding volumetric brain changes in sensory-motor and temporal regions in the training group.

Conclusions: Intensive balance training in the form of slackline learning can significantly improve vestibular system function; this leads not only to enhancement in balancing skills but also in one's ability to orientate in space without visual input and to neuroanatomical alterations in sensory-motor cortex. Modifying this method could be beneficial for AD patients who suffer from a loss of spatial navigation skills.

References

1. Allen GL, Kirasic KC, Rashotte M a, Haun DBM. Aging and path integration skill: kinesthetic and vestibular contributions to wayfinding. *Percept Psychophys*. 2004; 66(1):170-179.
2. Dordevic M, Hokelmann A, Muller P, Rehfeld K, Muller NG. Improvements in Orientation and Balancing Abilities in Response to One Month of Intensive Slackline-Training. A Randomized Controlled Feasibility Study. *Front Hum Neurosci*. 2017; 11:55.

RELATIONSHIPS BETWEEN *ACE*, *AGT*, *AGTR1*, *MB* GENOTYPES AND PHYSICAL PERFORMANCE PHENOTYPE IN LITHUANIAN ELITE ATHLETES

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Purpose: Angiotensin I converting enzyme (*ACE*), angiotensinogen (*AGT*) and angiotensin II type 1 receptor (*AGTR1*) genes are important for the angiotensin-renin system which is crucial for the function of the cardiovascular system and affects ones physical capacity. Myoglobin (MB) plays a crucial role in energy metabolism by carrying molecular oxygen between the capillaries and the mitochondria to satisfy the requirement for sustained work. The objective was to evaluate the association of 4 genetic variants (*ACE*(I/D), *AGT*(C704T), *AGTR1*(A1166C), *MB*(A79G)) on physical performance phenotype in Lithuanian athletes.

Methods: 180 Lithuanian elite athletes (endurance-oriented (n=81), power-oriented (n=44), mixed–anaerobic/aerobic athletes (n=55)) and 255 controls (healthy nonathletes group), were genotyped (PCR-RFLP). Anthropometric measurements, anaerobic muscle strength (based on handgrip strength (maximal isometric power of the forearm muscles), vertical jump (short-term explosive muscle power (STEMP)) and aerobic capacity function (VO_2max) were evaluated.

Results: According to our results, *ACE*-I allele was more frequent in the power-oriented group compared to other sports groups and the control. The frequency of *MB*-G allele was higher in endurance-oriented athletes than in controls (P=0.001). We found that the influence of *ACE, AGTR1* and *MB* polymorphisms on the phenotype is different depending on gender and associated with a complex phenotypic characteristic. The athletes, carriers of the *ACE* II and *AGTR1* AA genotypes in the power-oriented group had higher muscle mass, handgrip strength and STEMP compared to the *ACE* DD and *AGTR1* CC genotypes athletes. The *AGTR1* A/A and *MB* G/G significantly increases VO_2max level for males – effect of *MB* G/G almost twice larger as *AGTR1* A/A. The power-oriented athletes with the *MB* AA genotype had significantly higher height, muscle mass, grip strength and STEMP than GG genotyped athletes. Statistical analysis revealed no significant phenotypic indexes differences between athletes with different *AGT* genotypes.

Conclusions: Our results suggest that *ACE*, *AGTR1* and *MB* genetic variants influence human physical performance. The *ACE* II and *MB* AA genotypes are related to power sports and associated with anaerobic capacity. The *MB* GG genotype is associated with higher aerobic capacity. The *AGTR1* genotypes show unique characteristics and the A allele might influence general sporting prowess.

SHORT-TERM HEART RATE VARIABILITY OF ELDERLY PEOPLE

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Abstract

The heart rate variability (HRV) is an indicator of the state of the autonomic nervous system. The short-term HRV (time- and frequency-domain parameters) of 107 subjects between 60 and 84 years was measured with the Omegawave system. There were no significant differences between the three age groups (60-66, 67-73 and >73 years). But there was a tendency of a decline of SDNN, which indicates a decline of HRV, and a decline of LF power in the elderly groups. The results showed that the HRV of elderly people above 60 years is hardly changing.

Key words: *heart rate variability, elderly, Omegawave, cardiovascular system*

Introduction

The heart rate variability (HRV) describes the beat-to-beat variation of RR-intervals in the ECG. It is an indicator of the state of the dynamic stability of the cardiovascular system and evaluates the autonomic nervous system (Pumprla, Howorka, Groves, Chester & Nolan, 2002). In the last decades it became a popular diagnostic tool in science and sports. Although the mechanisms triggering HRV aren't completely understood, the majority agrees, that the HRV reflects a complex interaction between sympathetic and parasympathetic influences (Draghici & Taylor, 2016). Under normal conditions the sinoatrial node (SA), which is innervated by sympathetic and parasympathetic nerves, regulates the heart rate (Shaffer, McCraty & Zerr, 2014). Sympathetic and parasympathetic transmitters have different time courses in their effects. This is the reason why they exert different influences on HRV (Pumprla et al., 2002).

In general, a higher HRV is a sign for good adaptability and a good state of autonomic control mechanisms (Draghici & Taylor, 2016). Reyes del Paso, Langewitz, Mulder, van Roon & Duschek (2013) state restrictingly: "Finally, the fact that all HRV components predominantly relate to vagal control does not imply that they provide the same information about autonomic regulation."

Nonetheless, studies showed relations between lower HRV and higher mortality of patients because of cardiovascular diseases (Yataco, Fleisher & Katzel, 1997). There is only a small connection between HRV and behavior-related risk factors (Kluttig, et al., 2010). Unproved is the derivation of a higher mortality of healthy people with reduced HRV. On the other side, HRV seems to be a good indicator for the evaluation of preventive activities (Sammito, Thielmann, Seibt, Klussmann, Weippert & Böckelmann, 2014).

In the last two decades studying HRV of elderly people got important. Meanwhile, there are a lot of studies demonstrating reduced HRV of elderly people (i.a. Antelmi, de Paula, Shinzato, Peres, Mansur & Grupi, 2004). Longitudinal studies showed declines of HRV through aging (i.a. Jandackova, Scholes, Britton & Steptoe, 2016). However, it is not clear if this decline refers to normal aging processes or if it is also caused by drugs and cardiovascular diseases. Different studies used different methods, e.g. different recording lengths produce different absolute values (few minutes until 24 hours). Therefore, no quantitative comparisons are possible. There aren't norm values for different ages. HRV has to be measured not only once to get reliable data (Sammito et al., 2014). The advantage of HRV measurement is that it is simple, cost-efficient and non-invasive. The goal of this study is to measure the short-term HRV of people above 60 years with the Omegawave System (Omegawave Technology, Espoo, Finland).

Methods

107 subjects between 60 and 84 years were measured and divided into three age groups: 60 to 66, 67 to 73 and older than 73 years (table 1). The anthropometric data showed no significant differences between the groups. The subjects were recruited from sport and dance courses for seniors and advertisements. Exclusion criteria were severe neurological diseases (e.g. Parkinson`s disease) and pace maker. All subjects were informed about the procedure and had to sign a consent form. The subjects were measured with the system of Omegawave (Espoo, Finland). The measurements were taken according the protocol of Omegawave. The average of three measurements on three days was used for the statistical analysis to exclude possible artefacts. The parameters standard deviation of all RR-intervals (SDNN in ms), square root of the mean of the sum of the squares of differences between adjacent RR-intervals (RMSSD in ms), low frequency power (LF in ms²), high frequency power (HF in ms²), LF in normalized units (LF nu), HF in normalized units (HF nu) and the

ratio LF/HF were measured. Draghici & Taylor (2016) described the parameters. Statistical analysis was conducted with IBM SPSS 24. Normal distributions of the age groups of all parameters were conducted with Shapiro-Wilk test. Subjects with extra systols or signal problems were excluded. T-test resp. Mann-Whitney U test were used to measure differences between age groups. P-value was defined at .05.

Results

Table 1: Descriptive statistics of the sample

	Age groups (in years)		
	60 to 66 (n=40)	67 to 73 (n=32)	> 73 (n=35)
Female/male	33/7	21/11	21/14
Age, mean ±SD, years	63.78 ±1.89	69.91 ±2.02	76.80 ±2.53
Height, mean ±SD, cm	164.75 ±7.07	165.97 ±7.46	167.69 ±8.58
Weight, mean ±SD, kg	71.58 ±14.59	70.38 ±9.88	76.12 ±13.30
BMI, mean ±SD, kg/m²	26.29 ±4.66	25.51 ±2.86	27.04 ±3.76

LF nu und HF nu were the only normal distributed parameters. The statistical analysis indicates no significant differences between the groups in none of the parameters. At least there was a tendency between the age groups 60-66 and >73 in the parameter LF (p-value .051). Figure 1 shows the time-domain parameters SDNN and RMSSD. SDNN slightly declines (27.4; 26.91 resp. 24.08ms for 60-66; 67-73 resp. >73years) whereas RMSSD (16.99; 19.54 resp. 18.56ms) were unstable. Figure 2 illustrates the frequency-domain indices. LF declines continuously over the groups (63.18; 49.48 resp. 40.54ms²). HF has its peak in the 2nd group (33.54; 44.48 resp. 35.3ms²). LF nu (63.66; 58.6 resp. 58.63) and HF nu (36.34; 41.4 resp. 41.36) seem pretty stable over the groups. The ratio LF/HF (3.17; 3.19 resp. 3.48) is in the oldest group slightly higher than in the younger groups (figure 3).

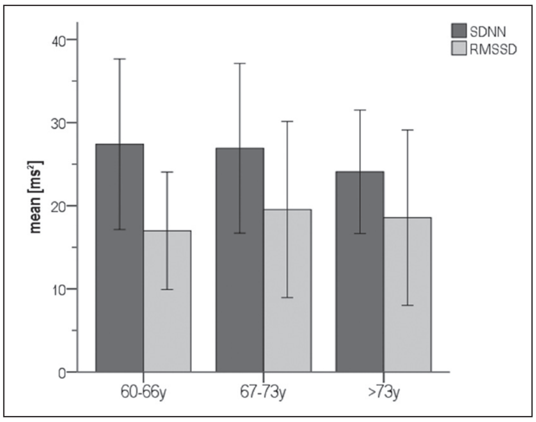

Figure 1: Results for time-domain HRV parameters. Data are presented as M ± SD.

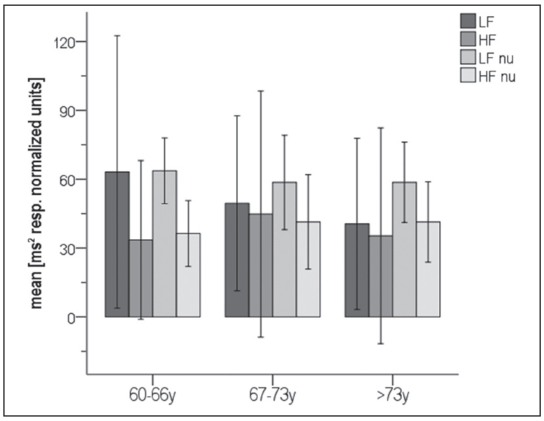

Figure 2: Results for frequency-domain HRV parameters. Data are presented as M ± SD.

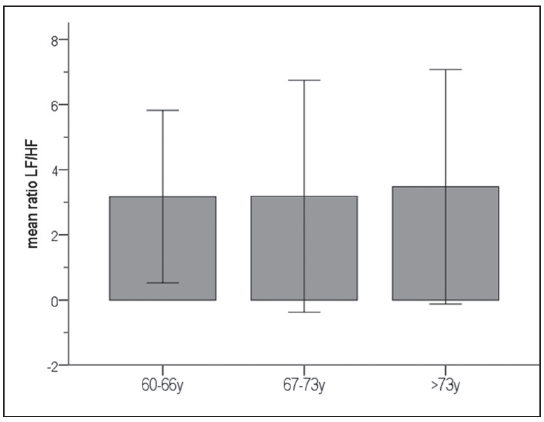

Figure 3: Results for ratio LF/HF. Data are presented as M ± SD.

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Discussion

Normally, at rest, parasympathetic activity predominates through acetylcholine release. In this state the heart rate is low and the HRV is higher than under sympathetic activity (Pumprla et al., 2002). Release of noradrenalin raises sympathetic activity and the heart rate. Physical and mental stress and diseases are expressions of increased sympathetic activity with low HRV (Draghici & Taylor, 2016). At these states the adaptability of regulatory systems is limited (Shaffer et al., 2014). The assertion that LF reflects sympathetic activity and LF/HF indicates sympathovagal balance is controversial (Reyes del Paso et al., 2013).

Because of their calculation method the time-domain parameters SDNN and RMSSD represent the variability of the RR-intervals. But it isn't clarified which part of the autonomic system is reflected by SDNN. Maybe, RMSSD is basically attributed to the parasympathetic system (Sammito et al., 2014). Draghici & Taylor (2016) states that both parameters "cannot distinguish between changes in HRV due to increased sympathetic tone or withdrawal of vagal tone".

Studies investigating the short-term HRV found reduced values of time-domain indices in elderly compared to young and middle-aged people (Agelink et al., 2001; Sinnreich, Kark, Friedlander, Sapoznikow & Luria, 1998). Long-term recordings also found these differences (Almeida-Santos, Barreto-Filho, Oliveira, Reis, da Cunha Oliveira & Sousa, 2016; Antelmi et al., 2004; Stein, Kleiger & Rottman, 1997). The longitudinal study from Jandackova et al. (2016) also detected a decline of SDNN over ten years. The behavior of RMSSD of elderly is not that clear (Almeida Santos et al., 2016; Antelmi et al., 2004). These studies are in line with our results showing no significant differences in RMSSD but a decline of SDNN. One reason for the controversial results of RMSSD could be the strong influence of ventilation (Draghici & Taylor, 2016).

Studies investigating short- and long-term HRV found reduced values in frequency-domain indices of seniors compared to young and middle-aged people. Ryan et al. (1994) and Sinnreich et al. (1998) found reduced values of LF and HF and increased values for LF/HF. On the other side Antelmi et al. (2004) showed that LF/HF increases until the age of 50 and then declines. We found a tendency of decline of LF and a small incline of LF/HF whearas HF showed no clear tendency. These conflicting results demonstrate that the behavior of the ratio isn't clear because of the different changes of LF and HF in the course of aging.

This is the first study investigating the HRV of seniors with the Omegawave system. Normally this system is used for athletes to monitor their fitness level and prevent overtraining. There are already studies which used Omegawave and they confirmed its validity (Parrado, García, Ramos, Cervantes, Rodas & Capdevila, 2010). However, Omegawave analyses only 120 heart beats and works with a chest strap with two electrodes. Therefore, a comparison of absolute values with other studies is not possible. On the other side this system is very user-friendly. Our data show high standard deviations, especially for the frequency-domain parameters. One reason could be the heterogeneity of the subjects in their cardiovascular states or drugs. Anyhow, subjects with extra systols and arrhythmia were excluded. To get significant results smaller age-groups with more subjects would be necessary. Another reason, why no significant differences were detected, could be that the HRV of elderly people isn't changing anymore.

Conclusion

This study investigated the short-term HRV of people above 60 years. The results showed no significant differences in HRV parameters between the three age groups. There was a small decline in SDNN and LF power from the youngest to the oldest group. In the two elderly groups LF nu was very little smaller. The results do not confirm a change of sympathetic or parasympathetic tone of elderly people.

References

1. Agelink, M. W., Malessa, R., Baumann, B., Majewski, T., Akila, F., Zeit, T., et al. (2001). Standardized tests of heart rate variability: normal ranges obtained from 309 healthy humans, and effects of age, gender, and heart rate. *Clinical Autonomic Research, 11*(2), pp. 99-108.
2. Almeida-Santos, M. A., Barreto-Filho, J. A., Oliveira, J. L., Reis, F. P., da Cunha Oliveira, C. C., & Sousa, A. C. (2016). Aging, heart rate variability and patterns of autonomic regulation of the heart. *Archives of Gerontology and Geriatrics, 63*, pp. 1-8.
3. Antelmi, I., de Paula, R., Shinzato, A. R., Peres, C. A., Mansur, A. J., & Grupi, C. J. (2004). Influence of Age, Gender, Body Mass Index, and Functional Capacity on Heart Rate Variability in a Cohort of Subjects Without Heart Disease. *American Journal of Cardiology, 93*(3), pp. 381-385.
4. Draghici, A. E., & Taylor, J. A. (2016). The physiological basis and measurement of heart rate variability in humans. *Journal of Physiological Anthropology, 35*(22), pp. 1-8.
5. Jandackova, V. K., Scholes, S., Britton, A., & Steptoe, A. (2016). Are Changes in Heart Rate Variability in Middle-Aged and Older People Normative or Caused by Pathological Conditions? Findings From a Large Population-Based Longitudinal Cohort Study. *Journal of the American Heart Association, 2*, pp. 1-13.

6. Kluttig, A., Schumann, B., Swenne, C. A., Kors, J. A., Kuss, O., Schmidt, H., et al. (2010). Association of health behaviour with heart rate variability: a population-based study. *BMC Cardiovascular Disorders, 10*, pp. 1-11.
7. Parrado, E., García, M. Á., Ramos, J., Cervantes, J. C., Rodas, G., & Capdevila, L. (2010). Comparison of Omega Wave System and Polar S810i to Detect R-R lntervals at Rest. *International Journal of Sports Medicine, 31*(5), pp. 336-341.
8. Pumprla, J., Howorka, K., Groves, D., Chester, M., & Nolan, J. (2002). Functional assessment of heart rate variability: physiological basis and practical applications. *International Journal of Cardiology, 84*, pp. 1-14.
9. Reyes del Paso, G. A., Langewitz, W., Mulder, L. J., van Roon, A., & Duschek, S. (2013). The utility of low frequency heart rate variability as an index of sympathetic cardiac tone: A review with emphasis on a reanalysis of previous studies. *Psychophysiology, 50*, pp. 477-487.
10. Ryan, S. M., Goldberger, A. L., Pincus, S. M., Mietus, J., & Lipsitz, L. A. (1994). Gender- and age-related differences in heart rate dynamics: are women more complex than men? *Journal of the American College of Cardiology, 24*(7), pp. 1700-1707.
11. Sammito, S., Thielmann, B., Seibt, R., Klussmann, A., Weippert, M., & Böckelmann, I. (2014, 6 30). *Leitlinie. Nutzung der Herzschlagfrequenz und der Herzfrequenzvariabilität in der Arbeitsmedizin und der Arbeitswissenschaft*. Retrieved 10 22, 2015, from AWMF online: http://www.awmf.org/leitlinien/detail/ll/002-042.html
12. Shaffer, F., McCraty, R., & Zerr, C. L. (2014). A healthy heart is not a metronome: an integrative review of the heart's anatomy and heart rate variability. *Frontiers in Psychology, 5*(1040), pp. 1-19.
13. Sinnreich, R., Kark, J. D., Friedlander, Y., Sapoznikow, D., & Luria, M. H. (1998). Five minute recordings of heart rate variability for population studies: repeatability and age–sex characteristics. *Heart, 80*(2), pp. 156-162.
14. Stein, P. K., Kleiger, R. E., & Rottman, J. N. (1997). Differing Effects of Age on Heart Rate Variability in Men and Women. *The American Journal of Cardiology, 80*(3), pp. 302-305.
15. Stenfors, C. U., Hanson, L. M., Theorell, T., & Osika, W. S. (2016). Executive Cognitive Functioning and Cardiovascular Autonomic Regulation in a Population-Based Sample of Working Adults. *Frontiers in Psychology, 7*(1536), pp. 1-13.
16. Yataco, A. R., Fleisher, L. A., & Katzel, L. I. (1997). Heart Rate Variability and Cardiovascular Fitness in Senior Athletes. *American Journal of Cardiology, 80*(10), pp. 1389-1391.

THE SECULAR CHANGES IN ANTHROPOMETRIC MEASURES OF PRESCHOOL GIRLS IN THE PERIOD FROM 1998 - 2013

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Abstract

The goal of this study is to determine secular changes in anthropometric measures of preschool girls at the age of six over a period of fifteen years. The study sample consisted of 372 preschool girls. The measurements were carried out four times (in 1998, 2003, 2008 and 2013). The sample of variables consisted of eight anthropometric measures. For the purpose of establishing the differences in anthropometric characteristics between girls for which measurements were taken four times over the period of fifteen years, the ANOVA was used, with Bonferonni post-hoc test. The obtained results reflect the inharmonious trend of change in certain anthropometric characteristics, which were established for girls at preschool age, during the observed period of fifteen years. Statistically significant differences between the generations of girls were not found only in two variables: Body Mass Index (BMI) and Body weight. The results obtained, not only regarding secular trends, but also the absolute values of means for the relevant variables (e.g. BMI), indicate important practical implications.

Key words: *inharmonious trend, morphological characteristics, 6-year-old children*

Introduction

The investigation of secular changes in anthropometric measures of preschool children is very important to emphasize possible changes in generational trends. Anthropometry is a research method of anthropology that aims to determine the dimensions of the human body and their assessment (Ekonomskileksikon, 2015). The goal of anthropometry is as accurate as possible measuring and quantitative characterization of morphological and physiological characteristics of human body (Ujević & Kaurić, 2013). Anthropometry is used in many research areas and is particularly important in the field of kinesiology in the studies that monitor the development and growth of children (Doi, Williams, & Frank, 2016; Herpertz-Dahlmann et al., 2003).

It has been established that growth and development are affected by a number of very complex endogenous and exogenous factors. The endogenous factors are biological heritage, genetics, hormonal status and gender, while the exogenous are nutrition, socio-economic status, climate, human race, birth weight, chronic diseases, seasonal differences, secular trend, physical activity, exercise and sport (Komlos & Baten 2003). Morphological changes in children are indicators of their health and nutritional status. Those changes, observed in several generations of the past century, had a positive trend, i.e., from one generation to the next the children were higher and matured earlier. This phenomenon is called the “secular trend”. The reason for the positive secular trend in the last century was a general improvement in nutrition and health care, better medical care, positive developments in terms of residence and fewer families (Šegregur, Kuhar & Paradžik, 2010).

Numerous researchers over the world investigated the secular trends in height, weight, as well as time- and age-related differences in the prevalence of overweight, obesity and in body composition in children in the past decades (Cetinić, Vidaković-Samaržija, & Cetinić, 2008; Horvat, Mišigoj-Duraković, & Prskalo, 2009; Kowal, Kryst, Woronkowicz, & Sobiecki, 2014; Marques-Vidal, Madeleine, Romain, Gabriel, & Bovet, 2008; Nascimento et al., 2010). These investigations of somatic characteristics point to the phenomenon of biological acceleration. The authors concluded that secular trend is influenced by genetic heritage, civilizational progress and environmental factors. The data about the increasing obesity that occurs early in human life, mainly because of sedentary behavior, and frequently combined with inadequate dieting are most disturbing.

The goal of this study is to determine the secular changes in anthropometric measures of preschool girls at the age of six over a period of fifteen years. In other words, to determine the differences in anthropometric measures of preschool girls in the defined age group.

Methods

The study sample consisted of 372 preschool girls at the age of 6.5 (± 6 months). The measurements were carried out four times over a period of 15 years. In 1998 the sample included 40 girls, in 2003 there were 98 girls in 2008 there were 122 preschool girls and in 2013 the sample comprised 112 girls. The sample of variables consisted of eight anthropometric measures: body weight, body height, upper arm circumference, forearm circumference, thigh circumference, calf circumference, sum of skinfolds (triceps skinfold, abdominal skinfold), and body mass index. For all of the respondents parents' consents were collected. Trained measurers carried out measuring observing the standard protocol during the mornings in three kindergartens in the city of Zagreb. The collected data were processed by the statistical program SPSS. For all variables the central and dispersive parameters were calculated. For the purpose of determining the secular changes in anthropometric measures of preschool girls over a period of fifteen years, i.e. in order to establish the differences in anthropometric characteristics between girls with the measurements being taken four times over the period of fifteen years, the ANOVA was used, with Bonferonni post-hoc tests (the variances for all the variables were homogenous). Naturally, all other presumptions for applying ANOVA were satisfied: all the variables are ratio-type, revealing normal distribution (Gaussian), with all subsamples of participants higher than 30. The results were commented on the level of significance of $p<0.05$.

Results and Discussion

Results of ANOVA that are reflecting secular trends between the generations of the girls at the age of six, for all measured anthropometric characteristics of preschool girls collected during the period from 1998 to 2013 can be seen in Table 1.

Table 1: Results of ANOVA between girls at the age of six for all anthropometric variables

Variables	Year	Mean	Std. Deviation	F (df= 3, 368)	Differences between groups
Body weight	1998	23.475	4.5120	0.324	-
	2003	**23.291**	3.9605		
	2008	23.567	3.9533		
	2013	**23.827**	3.8156		
Body height (cm)	1998	**119.058**	6.9805	**4.450****	1998-2013, 1998-2008
	2003	120.546	5.0689		
	2008	**122.289**	5.6265		
	2013	121.814	5.1550		
Overall skinfolds	1998	**17.0458**	10.4417	**11.783****	1998-2003, 2003-2013, 2008-2013
	2003	**24.0374**	12.2004		
	2008	21.4428	7.9063		
	2013	17.2440	6.6599		
Upper arm circumference	1998	18.888	1.9599	**12.214****	1998-2003, 2003-2013, 2008-2013
	2003	**17.650**	1.7993		
	2008	18.304	2.0011		
	2013	**19.265**	2.1802		
Forearm circumference	1998	**18.050**	1.3950	**12.398****	1998-2003, 2003-2013, 2008-2013
	2003	**16.867**	1.3763		
	2008	16.931	1.4611		
	2013	17.683	1.3668		
Thigh circumference	1998	36.422	3.9881	**3.343***	2008-2013
	2003	**35.240**	4.1716		
	2008	35.288	3.1360		
	2013	**36.498**	3.4958		
Calf circumference	1998	25.300	2.1665	**3.759***	2003-2013
	2003	**24.601**	2.1351		
	2008	25.314	2.1617		
	2013	**25.579**	2.2210		
Body Mass Index (BMI)	1998	**16.4770**	2.19875	1.735	-
	2003	15.9758	2.15913		
	2008	**15.6888**	1.83364		
	2013	15.9818	1.73602		

Legend: Bold – the highest and the lowest values of means and statistically significant differences; * significant differences at $p<0.05$; ** significant differences at $p<0.01$

The results obtained reflect inharmonious trend of change in certain anthropometric characteristics, which were established for girls in preschool age, at the age of 72±6 months, over the period of fifteen years. Statistically significant differences between the generations of girls were not found only for two variables: Body Mass Index (BMI) and Body weight. However, for all the other measures statistically significant differences were found, but only for some variables (for example for body height, thigh circumference, calf circumference…), so the trends could be perceived as harmonious during the observed time period. The highest number of statistically significant differences among the generations of preschool girls were found for the variable forearm circumference. This is understandable given the size of the sample and the relatively short time for possible changes in the measured anthropometric characteristics.

The data we were particularly interested in primarily related to possible changes in those anthropometric characteristics for which certain changes can be expected. This primarily refers to the measures of body weight, circumference and subcutaneous adipose tissue. We are all familiar with a trend that is taking place in most countries (Agras, Hammer, McNicholas, & Kraemer, 2004; Best, Neufingerl, van Geel, van den Briel, & Osendarp, 2010; Wang, Monteiro, & Popkin, 2002) and with consequence of sedentary lifestyle (Basterfield et al., 2011; Taylor, R. W., Williams, Farmer & Taylor, B J., 2013; Vincent, Pangrazi, Raustorp, Tomson & Cuddihy, 2003). A continuous increase in body weight and amount of subcutaneous adipose tissue was found. Croatia, unfortunately, is no exception (Mišigoj-Duraković, Heimer, S., Gredelj, Heimer, Ž., & Sorić, 2007; Poljičanin & Benjak, 2013).

Looking at the results of body weight it can be determined that with these measures there has been no statistically significant change. The values obtained for fifteen years are generally at the same level. This data is encouraging because it shows that in the studied sample of girls during this period there was no increase in body weight. This is also evidenced by the value of BMI, which did not significantly change either. What is less encouraging is value of BMI when we look at the tables prepared by the Centers for Disease Control and Prevention (2000). Results of the girls who participated in this study show that their values are at 75 percentile of the population and have reached the upper limit of a normal body weight and increased body weight. We cannot be satisfied with this result.

On the other hand, the results of various circumferences of extremities suggest that in the fifteen-year period their value mostly increased. These results are certainly significantly correlated with the results of subcutaneous adipose tissue. Based on the results significant increase in the value of subcutaneous adipose tissue in the first two measurements can be determined. Namely, in almost all measures until 2008 a significant increase was found. In that period for most measured variables certain changes can be observed and ,more importantly, they are all in the positive direction. A significant decrease in the value of subcutaneous adipose tissue is noticeable. At that time (around 2008), under the influence of scientific and professional community in the kindergartens of Zagreb significant changes in the nutrition of children were introduced (The Ministry of Health and Social Care, 2007). It was characterized by the abandonment of the previous practice of nutrition that was based mainly on carbohydrates and changing to the nutrition that included a significant amount of fruits and vegetables. The results obtained in 2013 indicate that it was a good decision. The values of skinfolds on the triceps, abdomen and subscapular have, between 2003 and 2013, been reduced by almost a quarter. It would be interesting to see if this trend will still continue.

Conclusion

These results, obtained over the fifteen-year period among girls aged six years, show that the trend of ballast mass stopped and turned into a positive direction. On the other hand, the values of BMI are still relatively high and it should be worked on in order to decrease them by increasing energy consumption through daily physical activity, which is at the moment insufficient. Recommendations presented by the World Health Organization say that each child should be physically active at least 60 minutes per day. This is primarily the responsibility of parents, educators, teachers and kinesiology experts as well as all those individuals who take part in the upbringing and education of preschool children.

References

1. Agras, S.W., Hammer, D.L., McNicholas, F., & Kraemer, C.H. (2004). Risk factors for childhood overweight: A prospective study from birth to 9.5 years. J Pediatr, 145(1), 20-25.
2. Basterfield, L., Adamson, A.J., Frary, K.J., Parkinson, N.K, Pearce, M.S., & Reilly, J.J. (2011). Longitudinal Study of Physical Activity and Sedentary Behavior in Children. Pediatr, 127(1), e24-e30. doi: 10.1542/peds.2010-1935
3. Best, C., Neufingerl, N., van Geel, L., van den Briel, L., &Osendarp, S. (2010). The nutritional status of school-aged children: Why should we care? Food Nutr Bull, 31(3), 400-417.
4. Centers for Disease Control and Prevention (2000). What is a BMI percentile? /on line/. Received on 13rd January 2017. From https://www.cdc.gov/growthcharts/data/set1clinical/cj41l023.pdf
5. Cetinić, J., Vidaković-Samaržija, D., & Cetinić, V. (2008). Fenomenbiološkeakceleracijeispolnidimorfizam u prirastuvisineitežine u učenikasrednješkoleblatoi vela luka. *MagistraIadertina*, *3*(1), 7-19.

6. Doi, L., Williams, A.J., & Frank, J. (2016). How has child growth around adiposity rebound altered in Scotland since 1990 and what are the risk factors for weight gain using the Growing Up in Scotland birth cohort 1? *BMC Public Health*, *16*(1). https://doi.org/10.1186/s12889-016-3752-z
7. Ekonomski leksikon (CD ROM/1995). *Leksikografski zavod Miroslav Krleža*, Masmedia, Zagreb /on line/. Received on 22nd December 2016 from http://www.enciklopedija.hr/Natuknica.aspx?ID=3195
8. Herpertz-Dahlmann, B., Geller, F., Böhle, C., Khalil, C., Trost-Brinkhues, G., Ziegler, A., &Hebebrand, J. (2003). Secular trends in body mass index measurements in preschool children from the City of Aachen, Germany. *European Journal of Pediatrics*, *162*(2), 104–109. https://doi.org/10.1007/s00431-002-1056-z
9. Horvat, V., Mišigoj-Duraković, M., &Prskalo, I. (2009). Body Size and Body Composition Change Trend in Preschool Children over a Period of Five Years. *Collegium Antropologicum, 33*(1), 99-103.
10. Komlos, J., &Baten, J. (2003). Looking Backward and Looking Forward: Anthropometric Research and the Development of Social Science History /on line/. Received on 13rd January 2017. fromhttps://epub.ub.uni-muenchen.de/59/1/komlos_baten.PDF
11. Kowal, M., Kryst, A., Woronkowicz, A., &Sobiecki, J. (2014). Long-term changes in body composition and prevalence of overweight and obesity in girls (aged 3-18 years) from kraków (poland) from 1983, 2000 and 2010. *Annals of Human Biology*, *41*(5), 415-427. https://doi.org/10.3109/03014460.2013.878394
12. Marques-Vidal, P., Madeleine, G., Romain, S., Gabriel, A., & Bovet, P. (2008). Secular trends in height and weight among children and adolescents of the Seychelles, 1956–2006. *BMC Public Health*, *8*, 166. https://doi.org/10.1186/1471-2458-8-166
13. Mišigoj-Duraković, M., Heimer, S., Gredelj, M., Heimer, Ž., & Sorić, M. (2007). Tjelesna neaktivost u Republici Hrvatskoj. Acta Med Croatica, 61,253-258. Tjelesna neaktivost u Republici Hrvatskoj. Acta Med Croatica, 61, 253-258
14. Nascimento, V. G., Bertoli, C. J., Bertoli, L. M. Q., Feferbaun, R., Abreu, L. C. de, & Leone, C. (2010). Tendência secular de crescimento em pré-escolares, Brasil. *Revista Brasileira de Crescimento E Desenvolvimento Humano*, *20*(2), 199-207.
15. Poljičanin, T., & Benjak, T. (2013). Hrvatski zdravstveno-statistički ljetopis 2012. Zagreb: Hrvatski zavod za javno zdravstvo
16. Šegregur, D., Kuhar, V., & Paradžik, P. (2010). Antropometrijska, motorička i funkcionalna obilježja učenika prvih razreda srednjih škola, *Hrvatski* športskomedicinski *vjesnik, 25*. 67-74.
17. Taylor, R.W., Williams, S.M., Farmer, V.L., & Taylor, B.J. (2013). Changes in Physical Activity over Time in Young Children: A Longitudinal Study Using Accelerometers. PLoS ONE, 8 (11), e81567. doi:10.1371/journal.pone.0081567
18. The Ministry of Health and Social Care (2007). Izmjene i dopune Programa zdravstvene zaštite djece, higijene i pravilne prehrane djece u dječjim vrtićima /on line/. Received on 13rd January 2017. from http://narodne-novine.nn.hr/clanci/sluzbeni/2007_11_121_3527.html
19. Ujević, D., & Kaurić, A.G. (2013). Anthropometry as complementary measurement of living standard. *Business excellence, 7*(2), 145-154.
20. Vincent, S.D., Pangrazi, R.P., Raustorp, A., Tomson, L.M., &Cuddihy, T.F. (2003). Activity levels and body mass index of children in the United States, Sweden, and Australia. Med Sci Sports Exerc, 35 (8), 1367-1373
21. Wang, Y., Monteiro, C., &Popkin, B. M. (2002). Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China and Russia. Am J ClinNutr, 75 (6), 971-977

CORRELATION BETWEEN HYPERMOBILITY SCORE AND INJURY RATE IN ARTISTIC GYMNASTICS PLAYERS

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Purpose: Generalized Joint Hypermobility (GJH) is suggested as a contributing factor for injuries in young athletes and adults. It is presumed that GJH causes decreased joint stability, thereby increasing the risk of joint and soft tissue injuries during sports activities, especially in situations like jumping, landing and change direction activities during sports performing. The aim of this study is to correlate the hypermobility rate (Beighton`s modification of the Carter-Wilkinson criteria of hypermobility) in gymnastics players and injury rate, during the one year period (from March 2015. till February 2016.).

Methods: This study observed 24 artistic gymnastics players and compared GJS score and injury rate in relations to players characteristics (age, sex) and gymnastics characteristics (training per day and number of years training gymnastics).

Results: We found no correlation between GJS score and injury rate, but we found high statistical significance between injury rate and number of years of gymnastics training.

Conclusions: According to this study there is no correlation between GJH rate and injury rate in artistic gymnastics players. More significant is total training period in injury rate.

CYCLING IN THE FUNCTION OF PHYSICAL ACTIVITY THROUGH ACTIVE COMMUTING

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Abstract

Active commuting is defined as walking or cycling to work, school, university, which makes it one of the ways to increase physical activity. The World Health Organization works on increasing the proportion of the population that meets the recommended accumulation of 30 minutes of moderate physical activity for five or more days per week, which can be achieved through active commuting, especially when using bicycles. The objective of this study was to examine the frequency of use of bicycles in the city of Zagreb and its association with the weather parameters. The research was conducted on a sample of 153 inhabitants of a building in Zagreb, in the urban area connected with the entire city via bikeway network. Data on the frequency of active commuting and weather conditions were acquired in a two-week period. Assumptions underlying this research are that the bicycle culture in the context of active commuting in Zagreb is not on the level of Western European cities and that bad weather conditions have significantly negative impact on the frequency of cycling during commuting. Bicycle owns 19.6% of the examinee. For active commuting bike is used by 6.36% of working-age employed individuals. The bicycle culture in the context of active commuting in Zagreb in comparison to Western European cities proved to be insufficient. Strong correlation was found between the amount of rain and the number of bikes in use ($r = -0.64$), which confirms the second assumption underlying this research. Proper and safe use of bikes in active commuting requires users' awareness, but also the public support through urban and transport policies; systematic and with a range of developments, from raising the quantity and quality of cycling infrastructure, to promotional campaigns, in order to improve public health.

Key words: *active transportation, bike, health, chronic non-communicable diseases, prevention*

Introduction

Physical activity (PA) that has the optimal intensity and continuity, has potential to reduce the incidence of chronic non-communicable diseases. Insufficient PA significantly contributes to an increase in health problems in modern societies where sedentary behaviour has become an integral part of everyday life (Buekers et al., 2015). According to the World Health Organization (WHO), the insufficient PA is defined as less than five times with 30 minutes of moderate activity per week, or less than three times with 20 minutes of high-intensity activity per week (Alwan, 2011). Physical inactivity is one of the most important health challenges of the 21st century because of its impact on chronic diseases with high mortality. Despite the high health burden resulting from the lack of PA, a lot of money is still spent on treatment, but only a minor part on the disease prevention (Buekers et al., 2015). Ogilvie et al. (2004) emphasise increasing PA in the population as a first-line option for improving public health. In the modern way of life, it is quite difficult to spare time in PA to improve health. This opens the opportunity for active commuting (AC): a term defined as walking, cycling and public transport utilization to work or school (Xu et al., 2013). Such active mobility related to transport is appropriate for integration of PA as a part of the daily routine (Dons et al., 2015; Xu et al., 2013). Accumulated contributions of PA through AC could help to achieve the recommended guidelines of 30 minutes of PA per day. Several authors emphasise the health benefits of AC (Merom et al., 2008; Rissel et al., 2012; Wanner et al., 2012). Wen and Rissel (2008) found travelling to work by car significantly correlated with the incidence of obesity, and that people who cycle to work are significantly less exposed (39.8%) to be overweight. Furthermore, transportation policies are increasingly trying to reduce traffic congestion by stimulating people to switch from cars to alternative modes of transportation, such as cycling (Ogilvie et al., 2004). Reducing the vehicle use and increasing the distance travelled by walking and/or cycling could have significant health benefits through reducing air pollution in the urban environment and against the prevalence of physical inactivity and associated manifestations of chronic non-communicable diseases (Fraser & Lock, 2011). The integration of cycling in the daily routine is a potential approach for increasing PA, appropriate for many individuals who spend 30 minutes or more in commuting. Health aspects of daily cycling took the attention of the health sector in order to increase the level of PA, thus the transportation and urban planning sectors in order to verify the investment in cycling and associated infrastructure (Götschi et al., 2016). Dons et al. (2015) provide that in addition to the direct health benefits of PA, active mobility is associated with mental health. In their systematic review of health perspectives of cycling as a part of daily life, Götschi et al. (2016) concluded that most studies demonstrate greater benefits of PA, in relation to risks of accidents and exposure to air pollution. Authors state that the combination of such transport and PA does not cost a lot and does not require special skills, which makes it a suitable modality for large segments of the population.

The transition from secondary school to university is one of the major life adjustments, usually accompanied by a PA reduction (Molina-García et al., 2013). Such a decline in PA can potentially become irreversible: adulthood often brings one-way trends – after passing the driving test and buying a car, bike goes dump or remains a relict of the childhood, or in the best scenario, an element of leisure time and recreation. On the other hand, the implementation of a healthy lifestyle through raising awareness of the advantages of active transport can provide lifelong benefits in the prevention of chronic diseases. Previous perception of a car as a necessity, even a status symbol, and alternative, of the bicycle as a working class transport modality, has shifted greatly; today the proportion of cyclists in traffic is one of the indicators of development of the country, through the prism of traffic culture, health and environmental awareness.

The objective of this study was to examine the frequency of use of bicycles in the city of Zagreb and its association with the weather parameters. Assumptions underlying this research are that the bicycle culture in the context of AC in Zagreb is not on the level of Western European cities and that bad weather conditions have significantly negative impact on the frequency of AC using bikes.

Methods

Research on the use of bikes for AC was carried out in the city of Zagreb, during 10 working days, on a sample of the middle city district building, with 153 inhabitants. The building has a ground floor bike garage, with 50 bike wall hangers. The urban district is longitudinally and transversely well connected to a city centre and the suburban area, via bikeway network. Apartments in the building do not have a balcony nor a lodge, so it is a high probability that all bikes are located in the garage. Data collection began on Sunday, April 10, 2016 at 10 pm, with the assumption that in the mentioned period probably all the bikes are stored. In the next 10 working days number of bikes in the garage was registered at 10 am, with the assumption that all the people who use their bikes for active transport, went to work. The procedure was repeated every day at 10 pm. During this period, weather forecast was monitored consistently at 10 am. The data on temperature, relative humidity and pressure, as well as data on precipitation and wind, were observed and recorded. Evidence on the bicycles that were used in the reporting period led the research to the bike owners: information on their age, gender, professional qualification, smoking habits and location of the workplace were obtained via interview. Data on the bike usage could not be collected over the weekend, since bicycles were then randomly taken in different time of day, which suggests their use mainly for the purpose of leisure and recreation, but not AC.

Results

In a sample of 153 inhabitants of the building, there were 30 bikes recorded. According to the above, every fifth tenant (19.6%) possesses a bike. In this study conducted in 10 working days, mean of 4.2 bicycles were in use (median 4), minimum 2, maximum 8, which match to 2.74% of the population of the building. If the results complete with the data of the Croatian Bureau of Statistics data on the working age population in the first quarter of 2016, according to which the employees are 43.2% and 7.8% unemployed and 49% inactive, the approximate number of 66 employees live in the building. According to that, the estimation is that the bike for everyday AC uses every 15th tenant in average, or 6.36% of the employed working-age population. In this research, mean age of the active commuters was 31.25 years, 62.5% were male, 75% have university degree and 25% secondary school degree. All are non-smokers. According to the place of work, an average of 9.4 km travel to work and back in total is calculated. That implicates more than 30 minutes of moderate PA per day. The mean temperature was 13.7 °C at a relative humidity of 64.3% and pressure 1016.67 hPa on average. Such weather conditions are appropriate for cycling. Since distribution showed normality, Pearson's coefficient of correlation was used for data processing. The strong negative correlation ($r = -0.64$) was found between rainfall and the number of bikes in use. Other weather parameters were not significantly associated with the frequency of using bikes.

Discussion

Physical inactivity is one of the leading risk factors for chronic non-communicable diseases (Dons et al., 2015). Mueller et al. (2015) point out that 3 hours of cycling per week can reduce 28% of the risk of the most common causes of death.

Based on the results of this research, it is estimated that one in five adults in Zagreb owns a bike, and for AC average usage is 6.36% among working-age employees, while in the literature (Kuhnimhof et al., 2010) data for Germany shows that almost a third of adults uses a bike as a transport modality during the working week. Oja et al. (2011) point out that utilizing bike through AC just for few kilometres, can significantly improve cardiorespiratory status in adults who are not in good shape. By increasing the distance, improvement can reach 30%. Progress is minor but still significant among individuals with moderate and high level of fitness (Oja et al., 2011). Given the many positive indicators related to AC, the question arises: why car remains dominant transportation option. According to Kuhnimhof et al. (2010), the probability of choosing a motorized mode of transportation raises with increasing distance. Bad weather conditions also reduce the probability of choosing non-motorized modes. Cycling is negatively determined by weather conditions more than walking. Apart from the quantity and quality of transport infrastructure, one of the main obstacles for cycling within the AC are inadequate conditions for leaving bikes securely. Molina-Garcia et al. (2013) suggest one solution to this aspect: the public bike-sharing program, which consists of a bikeway network with locations where bicycles can be rented and where they are securely parked. In Zagreb, there is such a public bike-sharing network for a while, but the number of locations to rent or leave the public bike is still insufficient and too far away from most workplaces, schools and universities, which is an essential criterion to stimulate a significant number of people toward that option of active transport.

Relation between health benefits and the risks of accidents and inhalation of polluted air was analysed in individuals who had changed the commuting modality from car to bicycle. On the basis of the research it is estimated that life expectancy related to increased PA is significantly higher (3-14 gained months), than it could be reduced due to increased respiration of polluted air (0.8-40 days) and to a higher potential for traffic accidents (5-9 days) (Oja et al., 2011). Xu et al. (2013) emphasised that the risk of injury per hour of AC, compared to recreational and professional sports, is relatively low. Health factors of increased PA exceed the risks significantly. Therefore, the promotion of active transport should be encouraged (Mueller et al., 2015). Recommendations for PA suggest duration of the activity in units of at least 10 minutes (Alwan, 2011). There are theories that regular cycling as on a daily or weekly basis, is more important for health than periodic vigorous activities (Götschi et al., 2016). Compared with walking, cycling health benefits are greater, due to a higher activity level (Oja et al., 2011). However, the causal nature of the associations remains unclear. The benefits resulting from cycling greatly depend on how active cyclists would be without cycling (Götschi et al., 2016). More generally, it is not known whether it appears to the acceptation of AC in groups that are already physically active, which gives a limited effect on physically inactive groups (Merom et al., 2008). Even high quality cross-sectional studies do not allow making conclusions regarding causality, and even the direction of correlations. Wanner et al. (2012) are discussing several limitations of the existing evidence which need to be taken into account in the review of the research: research design (studies are mostly cross-sectional), control of confounding factors such as other forms of PA, and the use of robust evaluation methods of active transportation based exclusively on instruments such as interviews, because there are still no standardized objective assessment tools.

Infrastructural separation of cyclists from traffic through the bikeways can play a key role in attracting more people to cycling as a form of AC, as well as increasing safety. The main reason to continue the AC cycling as a strategy for improving public health is its applicability to large groups of the population and to all age groups. If the stimulative trends in order to reduce population's physical inactivity continue, while cycling will become safer, the benefit-risk ratio will improve further (Götschi et al., 2016). Alternative modes of transportation must be available and users must perceive them as the optimal alternative to the car (Lavery et al., 2013).

The drawback of this study is the robustness of the methodology. In future research it is necessary to improve the objectivity of the assessment, including aspects emphasised by Wanner et al. (2012) - consistent control of other forms of PA in order to assess the independent effect of AC.

Conclusion

In this paper, current knowledge about the broader context of AC is presented. In order to compare the scientific knowledge and present situation and perspectives for AC in in the city of Zagreb, a study of the frequency of use of bicycles and its association with the weather parameters was conducted. The research extended for two weeks, on a sample of the building with a bike garage, in the urban area well connected with the entire city via bikeway network.

The assumption underlying this research, that the culture of cycling in the context of the AC in Zagreb is minor in comparison to Western European cities, was confirmed. The strong negative correlation (r = -0.64) found between the rainfall and the number of bikes in AC use, confirmed the hypothesis that bad weather conditions have significantly negative impact on the frequency of using bikes for AC.

The existing evidence-based knowledge supports promotion of cycling as an important contribution to public health improvement. The causal relation between active transport, PA and health, should be comprehensively investigated. More research is needed, longitudinally designed, with improved, objective assessment methods. Further research should focus on raising awareness of cycling in the function of PA through AC to maintain a long-term behaviour.

References

1. Alwan A. (2011). *Global status report on noncommunicable diseases 2010*. World Health Organization.
2. Buekers J, Dons E, Elen B, Panis LI. (2015). Health impact model for modal shift from car use to cycling or walking in Flanders: application to two bicycle highways. *Journal of Transport & Health*, *2*(4), 549-562.
3. Dons E, Götschi T, Nieuwenhuijsen M, De Nazelle A, Anaya E, Avila-Palencia, et al. (2015). Physical Activity through Sustainable Transport Approaches (PASTA): protocol for a multi-centre, longitudinal study. *BMC public health*, *15*(1), 1126-37.

4. Fraser SD, Lock K. (2011). Cycling for transport and public health: a systematic review of the effect of the environment on cycling. The European Journal of Public Health, 21(6), 738-743.
5. Götschi T, Garrard J, Giles-Corti B. (2016). Cycling as a part of daily life: A review of health perspectives. Transport Reviews, 36(1), 45-71.
6. Kuhnimhof T, Chlond B, Huang P.C. (2010). Multimodal travel choices of bicyclists: multiday data analysis of bicycle use in Germany. *Transportation Research Record: Journal of the Transportation Research Board*, (2190), 19-27.
7. Lavery TA, Páez A, Kanaroglou, P.S. (2013). Driving out of choices: An investigation of transport modality in a university sample. Transportation research part A: policy and practice, 57, 37-46.
8. Merom D, Miller YD, van der Ploeg HP, Bauman A. (2008). Predictors of initiating and maintaining active commuting to work using transport and public health perspectives in Australia. *Preventive medicine*, *47*(3), 342-346.
9. Molina-García J, Castillo I, Queralt A, Sallis JF. (2013). Bicycling to university: evaluation of a bicycle-sharing program in Spain. *Health promotion international*, 30(2):350-358.
10. Mueller N, Rojas-Rueda D, Cole-Hunter T, de Nazelle A, Dons E, Gerike R, et al. (2015). Health impact assessment of active transportation: A systematic review. *Preventive medicine*, *76*, 103-114.
11. Ogilvie D, Egan M, Hamilton V, Petticrew M. (2004). Promoting walking and cycling as an alternative to using cars: systematic review. *Bmj*, *329*(7469), 763-768.
12. Oja P, Titze S, Bauman A, De Geus B, Krenn P, Reger-Nash B, Kohlberger T. (2011). Health benefits of cycling: a systematic review. *Scandinavian journal of medicine & science in sports*, *21*(4), 496-509.
13. Xu H, Wen LM, Rissel C. (2013). The relationships between active transport to work or school and cardiovascular health or body weight a systematic review. *Asia-Pacific journal of public health*, *25*(4), 298-315.
14. Wanner M, Götschi T, Martin-Diener E, Kahlmeier S, Martin BW. (2012). Active transport, physical activity, and body weight in adults: a systematic review. *American journal of preventive medicine*, *42*(5), 493-502.
15. Wen LM, Rissel C. (2008). Inverse associations between cycling to work, public transport, and overweight and obesity: findings from a population based study in Australia. *Preventive medicine*, *46*(1), 29-32.
16. Priopćenje Državnog zavoda za statistiku o aktivnom stanovništvu u Republici Hrvatskoj u prvom tromjesečju 2016. /on-line/. Retrieved December 5, 2016 from: http://www.dzs.hr/Hrv_Eng/publication/2016/09-02-07_01_2016.htm

CAN AN ATHLETE'S GENES INFLUENCE ACL INJURY?

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Injuries of soft tissue and locomotory system, like Achilles tendon and anterior cruciate ligament (ACL) are two most frequent sports injuries among recreational sportsmen, as well as among professional athletes. More recent research has shown that individuals who are physically active with sports activities and endured Achilles tendon injury often share certain genetic characteristics. The aim of this project is to investigate genetic predispositions for occurrence of sports injuries and to develop a genetic test, which will serve to determine these predispositions and then to prepare a programme on the basis of these predispositions for individualised exercises to prevent sports injuries. The project will result in introduction of a new DNA test in the portfolio of Genos DNA Laboratory which will provide athletes, as well as amateurs, with information about personal inclination to injuries. On the basis of individual genetic predispositions and along with consultation with health professionals, a personalised plan of exercises will be created to reduce possibility of sports injuries, consequences of long-term rehabilitation or operation procedure, as well as of absence from sports terrains, which is of primary importance to professional athletes and their clubs. When a ligament or tendon injury occurs in the case of amateurs, this often means complete abandoning of recreational sports activity which increases probability of accepting unhealthy lifestyle, increase of body weight and therefore potential occurrence of cardiovascular diseases or diabetes mellitus.

PREVALENCE OF OVERUSE INJURIES AMONG A GROUP OF CROATIAN ROWERS

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Abstract

In this article, we examine the prevalence of overuse injuries among a group of elite Croatian rowers. The prevalence of all injuries between male and female for a specific body region were shoulder 7,40%, trunk/abdomen 7,40%, the low back 48,14%, pelvis/groin/buttock/hip/thigh 0,00%, knee 22,22% and lower leg 3,7%. The relation between age and occurrence of injuries in shoulder and the low back, showed a statistically important difference: the low back ($F = 4{,}40$; $p = 0{,}04$), shoulder ($F = 6{,}92$; $p = 0{,}01$). The relationship between sport age (total rowing years) and occurrence of injuries in shoulder, the low back, and knee showed statistically significant difference: shoulder ($F = 6, 39$; $p = 0, 01$); low back ($F = 6{,}92$; $p = 0{,}01$) and knee ($F = 6{,}21$; $p = 0{,}02$). Some of these findings have not been described in the scientific literature.

Introduction

The rowing is a sport with a long tradition that gains growing popularity in last years. The rowing ergometer has become a standard piece of training equipment in many endurance sports. The competitive rowing considers for one of the most physically demanding sports of today (Hagerman, 1994). The majority of the rowing injuries are chronic, overuse injuries (Hosea & Hannafin, 2012). The low back, knee, shoulder and forearm/wrist are most frequent injured body regions among rowers (Hosea & Hannafin, 2012). In this article, we present the occurrence of overuse injuries among Croatian rowers.

Methods

As a part of the initiative for early detection and prevention of injuries in rowing, which came from the Croatian Rowing Federation and the selector of the Croatian rowing team, the authors of this paper have been involved in the process of observation, video recording and biomechanical evaluation of rowers during a spring preparation camp held in Zagreb. We made analysis *ex-post facto*. We performed the sports anamnesis and medical interview on a group comprised of 27 rowers of the Croatian national team during the spring preparation camp. We have chosen the medical and sports interview as a form most convenient for this study. We defined an injury as either the absence (no injury) or presence (injury) of any of these symptoms in anamnesis: pain, discomfort, functional lesion and edema of a particular body region, that suspended a rower from a training activity, competition, or event that led an individual to seek medical attention. In addition, we defined the low back pain as a pain or discomfort in the low back region (from thoracic-lumbar junction to the end of sacrum) with or without radicular symptoms, the presence or absence of pain in sitting position and the presence or absence of morning pain and/or stiffness in the lumbar region that lasts less than 30 minutes. In all cases, we also included a battery of anamnesis questions to exclude possible organic or inflammatory rheumatologic disease. We separated the rowers into two groups according to the prevalence of particular injuries (i.e. presence or absence). A descriptive analysis, as well as a univariate analysis, was processed using the statistical package Statistica for Windows (version 13).

Results

In our study, we have included 27 rowers: 21 male rowers and 6 female rowers. Results are presented in Table 1.

Table 1: analysis of variance between female and male rowers

	Female (n= 6)		Male (n= 21)		variance	
Variable	Mean	Std.Dev.	Mean	Std.Dev.	F	p
Age	18,66	2,53	17,94	2,47	0,32	0,578
Sp.age	6,66	4,55	6,14	3,05	0,11	0,742
Height	186,85	4,79	186,86	4,79	10,67	0,003
Weight	72,66	3,20	82,66	8,90	7,12	0,013

Legend: Sp.age = sport age (years spent in rowing sport)

Between female and male rowers we did not find any statistical difference in variables for age, sport age; variance for age were (F = 0,32; p = 0,57) and for sport age variance were (F = 0,11; p = 0,74). Among anthropometric variables for height and weight, a statistical difference was present for both variables: height (F = 10,67; p = 0,00) and weight (F = 7,12; p = 0,01). Prevalence of all injuries between male and female for specific body region were: shoulder 7,40%, trunk/abdomen 7,40%, low back pain 48,14%, pelvis/groin/buttock/hip/thigh 0,00%, knee 22,22% and lower leg 3,7% (Table 2.). The findings for these regions are in correlation findings reported in the literature (Smoljanovic at al., 2015).

Table 2: Injuries by gender

Injuries	Female (n= 6)	Male (n= 21)	Total injuries	Total Athletes (n = 27)
	N (%)	N (%)	N (%)	(%)
Shoulder	0(0)	2(10)	2(8)	7,40
Trunk/Abdomen	0(0)	2(10)	2(8)	7,40
Low back pain	4(80)	9(45)	13(52)	48,14
Pelvis/Groin/ Buttock/Hip/Thigh	0(0)	1(5)	1(4)	0,00
Knee	1(20)	5(25)	6(24)	22,22
Lower leg	0(0)	15)	1(4)	3,70
Total	5(100)	20(100)	25(100)	

Table 3: Analyze of variance: injuries thru anthropometrics variables

		Age (year)				Sports age (year)				Height (cm)				Weight (year)			
	Prev	WOI	WI	variance		WOI	WI	variance		WOI	WI	variance		WOI	WI	variance	
Injuries	N (%)	Avg±StDev	Avg±StDev	F	p	Avg±StDev	Avg±StDev	F	p	Avg±StDev	Avg±StDev	F	p	Avg±StDev	Avg±StDev	F	p
Shoulder	2(8)	17,74±2,37	22,57±4,52	6,92	,01	5,84±2,94	11,50±4,95	6,39	,01	185,1±16	184,5±6,36	0,02	,88	80,04±8,51	85,50±17,67	0,67	,42
Trunk/Ab	2(8)	18,18±2,92	17,12±1,31	0,25	,62	6,40±3,41	4,50±2,12	0,58	,45	185,1±6,1	185,0±7,07	0,00	,97	80,6±9,25	78,5±6,36	0,97	,76
LBP	13(52)	17,08±1,29	19,19±3,51	4,40	,04	4,57±1,55	8,07±3,84	6,92	,01	186,06±4,9	184,1±7,27	0,71	,41	81,00±6,53	79,84±11,33	0,11	,75
PGBHT	1(4)	18,05±2,87	19,38	0,21	,65	6,19±3,39	8,00	0,27	,65	185,30±6,1	180,00	0,72	,40	80,73±9,05	73,00	0,70	,41
Knee	6(24)	17,54±2,18	19,93±4,06	3,66	,07	5,47±2,71	9,00±4,15	6,21	,02	184,49±6,6	187,2±3,5	0,95	,34	79,74±8,63	82,92±10,70	0,57	,45
Lower leg	1(4)	18,02±2,85	20,12	0,52	,47	6,07±3,27	11,00	2,18	,15	184,96±5,9	194,00	2,32	,14	79,88±8,68	95,00	2,92	,10

Legend: Prev = Prevalence; WOI = without injury; WI = with injury; PGBHT = Pelvis/Groin/Buttock/Hip/Thigh

The relation between age and prevalence of injuries in shoulder, low back, showed statistically important difference: shoulder (F = 6,92; p = 0,01) and low back pain (F = 4,40; p = 0,04), This is partially in line with the previous publications on the low back pain (Teitz et al., 2002), but similar findings for shoulder we did not find in the literature. What we found is the relation between sport age (total ages in years in rowing) and occurrence of injuries in shoulder, low back, and knee showed statistically significant difference: shoulder (F = 6,39; p = 0,01), low back pain (F = 6,92; p = 0,01) and knee (F = 6,21; p = 0,02).

Discussion

Before writing this article, we have searched Google Scholar, Pub Med for terms: rowing years, rowing experience, rowing age. After reviewing the available scientific literature to- date, we have not found data on the rowing population that links the total time in years spent rowing (sports age) and the overuse injuries of more than one body region i.e. low back, shoulder and knee. In our study, the relationship between the sports age (total ages in years spent rowing) and the prevalence of the low back pain was statistically significant, (F = 6,92; p = 0,01). Regarding the incidence of the low back as an isolated body part, Newlands at al. describe the connection between the number of hours spent rowing on the ergometer and the low back pain, (Newlands et al., 2015). Other authors review the incidence of the low back pain between 1,5 to 3,7 / 1000 h of rowing (Wilson, Gissane, Gormley, & Simms, 2010). Thornton et al. found that 12-month incidence for the low back pain linked to the rowing activities was 32-53% and that the majority of low back injuries are chronic and associated with the training volume and kinematics (Thornton et al., 2016). In relation to the rowing experience, Clay et al. reported the association between the rowing experience and the score in Functional movement screen-FMS, but not in association with the injuries per se. To our knowledge, the data regarding the rowing experience (years of rowing) is published mainly in the context of demographics (Socratis et al., 2013; Smoljanovic et al., 2015), but not in a context that directly links a specific rowing injury with terms such as rowing experience, rowing years or sports age.

The low back pain is a common complaint among rowers and accounts between 2-53% of all reported injuries in rowing (Bahr et al., 2004; Smoljanovic et al., 2015; Teitz, O'Kane, & Lind, 2003; Thornton et al., 2016). This data is in line with our findings (52% of all injuries among both genders). Among the adolescent population, the reported prevalence was between 53% for female and 65% for male rowers (Ng, Perich, Burnett, Campbell, & O'Sullivan, 2014). In our study, we had a slightly higher prevalence for LBP prevalence for women were 80% and 45% for men. In overuse syndromes, the previous injury is the strongest predictor of new or recurrent injury (Pecina & Bojanic, 2003; Thornton et al., 2016). According to the research of Teitz et al. (2002), factors significantly associated with the development of back pain included age, history of rowing before age 16, use of hatchet oar blade, free weight training, weight machines and the ergometer training sessions longer than 30 minutes. Other predictors of the low back pain are the number of the total training hours, the difference in season training (Newlands, Reid, & Parmar, 2015; Wilson et al., 2010). The injury mechanism in the low back pain can be attributed to various factors such hyperflexion of and compression of lumbar spine during the catch (Morris, Smith, Payne, Galloway, & Wark 2000), improper rowing technique, muscular imbalance, kinematics and previous low back injury (McGregor, Anderton & Gedroyc (2002) and Ng et al. (2014). Besides this, it is important to note the discrepancies between clinical signs and imaging diagnostics (Maurer et al., 2011), the difference in pathomechanics between disc prolapsed and degenerative disc degeneration (Kanna, Shetty & Rajasekaran 2011), and the findings of disc degeneration and disc protrusion among non-sport asymptomatic pediatric patients (Ramadorai, Hire, DeVine, Brodt, & Dettori et al., 2014). Chronic repetitive loading of this type and the fatigue of the back musculature leads to the impairment of sensor motor control mechanisms and decreased reflexive action (Baugh & Kerr, 2016; Roy et al., 1990). In our study, we found that the relationship between the sports age (total ages in years spent in rowing) and the occurrence of knee injuries showed a statistically significant difference: ($F = 6{,}21$; $p = 0{,}02$). Similar findings we did not find in the scientific literature. The prevalence of knee injuries is between 16 to 18% (Rumball, Lebrun, Di Ciaccia, & Orlando, 2005; Smoljanovic et al., 2015). In our study, knee injuries represent 24% of all injuries, what is a somewhat higher result. Knee pain is common in rowers (Hosea & Hannafin, 2012; Jayson, 1997; Karlson, 2000). The majority of injuries are chronic in their nature and mostly due to overuse. Patello-femoral pain syndrome, iliotibial tract tendinopathy, and the acute or chronic inflammations of knee bursa apparatus are frequent among rowers (Hosea & Hannafin, 2012).Regarding the rowing kinematics, at the start of the catch, the knee is in flexion. This places the knee under the compressive but also the rotational and translation shear load, which can eventually result in injury. During the indoor training, especially during weight lift training and running, besides overuse injuries, traumatic injuries of knee apparatus are possible (Pecina & Bojanic, 2003). We found that the relationship between the sports age (total ages in years spent in rowing) and the occurrence of injuries in the shoulder, showed a statistically significant difference: shoulder ($F = 6{,}39$; $p = 0{,}01$). Similar findings we did not find in the scientific literature. The prevalence of shoulder injuries among rowers is about 7,0% of all injuries, what is in line with our findings (7,40% of all injuries). The majority of these injuries are due to overuse; traumatic injuries among rowers are not frequent (Rumball et al., 2005; Smoljanovic, 2015). The upper extremity is the third most common location of injury in rowers (Hosea & Hannafin, 2012). For the optimal shoulder function, the scapulothoracic rhythm must be optimal, ensuring optimal kinematics of joint structures. Impingement of rotator cuff tendons and local bursitis are the most frequent overuse injuries in the shoulder complex. Congenital deviations in the bony structure of scapula, deviations from the optimal posture including deviations in spine curves, muscle imbalances in the neck and scapulothoracic muscles could be the precipitating factors in injury mechanism. All of these can eventually result in the weakness of the scapulothoracic area, muscles in the neck and thorax, and can eventually result in shoulder injury (Pecina & Bojanic, 2003). Decentralized glenohumeral joint, due to a more anterior glenohumeral position, may lead to impingement and instability (Kibler et al., 2002). The weaknesses of this study are a small number of participants (N=27), a small sample of female subjects in this study (N=6) relative to male subjects (N=21), and the fact that this sample rather represents the elite group of the Croatian rowers and not rowers in general. Furthermore, all the data collected came from interviews, and not from official medical injury databases. Croatia is a small country where rowing is not so popular and massive sport and a number of rowers and especially the elite rowers are relatively small.

Conclusion

In our study, we found that in rowing the sports age and the chronological age could be connected to the injuries of the low back pain, knee, and shoulder. These findings may suggest possible cumulative effects of longstanding specific sports activity such as rowing and occurrence of chronic overuse injuries among rowers. The chronological age of a rower could be an important factor not just for the low back injury, as previously reported in the literature, but also a factor for the shoulder injury as well. However, further investigations in this field are necessary.

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References

1. Bahr, R., Andersen, S.O., Løken, S., Fossan, B., Hansen, T., & Holme, I. (2004). Low back pain among endurance athletes with and without specific back loading—a cross-sectional survey of cross-country skiers, rowers, orienteerers, and nonathletic controls. *Spine*, 29(4), 449-454.
2. Baugh, C.M., & Kerr, Z.Y. (2016). High School Rowing Injuries: National Athletic Treatment, Injury and Outcomes Network (NATION). *Journal of athletic training*, 51(4), 317-320.
3. Clay, H., Mansell, J., & Tierney, R. (2016). Association between rowing injuries and the functional movement screen™ in female collegiate division i rowers. *International journal of sports physical therapy*, *11*(3), 345.
4. Hagerman, F.M.C. (1994). Physiology and nutrition for rowing. In: Lamb D, et al., (editors). *Perspectives in exercise science and sports, medicine*. Carmel: Cooper Publishing Group; p. 221-302.
5. Hosea, T. M., & Hannafin, J. A. (2012). Rowing injuries. *Sports health*, *4*(3), 236-245.
6. Karlson, K. A. (2000). Rowing injuries: identifying and treating musculoskeletal and nonmusculoskeletal conditions. *The Physician and sportsmedicine*, *28*(4), 40-50.
7. Kibler, W. B., Uhl, T. L., Maddux, J. W., Brooks, P. V., Zeller, B., & McMullen, J. (2002). Qualitative clinical evaluation of scapular dysfunction: a reliability study. *Journal of Shoulder and Elbow Surgery*, *11*(6), 550-556.
8. Jayson, M. I. (1997). Why does acute back pain become chronic?. *BMJ*: British Medical Journal, 314(7095), 1639.
9. McGregor A, Anderton L, Gedroyc W. (2002).The assessment of intersegmental motion and pelvic tilt in elite oarsmen. Med Sci Sports Exerc.; 34:1143-9.
10. Morris, F. L., Smith, R. M., Payne, W. R., Galloway, M. A., & Wark, J. D. (2000). Compressive and Shear ForceGenerated in the Lumbar Spine of Female Rowers. *International journal of sports medicine*, *21*(07), 518-523.
11. Newlands C, Reid D, Parmar P. (2015). The prevalence, occurrence and severity of low back pain among international level rowers. *Br JSports Med*. 49(14):951-6. doi:10.1126/bjsports-2014-093889
12. Ng, L., Perich, D., Burnett, A., Campbell, A., & O'Sullivan, P. (2014). Self-reported prevalence, pain intensity and risk factors of low back pain in adolescent rowers. *Journal of Science and Medicine in Sport*, *17*(3), 266-270
13. Pecina, M. & Bojanic, I. (2003). Overuse Injuries of the Musculoskeletal System, Second Edition, CRC Press
14. Perich, D., Burnett, A. & O'Sullivan, P. (2007, October). *Low back pain in adolescent female rowers and the associated factors*. In ISBS-Conference Proceedings Archive (Vol. 1, No. 1).
15. Ramadorai, U., Hire, J., DeVine, J. G., Brodt, E. D., & Dettori, J. R. (2014). Incidental findings on magnetic resonance imaging of the spine in the asymptomatic pediatric population: a systematic review. *Evidence-based spine-care journal*, *5*(02), 095-100.
16. Roy, S.H., De Luca, C.J., Snyder-Mackler, L.Y.N.N., Emley, M.S., Crenshaw, R. L. & Lyons, J. P. (1990). Fatigue, recovery, and low back pain in varsity rowers. *Med Sci Sports Exerc*, 22(4), 463-9.
17. Rumball, J.S., Lebrun, C.M., Di Ciacca, S.R. & Orlando, K. (2005). Rowing injuries. *Sports medicine*, 35(6), 537-555.
18. Socratis, K., Eleni, D., Kostas, D., & Vasilios, D. (2013). Injuries of greek rowers participating on different competitive categories. *Biology of Exercise*, *9*(2).
19. Smoljanovic, T., Bohacek, I., Hannafin, J. A., Terborg, O., Hren, D., Pecina, M., & Bojanic, I. (2015). Acute and chronic injuries among senior international rowers: a cross-sectional study. *International orthopaedics*, *39*(8), 1623-1630.
20. Teitz C, O'Kane J, Lind B. (2003). Back pain in former intercollegiate rowers. *Am J Sports Med*.;30:674-9.
21. Thornton, J. S., Vinther, A., Wilson, F., Lebrun, C. M., Wilkinson, M., Di Ciacca, S. R. & Smoljanovic, T. (2016). Rowing injuries: an updated review. *Sports medicine*, 1-21. doi:10.1007/s40279-016-0613-y
22. Wilson, F., Gissane, C., Gormley, J. & Simms, C. (2010). A 12-month prospective cohort study of injury in international rowers. *British journal of sports medicine*, 44(3), 207-214.

EFFECT OF SODIUM BICARBONATE AND SODIUM CITRATE SUPPLEMENTATION ON SWIMMING PERFORMANCE

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Abstract

An ingestion of dietary buffering agents has been proposed to enhance performance in high intensity exercise. This study investigated the effect of ingesting sodium bicarbonate (SB) and sodium citrate (SC) on middle distance swimming performance and blood responses. Six elite male freestyle swimmers (20.7±2.1 yrs; 184±6 cm; 79.9±3.9 kg; 10.6±1% body fat) participated in a double blinded, placebo controlled crossover trial. Eighty-five minutes after consuming SB (0.3 g/kg), SC (0.3 mg/kg) or placebo (PL) participants completed single 400-m freestyle maximal test on three consecutive days. The order of the trials was randomized. A capillary blood samples were obtained on 4 occasions. In a resting state (baseline), 60 min post-ingestion, immediately post-trial and 15 min post-trial to determine pH, HCO_3^- concentration and base excess (BE). Blood analytes responses were significantly different from PL following SB ingestion in all post-ingestion time sampling points ($p<0.05$). There was no statistically significant difference in performance between the conditions. In conclusion, an acute supplementation of SB, not SC before swimming task increase performance by ~1%.

Key words: *dietary supplements, ergogenic aid, nutrition*

Biology & Medicine of Sport and Exercise

Introduction

Many athletes use dietary supplements in an effort to maximize performance. It is widely accepted that ingestion of dietary supplements that may nutritionally affect intracellular and extracellular buffering capacity is an evidence-based strategy for improving sport performance (Maughan, 2014). Ingestion of SB has previously been found to enhance buffering capacity and in turn performance in repeated (Gao, Costill, Horswill, & Park, 1988) rather than in single, short-term, high-intensity swimming exercise bout (Joyce, Minahan, Anderson, & Osborne, 2012). Despite clear physiological rationale explaining performance-enhancing potential, many studies fail to confirm the use of SB mainly due to the gastrointestinal discomfort observed in majority of studies and nearly in all known supplementation protocols (Kahle, Kelly, Eliot, & Weiss, 2013). Therefore, the use of sodium citrate (SC) has been introduced as an alternative to SB due to the perception that it may elicit less gastrointestinal (GI) discomfort (Carr, Slater, Gore, Dawson, & Burke, 2011). The performance benefits of SC ingestion before high-intensity exercise however appear to be limited (Russell et al., 2014). In contrast, some studies found SC as not an effective ergogenic aid for high-intensity exercise (Someren et al., 1998). Currently, an ingestion of 0.3 g SB/kg/body mass 60-90 min before exercise is commonly recommended (Maughan, 2014). This protocol is believed to improve performance in high-intensity events of short duration (1 min) by 1.7% (Carr, Hopkins, & Gore, 2011). However not much is known about an effect on events with a duration of 4-5 min. Moreover, a dose response study of SB ingestion recently revealed large inter-individual variability in the magnitude of the increase in blood HCO_3^- concentrations over 3-h period post-ingestion, which may partly explain negative consequences and non-ergogenic outcomes (Jones et al., 2016). The aim of this study was to test a currently recommended protocol for SB supplementing and investigate the effects of SB and its substitute SC on a single 400-m swimming freestyle performance.

Methods

Participants

Six elite level male swimmers (20.7±2.1 y; 79.9±3.9 kg; 10.6±1% body fat; 50-60 training km/week) volunteered to participate in this study. All participants were nationally ranked with 200 and 400 m free-style personal best (long course) ~1:58 and 4:14, respectively. After an explanation of all experimental procedures, each participant signed a written informed consent to participate in this study. The Ethics Board of the Masaryk University approved this study.

Experimental protocol

A detailed experimental design is show in Figure 1. A study was double blinded and placebo controlled. Participants ingested identical gelatine capsules containing either SB (0.3 mg/kg BM), SC (0.3 mg/kg BM) or placebo (PL). A starch, 0.18 mg/kg body mass (BM) was used as PL. A pharmacist in a local pharmacy professionally prepared the capsules. The total amount of capsules distributed to participants (23-26) and ingested within 5 minutes was not associated with digestive problems we previously verified (Kumstát, Šimko, & Hlinský, 2015). A supplementation was followed by a single 400 m free style time-trial experimental swimming test held in a long course. The order of the supplementation was randomized. Participants attended three supplementation-testing sessions on three consecutive days. All pre and post testing sessions (blood samples, data collection, supplement ingestion, resting between blood sampling) took place in a calm, thermoneutral warm-up room next to the pool. After reporting to the warm-up room, resting blood samples were obtained (~2h postprandially). After that, participants were administered SB, SC or PL in a random order. Participants were instructed to consume the capsules with a piece of banana and 500ml of water to combat GI symptoms. Following supplement ingestion, participants rested under the control of researchers for 60 minutes and were allowed to ingest water ad libitum. After that second blood samples were obtained. Participant was then asked to go immediately on the pool. After 15 minutes of predefined warm up (5min out of water stretching followed by 800 m swim) session an individual 400 m freestyle time-trial test was performed. Each participant was instructed to approach the race pace. Every swim was started from water and timed by an experienced coach using a stop timer (Quartz, model 898). Fingertip capillary blood was obtained on four occasions: at rest before participants ingested tested supplement (baseline) and after 60 min of rest (post-ingestion), immediately after 400m swimming test (post-trial I) and 15 min after the post-trial I sample (post-trial II). Whole blood samples were collected by finger prick using a sterile single-use lancing device with 2.3 mm penetration depth to penetrate the finger. Amount of ~60 µl of blood was collected into plain heparinized capillary tubes, immediately injected into sensor cards and analysed for pH, HCO_3^- and base excess (BE). The device used for blood analysis was an electro-chemical apparatus Gastat Navi (Techno MedicaCo., Ltd.). Time needed for blood sample collection was ~2-3 min depending on each participants finger prick bleeding. Each blood analysis took 165 s before results were automatically printed. The same examiner consistently did the blood collection during all trials. Nutritional supplements containing creatine and beta-alanine were not allowed to use for at least four weeks prior to or during the study. Caffeine intake was forbidden only throughout the testing-days period. A 4-days prospective food intake record was collected from participants at least one week before start of the study. Participants were given an individualized nutritional plan that ensured a minimum of 7-8 g carbohydrates (CHO)/kg/BM. All participants were instructed to eat according to the prescribed daily plan during all three consecutive testing days to ensure as similar nutritional condition as possible. This was analysed for adherence with non-significant difference between prescribed (~7,9 g CHO/kg BM) and adhered (~7,4 g CHO/kg BM). A NutriPro software (Fitsport-komplex s.r.o., Czech Republic) was used to analyse energy intake and macronutrient distribution.

Statistical analyses

All statistical analyses were conducted using Statistica (StatSoft CR s.r.o., Czech republic) software and Microsoft Excel (Microsoft Inc., USA). Normality was assessed by Shapiro-Wilk test. Paired *t* test were used to compare the blood measures (pH, HCO_3^- and BE) under experimental conditions at different sampling times. One-way ANOVA with LSD post hoc analysis was used to assess differences between SC, SB and PL conditions. A Cohen´s *d* was used to determine effects size. Statistical significance was accepted at $p \leq 0{,}05$ with data presented as mean ± standard deviation (SD). A coefficient of variance was used to assess inter-variable changes.

Results

There were no significant differences in the time of the 400-m test between SB, SC and PL conditions. However, supplementation of SB does improve performance times over placebo in 5 out of 6 participants (responders). When corrected for responders, no significant performance improvement was found (time improvement of 0.11-1.84%; 0.31-5.01 s). In contrast, SC condition led to decreased performance in 5 out of 6 participants (time impairment of 0.26-1.01%) (Figure 1 a, b).

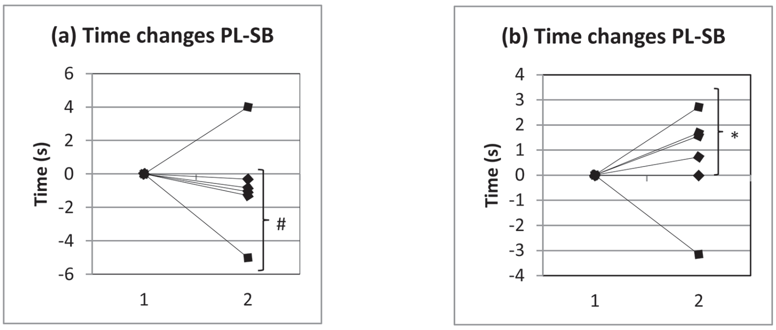

*Figure 1 a, b: Change in performance time comparing placebo (PL) and sodium bicarbonate (SB) (Figure a) or sodium citrate (SC) (Figure b) supplementation trials; # time improvement (n = 5); * time impairment (n=5).*

There were significant main effects for blood HCO_3^- concentration, BE and pH values both in SB and SC condition over placebo in all post-ingestion measurements points ($p<0.05$), except for the non-significant response from placebo in SC 60 min post ingestion. All blood analytes response over sampling time points are presented in Table 1.

Table 1: Blood HCO_3^-, Base Excess and pH responses for all experimental conditions. Significant time effects (p < 0.05) from baseline ([a]) and from post-trial I to post-trial II ([b]); Values are Mean (SD)

	PL	SB	SC
pH (unit)			
baseline	7.47 (0.02)	7.46 (0.02)	7.45 (0.02)
post-ingestion	7.46 (0.01)	7.50 (0.03)[a]	7.49 (0.02)
post-trial I	**7.28 (0.03)[a]**	**7.33 (0.06)[a]**	**7.35 (0.06)[a]**
post-trial II	**7.42 (0.01)[a,b]**	**7.45 (0.02)[b]**	**7.45 (0.03)[b]**
HCO_3^- (mmol/L)			
baseline	19.1 (5.04)	20.18 (2.63)	20.1 (2.61)
post-ingestion	17.41 (1.81)	24.43 (1.6)[a]	22.08 (2.30)
post-trial I	**10.26 (1.52)[a]**	**13.16 (2.73)[a]**	**13.7 (3.61)[a]**
post-trial II	**15.05 (1.12)[a,b]**	**18.8 (3.38)[b]**	**18.75 (3.16)[b]**
Base excess (mmol/L)			
baseline	-2.63 (4.04)	-2.23 (2.44)	-2.41 (2.47)
post-ingestion	-4.31(1.57)	2.23 (0.91)[a]	-0.6 (2.03)
post-trial I	**-13.88 (1.63)[a]**	**-10.65 (3.02)[a]**	**-9.71 (4.30)[a]**
post-trial II	**-7.1 (0.73)[b]**	**-3.38 (3.12)[b]**	**-3.51 (2.86)[b]**

Post hoc analysis showed that baseline of all blood analytes was not significantly different between PL, SB and SC conditions. The response of blood HCO_3^- concentration and BE in post-ingestion, post-trial I and post-trial II was significantly different between all conditions ($p<0.05$). There was a significant main effect in HCO_3^- concentrations, BE and pH in all time points for SB and SC over PL ($p<0.05$) except for non-significant difference in 60 min post-ingestion between SC and PL.

Discussion

We showed that acute supplementation of SB or SC (0.3 g /kg BM) ~ 90 min before ~4.5 min maximum swimming task, has different ergogenic effect. In 5 out of 6 participants an SB ingestion enhance performance by ~1% (0.1-1.8%) (little effect, Cohen´s d=0.2). In contrast, we found that ingestion of SC led to mean performance impairment of 1,33% in 5 participants. Despite clear changes in blood concentrations of pH, HCO_3^- and BE seen after supplementation trials, an ergogenic aspect of supplementation was neglected. According to Robergs, Hutchinson, Hendee, Madden, & Siegler (2005) a consumption of 0.3 g of SB/kg BM typically increases blood HCO_3^- concentration by 5-6 mmol/l from baseline. In a recent dose response study Jones et al. (2016) found a highly variable increase in blood HCO_3^- concentration of 6-12,3 mmol/l similarly to our study (1.3 – 11 mmol, mean 4.25 mmol). The highest variability in blood HCO_3^- concentration increase was found between 20-75 min post ingestion (Jones et al., 2016). Inter-individual variability has been found high and rather independent of the dose ingested and coefficient of variation (CV) to be 29, 32 and 44% in 0.1, 0.2 and 0.3 g of SB/kg BM respectively. This variability corresponds with the reported variation in time window between ingestion and peak response of blood bicarbonate (75-180 min) for 0.3 mg/kg (Jones et al., 2016). In our study a 400 m time trial test started 85-90 min post-ingestion with last time point (peak levels) of HCO_3^- measured at 60 min post-ingestion suggesting our participants may not reach peak levels. Carr, Hopkins, et al., (2011) suggested an elevation in a blood HCO_3^- concentration after SB ingestion of 5-6 mmol/l to be a “zone of potential ergogenic effect” and a “zone of almost certain ergogenic effect” was hypothesized to be an increase of >6 mmol/l. In our group of responders mean blood bicarbonate elevations were 4,25±1.6 mmol/l. Not surprisingly, the second lowest increase over the baseline levels (1.8 mmol) was found in the participant who was concurrently the only non-responder. Timing and his fact may be an explanation for little improvements in performance after SB ingestion. In contrast to Russell et al. (2014) and others, we found no improvement of performance after SC ingestion. No significant changes in pH, blood concentrations of HCO_3^- and BE were observed 60 min post-ingestion, in contrast to SB. Additionally mean blood elevation of HCO_3^- was only 1.98 mmol which was 13.5% lower increase compared to SB. It has been recently shown that a HCO_3^- kinetics after SC ingestion has much lower dynamics (Urwin et al., 2016). As such, administration of SC ~ 90 min before the exercise is not sufficient to induce improvements in buffering potential. Russell et al. (2014) administered 0.5 g kg^{-1} of SC 120 min pre-trial and found a modest time improvement in 5 out of 10 participants. Therefore, it may be recommended to prolong the time between ingestion of SC and performance trial.

As we focus on elite athletes, a limitation of the study is a final sample size. However a small sample size of n=6 (Pruscino, Ross, Gregory, Savage, & Flanagan, 2008), n=7 (Peart et al., 2013) or n=8 (Joyce, Minahan, Anderson, & Osborne, 2012) is not exceptional in similarly fashioned studies. Because the ability of the statistical test used to identify the performance changes was poor, we use Cohen´s *d* to determine effects size. However, both procedures revealed that an ergogenic effect of SB ingestion prior 400m swim is limited and practically not significant. Moreover, currently used loading strategies for SB may not be applicable for SC ingestion. The magnitude of the blood responses, time to peak in blood concentrations or performance effects are not the same when the same pre -exercise-loading protocol is used for SC.

Conclusion

We showed that acute supplementation of sodium bicarbonate 60 min before ~4.5 min swimming task increase performance by ~1%. In contrast, we found sodium citrate as not ergogenic. Despite clear changes in blood concentrations of pH, bicarbonate and BE we assume that significant ergogenic aspect of acute supplementation prior 400 m swimming is mainly affected by an individual responsiveness.

Acknowledgement

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References

1. Carr, A. J., Hopkins, W. G., & Gore, C. J. (2011). Effects of Acute Alkalosis and Acidosis on Performance. *Sports Medicine*, *41*(10), 801-814.
2. Carr, A. J., Slater, G. J., Gore, C. J., Dawson, B., & Burke, L. M. (2011). Effect of Sodium Bicarbonate on [HCO3−], pH, and Gastrointestinal Symptoms. *International Journal of Sport Nutrition and Exercise Metabolism*, *21*(3), 189-194.
3. Gao, J. P., Costill, D. L., Horswill, C. A., & Park, S. H. (1988). Sodium bicarbonate ingestion improves performance in interval swimming. *European Journal of Applied Physiology and Occupational Physiology*, *58*(1-2), 171-174.
4. Jones, R. L., Stellingwerff, T., Artioli, G. G., Saunders, B., Cooper, S., & Sale, C. (2016). Dose-Response of Sodium Bicarbonate Ingestion Highlights Individuality in Time Course of Blood Analyte Responses. *International Journal of Sport Nutrition and Exercise Metabolism*, *26*(5), 445-453.
5. Joyce, S., Minahan, C., Anderson, M., & Osborne, M. (2012). Acute and chronic loading of sodium bicarbonate in highly trained swimmers. *European Journal of Applied Physiology*, *112*(2), 461-469.
6. Kahle, L. E., Kelly, P. V., Eliot, K. A., & Weiss, E. P. (2013). Acute sodium bicarbonate loading has negligible effects on resting and exercise blood pressure but causes gastrointestinal distress. *Nutrition Research*, *33*, 479-486.
7. Kumstát, M., Šimko, O., & Hlinský, T. (2015). Sodium Bicarbonate, Caffeine, and Their Combination Does Not Enhance Repeated 200-m Freestyle Performance. Presented at the 10th International Conference on Kinanthropology, Brno.
8. Maughan, R. J. (2014). The Encyclopaedia of Sports Medicine: An IOC Medical Commission Publication, Sports Nutrition. John Wiley & Sons.
9. Peart, D., Kirk, R., Hillman, A., Madden, L., Siegler, J., & Vince, R. (2013). The physiological stress response to high-intensity sprint exercise following the ingestion of sodium bicarbonate. *European Journal of Applied Physiology*, *113*(1), 127-134.
10. Pruscino, C. L., Ross, M. L. R., Gregory, J. R., Savage, B., & Flanagan, T. R. (2008). Effects of Sodium Bicarbonate, Caffeine, and Their Combination on Repeated 200-m Freestyle Performance. *International Journal of Sport Nutrition & Exercise Metabolism*, *18*(2), 116-130.
11. Robergs, R., Hutchinson, K., Hendee, S., Madden, S., & Siegler, J. (2005). Influence of Pre-Exercise Acidosis and Alkalosis on the Kinetics of Acid-Base Recovery Following Intense Exercise. *International Journal of Sport Nutrition and Exercise Metabolism*, *15*(1), 59-74.
12. Russell, C., Papadopoulos, E., Mezil, Y., Wells, G. D., Plyley, M. J., Greenway, M., & Klentrou, P. (2014). Acute versus chronic supplementation of sodium citrate on 200 m performance in adolescent swimmers. *Journal of the International Society of Sports Nutrition*, *11*(1), 26.
13. Someren, K. van, Fulcher, K., McCarthy, J., Moore, J., Horgan, G., & Langford, R. (1998). An Investigation into the Effects of Sodium Citrate Ingestion on High-Intensity Exercise Performance. *International Journal of Sport Nutrition*, *8*(4), 356-363.
14. Urwin, C. S., Dwyer, D. B., & Carr, A. J. (2016). Induced Alkalosis and Gastrointestinal Symptoms After Sodium Citrate Ingestion: a Dose-Response Investigation. *International Journal of Sport Nutrition & Exercise Metabolism*, *26*(6), 542-548.

STROKE RATES AS A MEASURE OF TRAINING LOAD IN YOUNG ROWERS

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Abstract

Purpose of this study was to establish the adequacy of the metabolic reaction in the organism of young rowers to intensity as shown by the stroke rate. The adequacy of the response should give information about the validity of dosing training loads for the purpose of good management of the development of sports mastery. The **Methods** applied in the study included 20 young rowers (age 16.03 ± 0.93; height 186.89 ± 4.71; 77.15 ± 8.63 mass, body mass index 22.07 ± 2.16), who, rowing in single sculls, completed four stages of discontinuous progressive load (4 x 5 minutes), where each leg was of a set stroke rate (16-18; 20-22; 24-26 and 28-30), with appropriate stroke power. Heart rate was measured by using heart rate monitors of the brand Polar, and at the end of each 5 minute leg, a sample of capillary blood was taken from the finger tip. **Results** indicate that only 5 rowers showed values of metabolic reactions within the expected values. The responses of the other rowers indicate significantly higher values of metabolic reactions than expected. This leads them to the possibility of forming the overtraining syndrome, which can cause injuries. From these values derives the **Conclusion**, expressed through the need to carry out diagnostics of the training state, in order to adequately programme the training load (intensity / extensity).

Key words: *stroke rate, blood lactate, heart rate*

Introduction

Rowing is a monostructural cyclic activity, very demanding in its energy aspect, of both aerobic and anaerobic energy (Hartmann, 1990). As a rule, competition is carried out without the possibility of contact with the adversary, which urges the rower, or crew, to exhibit their maximal motoric and energy capabilities, with as much quality as possible rowing technique as the degree of usage of the energy potentials. Aside from this, tactics also play a role in the race, but that will not be considered in this paper.

How high the internal loads on the organism while engaging in rowing activity can be, is best shown by the research of Nielsen (1999) during which an Olympic winner after performing a ‘2000-m’ maximal test on a rowing ergometer produced 32.0 $mmol \cdot l^{-1}$ of lactate, “spent” all bicarbonates (concentration was not detectable), while the pH value was 6.74. The task of the coach is to develop the energy capacities of rowers to their maximum, and to prepare the rowers to be able (both physically and mentally) to exhibit their maximal capabilities at the right time. Therefore the task of the coach is to plan, organize and manage the process of developing the motoric, energetic and technical characteristics of rowers. For that he needs as many objective, valid and reliable parameters as possible.

In training, the coach determines the tasks (stimuli) with which he strives to provoke a reaction in the organism in the form of transformational and adaptational processes. External stimuli are represented by the speed of movement of the boat (split time on rowing ergometer), whether absolute or relative to the speed during the race (time on the competition – race speed), as well as the stroke rate. To such external stimuli, the organism responds with internal, metabolic reactions as indicated by oxygen consumption (VO_2), percentage of maximal VO_2, heart rate (HR) and disruption of acid-base balance measured by concentration of lactate in the blood. The listed data is collected by carrying out diagnostic procedures in the laboratory and on the water. Based on this data, adequate training loads can be assigned and, equally important, tracking and analysis of the training can be performed. Because there is a limit to accessibility of laboratories, sport scientists have tried to find links between the above listed parameters to enable the coaches to get information as valid as possible for predicting the training load. In such a way famous indirect tests were formed for: 1) determining VO_2 max: Cooper test, and Multistage fitness test (Leger, Mercier, Gadoury,& Lambert, 1988); 2) determining the anaerobic threshold (Conconi, 1982). At the same time, some authors tried to simplify the approach by which training could be managed on the basis of just one indicator - the heart rate (Burke,1998), or they gave highest attention to, at that time, the most prevalent parameter - lactate (Janssen, 2001). Nevertheless, in rowing sport, the most prevalent approach is the one in which stroke rate and heart rate are tracked, and put in relation to internal parameters: lactate concentration and oxygen consumption (Åstrand, Rodahl, Dahl, & Stromme, 2003; Babraj & Voiliantis, 2007; Bourdon, 2000; Fritch, 2000;

Guellich, Seiler & Emrich, 2009; Hartmann, Mader, & Hollmann, 1990; Herberger, 1983; Jensen, Nielsen, & Smith, 1990; Seiler & Tonnessen, 2009).

Because rowers, besides their basic work in the rowing boat, also engage in substitute work on the rowing ergometer and in running, it is interesting to know if there is a connection between reactions of the organism to different types of working load. Therefore it is interesting to follow the experiences of successful coaches. Marti Aitken says: "Some physiologists and coaches use the ergometer step test described in the last section to determine a heart rate for all aerobic training. However, I have found that this is not always accurate. For 60 percent of athletes it is a good indicator, but for the other 40 percent it is incorrect. I use the step test only to determine the athletes' aerobic fitness. To determine training heart rate based on lactate production, I conduct a test in the boat" (Aitken, 2005).

From the above statement, the main goal of this paper originated: to determine relations of the training loads indicated by the stroke rate, heart rate and blood lactate reaction, to determine the reliability of usage of the listed parameters in the analysis of training work and management of the development of young rowers.

Methods

The results of the research represent an *ex post facto* analysis of data collected by carrying out diagnostics of the training state of junior rowers, which was performed at the request of the rowing club Neptun from Dubrovnik. On the first day, a progressive discontinuous test of lactates on the rowing ergometer was performed (Marinović, 2011) from which information on the maximal heart rate was derived. On the third day reactions of the organism to carrying out tasks at a given pace were followed. The testing was carried out on a sample of 20 rowers (age 16.03±0.93; height 186.89±4.71; mass 77.15±8.63; body mass index 22.07±2.16). The test was performed in single sculls, by rowing 4x5 minutes at a given pace (16-18; 20-22; 24-26 and 28-30 strokes per minute) while they were instructed that the stroke power should be adequate to the pace of rowing during training. The pause between performances was necessitated by the time required to take a sample of capillary blood from the fingertip (cca 3 min).

Heart rate was measured by using a heart rate monitor (Polar, Electro Oy, Finland – models RS400 and RS800). The records were transferred to a computer by using the software ProTrainer, which enables the tracking of pulse every 5 seconds during test performance. The measurer followed a rower in a motorboat and approached the rower at the end of the 5 minute leg. From the fingertip, a sample of capillary blood was gathered (20 µl) by using capilette for Reflotron (Selzer GmbH, Waghausel, Germany). Immediately after being gathered, the sample was analyzed using the Accutrend Plus portable lactate analyzer (Roche Diagnostics GmbH, Mannheim, Germany).

The data was processed using the statistics package Statistica 13, during which were calculated the basic descriptive parameters, a test of means against reference constant (value), a histogram of distribution of lactate concentration at rest, as well as a scatterplot of data of lactate concentration and heart rate at each stage of the load. Test of means against constant references (value) was performed for all variables monitored during the four stages of the load. Since the expected values for some variables were within the range, this estimate was carried out for the lower and upper limits of the range.

Results

Test results are presented in Table 1. The third column presents the expected values according to materials (Hartmann et al., 1990; Ramson, 2011; Seiler & Tonnessen, 2009; Stöggl & Sperlich, 2015) adopted by the International Rowing fedaration (FISA) as educational material for rowing (http://www.worldrowing.com/mm//Document/General/General/12/64/45/Minimum_Guidelines _for_Safe_Rowing_English.pdf).

The last two columns present the ***t*** value and reliability assessment ***p*** of the arithmetic mean of the measured variables against the constant (expected) value. The reference range of lactate concentration in homeostasis is 0.6 to 2.2 mmol·l^{-1} (Karlson, 1993). In trained athletes, particularly in endurance sports, these values are significantly lower and are around 1.0 to 1.5 mmol·l^{-1}. From the histogram of lactate levels at rest (Figure 1), it is clear that half the examinees have their organism in homeostasis, although five have lactate in the upper part of the range, indicating the possibility of individually insufficient regeneration. The second half of the rowers have lactate concentration above the reference value, with some values around 3.0 mmol·l^{-1}, and some even higher. A histogram (Figure 2) also shows the distribution of the maximum heart rate. Prediction of the maximum heart rate (220 - age) in this sample is not be applicable, because the sample of rowers indicates a statistically significantly lower value than assumed.

Table 1: Expected value, descriptive statistics of measured variable and test of means against reference constant (value)

Stroke rate	Variable	Expected value	Mean	StDev	Min	Max	Means against ref. constant	
							t-value	p
Rest	La (mmol·l^{-1})		2.07	0.69	0.80	3.30		
16 - 18	La (mmol·l^{-1})	<2	3.37	1.39	1.30	6.50	*4.39*	*0.000*
	HR (stroke·min^{-1})	135-150	156.95	11.32	130.00	178.00	*8.67* *2.74*	*0.000* *0.012*
	HR(%)	65-75	79.99	5.76	67.36	88.56	*12.13* *4.40*	*0.000* *0.000*
20 - 22	La (mmol·l^{-1})	2	4.04	1.68	1.00	7.60	*5.43*	*0.000*
	HR (stroke·min^{-1})	150-170	165.25	10.25	142.00	183.00	*6.65* *2.07*	*0.000* *0.051*
	HR(%)	75-85	84.21	5.07	73.58	91.89	*8.86* *0.05*	*0.000* *0.956*
24 - 26	La (mmol·l^{-1})	4	7.20	2.39	4.40	13.60	*5.98*	*0.000*
	HR (stroke·min^{-1})	170-180	179.35	7.64	168.00	197.00	*5.47* *0.38*	*0.000* *0.707*
	HR(%)	85-90	91.41	3,98	83.74	97.46	*7.23* *2.23*	*0.000* *0.037*
28 - 30	La (mmol·l^{-1})	4-8	10.62	3.41	3.80	17.80	*8.69* *3.44*	*0.000* *0.002*
	HR (stroke·min^{-1})	180-190	185.90	7.11	176.00	205.00	*3.71* *2.57*	*0.001* *0.018*
	HR(%)	90-95	94.73	3.24	89.50	99.03	*6.41* *0.67*	*0.000* *0.512*
	HR_{max}	204	196.30	5.94	185.00	207.00	*5.67*	*0.000*

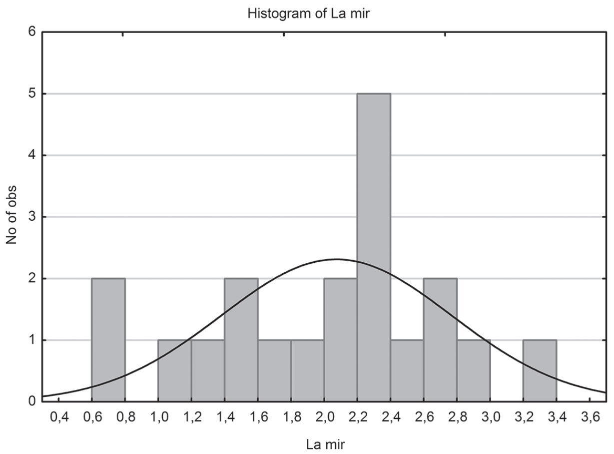

Figure 1: histogram of La at rest

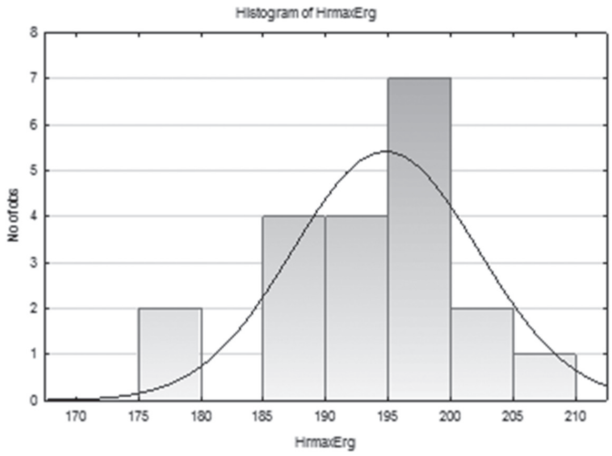

Figure 2: histogram of the heart rate maximum

Descriptive statistics of almost all measured variables is statistically significantly different from the expected values, indicating the possibility of significantly different reactions of the organism than expected. The percentage of maximal HR in the upper level during the testing stage at the stroke rate of 20-22 strokes per minute (p = 0.956), and HR in the upper level during the testing stage at the stroke rate of 24-26 strokes per minute (p = 0.707) suggest that there is no statistically significant difference between the measured and expected values. All other measured values show a significant difference from the expected value.

In order to get a better picture of the measured variables, a scatterplot was made of lactate and HR at each testing stage. Rowing at the pace of 16-18 strokes per minute is expected to be in the zone of recuperative or extensive endurance training - expected metabolic reaction should create a lactate concentration of less than 2.0 mmol·l^{-1} and have a heart rate of up to 150 beats per minute (Hartmann et al., 1990). Such expectations were met by only three rowers (Figure 3), while two others were within the expected lactate zone, with slightly elevated HR. Four others were in the expected range according to the heart rate, but with a significantly higher concentration of lactate (two of which are over 4.0 mmol·l^{-1}).

And while the work intensity at 16-18 strokes per minute should constitute recovery of the body from hard, anaerobic training, eight young rowers (40.0%) were responding with metabolic acidosis.

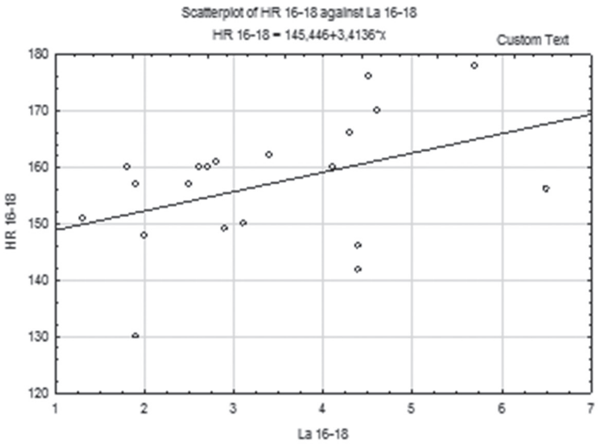

Figure 3: scatterplot HR (16-18) against La

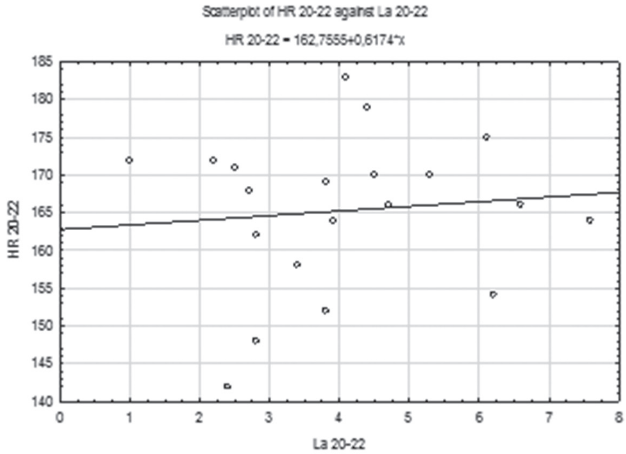

Figure 4: scatterplot HR (20-22) against La

The second load stage, rowing at the pace of 20-22 strokes per minute, should have represented the stimulus intensity for the development of extensive endurance (La = 2.0 mmol·l^{-1}; HR = 150-170). With a certain tolerance (± 0.5 mmol·l^{-1}), that criteria would be met by 5 rowers (Figure 4). However, of the other rowers, nine (45.0%) were in the anaerobic zone with their metabolic reaction (La > 4.0 mmol·l^{-1}).

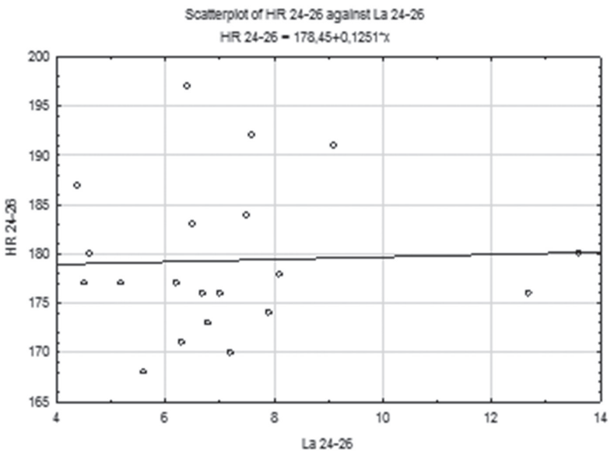

Figure 5: scatterplot HR (24-26) against La

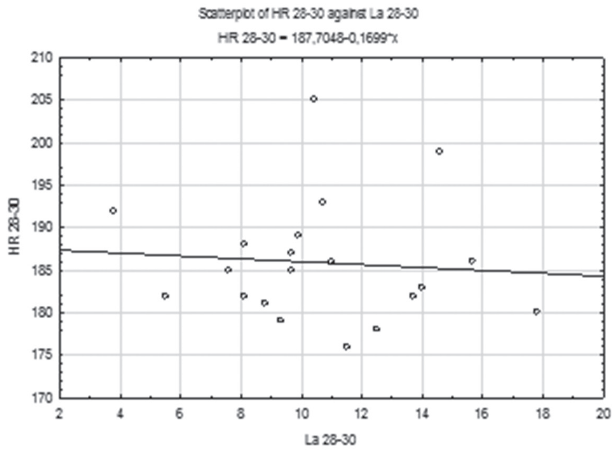

Figure 6: scatterplot HR (28-30) against La

Rowing at the pace 24-26 strokes per minute, the expected metabolic reaction of the body was around the anaerobic threshold (La = 4.0 mmol·l^{-1} ; HR = 170-180). The measured values (Figure 5) indicate that all test subjects were in the anaerobic zone. Five rowers (25%) responded metabolically up to 6.0 mmol·l^{-1}. At this testing stage, it is necessary to notice the imbalance of the metabolic reaction as indicated by lactate concentration and heart rate. Five rowers reacted with significantly higher La concentration and HR, whereas ten rowers (50%), in response to the given load (stroke rate 24-26) reacted by lactate concentration greater than 6.0 mmol·l^{-1}, while their HR was below 180·min^{-1}. This relation of high lactate and low heart rate opens up an area for its analysis.

The last load stage (stroke rate = 28-30) is expected to generate the metabolic reaction of the organism La = 4.0 to 8.0 mmol·l^{-1}. Only five rowers (25%) achieved lactate concentration within the expected values (Figure 6). As many as 10 rowers (50%) achieved lactate concentration greater than 10.0 mmol·l^{-1}. In this testing stage, it is also very interesting to notice the unexpected behavior of (high) lactate concentration and (relatively low) heart rate for the given load.

Discussion

In the last thirty years, extensive research was carried out in the rowing sport, especially in the area of physiology. According to the established demands of rowing, training directions in the management of sport form were set (Secher & Voliantis, 2007; Stöggl & Sperlich, 2015). The largest amount of training load in rowing is conducted at loads up to the anaerobic threshold, with work at extensive aerobic endurance being dominant (Hartmann et al., 1990; Jensen et al., 1990; Purge, 2006). This represents the load which in this study involved rowing at the pace of 22 strokes per minute. The analysis of the measured data indicates that only 5 test subjects achieved the expected results, and that it is only 25% of the study participants that the framework for dosing and monitoring of training recommended by FISA can be properly applied (http://www.worldrowing.com/fisa/publications/fisa-manual). In doing so, it is considered necessary to note that three of these five rowers have successful competitive characteristics: one was a member of a junior eight that won the bronze at the European Championship for juniors, while two are Croatian cadet champions for two consecutive years. Therefore, it should be noted that the results of many scientific research were carried out mainly on a selected (on a natural and an expert-scientific basis) sample of rowers. It is also necessary to state that principles are set primarily on measures of central tendency, while the variability of data is more or less ignored. Therefore, it often happens in practice that young rowers at a very early age (puberty and adolescence) are treated as "***top athletes in a small package***." This also brings us to the possibility of errors in dealing with all the athletes whose body does not respond in the expected way.

"By definition, overuse syndrome occurs as a result of accumulated repetitive microtrauma that transcends reparative abilities of the tissue. In other words, in contrast to acute injuries, where in a fraction of a second very high mechanical energy leads to the destruction of tissue, the case of overstressing a lot of repetitive microtrauma, which in themselves are not enough to cause damage, will lead, over a certain period of time, to damage or the development of overuse injuries." (Ivović & Pečina, 2009). This is in line with the research of the authors Kosinac & Marinovic (1997), where low back pain disorder has an incidence of 51.0%, as well as the of research Kosović and Marinović (2017) where the incidence of LBP is at a similar ratio, whereby the incidence of LBP is related in the strongest variance to years of experience in rowing.

With these citations, the statement of Tudor Bompa is completely clear: "The amount that children and youth will improve their physical abilities in a particular sport is the direct result of the amount and quality of work they achieve in training... If they increase the load to much, some immediate benefits may be visible, but they substantially increase the likelihood of injuries." (Bompa, 2000).

Conclusion

Twenty young Croatian rowers were subjected to testing of metabolic reactions in various intensities of work on the water, indicated by frequency of strokes. By measurements carried out in four stages at different strokes ratios (16-18; 20-22; 24-26 and 28-30), values were measured that are in a statistically significant departure from expected values. In this way, it is difficult to make a judgment about valid management of the training process. It is therefore recommended to coaches, especially of athletes of a young age, to carry out valid diagnosis of training state and monitoring of training, in order to guard against the negative effects of training on the status on the organism of (young) athletes.

Acknowledgement

The authors express gratitude to the rowing club Neptun from Dubrovnik, headed by Mr. Maro Kapović, who expressed their interest and provided material support in the implementation of this research, with the hope that it will be beneficial for Croatian rowing.

References

1. Aitken, M. (2005). Developing an Aerobic Base. In Nolte, V. (ed.). *Rowing faster*. Human Kinetics.
2. Guellich, A., Seiler, S., & Emrich, E. (2009). Training methods and intensity distribution of young world-class rowers. *International journal of sports physiology and performance*, *4*(4), 448-460.
3. Åstrand, P.O., Rodahl, K., Dahl, H.A., Stromme, S.B. (2003). *Textbook of work physiology: physiological bases of exercise*. Human Kinetics.
4. Babraj, Z. B., Voliantis, S. (2007). Training. In Secher, N. H., & Volianitis, S. (Eds.). *Handbook of sports medicine and science, rowing*. Blackwell Publishing
5. Bompa, T. (2000). Total training for young champions. Human Kinetics
6. Bourdon, P. (2000). Blood lactate transition thresholds: Concepts and controversies. In Gore, C. (ed.). *Physiological tests for elite athletes*. Human Kinetics.
7. Burke, E. (1998). *Precision heart rate training*. Human Kinetics.
8. Conconi, F., Ferrari, M.P., Ziglio,G.P, Droghetti, P. & Codeca, L. (1982). Determination of the anaerobic threshold by a noninvasive field test in runners. *Journal of Applied Physiology*, *52*(4), 869-873.

9. Fritsch, W. (2000). *Rowing: training-fitness-leisure*. Meyer & Meyer Verlag.
10. Hartmann, U., Mader, A., & Hollmann, W. (1990). Heart rate and lactate during endurance training programs in rowing and its relation to the duration of exercise by top elite rowers. *FISA*
11. Herberger, E. (1983). *Rowing: The GDR Text of Oarsmanship. Toronto: Sport Books Publisher.*
12. Ivović, A., Pečina, M (2009). Sindromi prenaprezanja u djece sportaša**.** *Paediatr Croat*, 53 (Supl 1): 216-222
13. Janssen, P. (2001). Lactate threshold training. Human Kinetics
14. Jensen, K., Nielsen, T. S., & Smith, M. (1990). Analysis of the Italian national training program for rowing. *Fisa Coach*, *1*, 1-5.
15. Karlson, P. (1993). Biokemija za studente kemije i medicine (Biochemisty for students of chemistry and medicine). *Školska knjiga, Zagreb*
16. Kosinac, Z. & Marinović, M. (1997). The back pain of rowers. *III. International Symposium Sport of the Young*, Bled, 706-709
17. Kosović, O. & Marinović, M. (2017). *Overuse injuries incidence in Croatian rowers*. Unpublished manuscript.
18. Leger, L.A., Mercier, D., Gadoury, C., Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences*, 6: 93-101
19. Marinović, M. (2011). Povezanost respiracijskih, energetskih i metaboličkih pokazatelja s fizičkom učinkovitosti veslača na veslačkom ergometru (Correlation between respiratory, energetic, and metabolic indicators with the physical efficiency of the rowers on a rowing ergometer) (unpublished doctoral dissertation), Faculty of Kinesiology, University of Split
20. Nielsen, H. B. (1999). pH after competitive rowing: the lower physiological range?. *Acta physiologica scandinavica*, *165*(1), 113-114.
21. Purge, P. (2006). *Performance, mood state and selected hormonal parameters during the rowing season in elite male rowers*.
22. Rämson, R. (2011). *Adaptation of selected blood biochemical stress and energy turnover markers to different training regimens in highly trained male rowers* (Doctoral dissertation).
23. Seiler, S., Tonnessen, E. (2009). Intervals, Thresholds, and Long Slow Distance: the Role of Intensities and Duration in Endurance Training. *Sportscience* 13, 32-53
24. Stöggl, T. L., & Sperlich, B. (2015). The training intensity distribution among well-trained and elite endurance athletes. *Frontiers in physiology*, *6*.

MUSCULAR STRENGTH AND POWER, BUT NOT MUSCULAR ENDURANCE, ACUTELY ENHANCED AFTER CAFFEINE INGESTION IN RESISTANCE-TRAINED MEN

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Purpose: We aimed to assess the acute effects of caffeine ingestion on muscular strength and power, muscular endurance, rate of perceived exertion (RPE), and pain perception (PP) in resistance-trained men.

Methods: Seventeen volunteers (mean±SD: age = 26±6 years, stature = 182±9 cm, body mass = 84±9 kg, experience = 7±3 years) with a low habitual caffeine intake (58±92 mg/day) consumed placebo or 6 mg/kg of anhydrous caffeine one hour before testing. Muscular power was assessed with seated medicine ball throw and vertical jump exercises, muscular strength with one-repetition maximum (1RM) barbell back squat and bench press exercises, and muscular endurance with repetitions of back squat and bench press exercises (load corresponding to 60% of 1RM) to momentary muscular failure. RPE and PP were assessed immediately after the completion of the back squat and bench press exercises.

Results: Compared to placebo, caffeine intake enhanced 1RM back squat performance (+2.8%; p=0.016), which was accompanied by a reduced RPE (+7%; p=0.037), and seated medicine ball throw performance (+4.3%, p=0.009). Improvements in 1RM bench press were not noted although there were significant (p=0.029) decreases in PP related to this exercise when participants ingested caffeine.

Conclusions: The results point to an acute benefit of caffeine intake in enhancing lower-body strength, likely due to a decrease in RPE; upper-, but not lower-body power; and no effects on muscular endurance, in resistance-trained men. Individuals competing in events in which strength and power are important performance-related factors may consider taking 6 mg/kg of caffeine pre-training/competition for performance enhancement.

CORRELATES OF PHYSICAL INACTIVITY IN CROATIAN ADOLESCENTS: THE CRO-PALS STUDY

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Purpose: The objective of this observational study is to investigate the associations among various factors and physical inactivity level among adolescents in Croatia.

Methods: The present study is a part of the major CRO-PALS investigation which is an on-going longitudinal study involving almost ~900 adolescents (age 15.6±0.4 y, 51% boys) from 14 public and private high schools in Zagreb, Croatia. The analyses presented here are based on year 1 data from 828 individuals. Weekly volume of physical activity, sedentary behaviors and sleep as well as demographic information were collected by previously validated, self-administered SHAPES questionnaire (Wong, et al., 2006). Body-height and body-mass were measured using standard procedures, while percent body-fat was estimated via skinfold measurement according to Slaughter, et al. (1988). Physical inactivity was defined as not meeting the current physical activity guidelines set by the World Health Organization guidelines (2010). Binary logistic regressions were calculated to establish the associations between the studied covariates and physical inactivity level (dichotomous criterion: physical activity vs inactivity). Both crude and adjusted associations were examined. After examining the effect of gender, separate analyses in boys and girls were further adjusted and performed.

Results: In crude model, girls demonstrated a higher likelihood of being physically inactive compared to boys (OR=1.93, 95% CI=1.46-2.56). Correspondingly, after further adjustment for confounding variables the odds changed only marginally (Adjusted model; OR=1.86, 95% CI=1.24-2.80). Notably, amongst other covariates the strongest predictor of physical inactivity among boys was school type (OR=1.593, 95% CI=1.033-2.454), whereas for girls, body-fat percentage (OR=0.951, 95% CI=0.925-0.978) and screen time (OR=0.998, 95% CI=0.997-1.000) were the most influential predictors.

Conclusions: Apparently, gender plays a vital role in defining the odds for physical inactivity during adolescence. Therefore, exercise programs should be tailored for adolescent girls in particular, to target the well-known health threatening consequences originating from physical inactivity (van der Horst et al., 2009). In addition, we propose systematic monitoring of physical activity in adolescents as a potentially effective control mechanism.

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References

1. Slaughter MH, Lohman TG, Boileau R, Horswill CA, Stillman RJ, Van Loan MD, Bemben DA. (1988). Skinfold equations for estimation of body fatness in children and youth. *Human Biology*; 709-723.
2. van der Horst K, Oenema A, te Velde SJ, Brug J. (2009). Gender, ethnic and school type differences in overweight and energy balance-related behaviours among Dutch adolescents. *International Journal of Pediatric Obesity*; *4*(4): 371-80.
3. World Health Organization. (2010). Global recommendations on Physical Activity for health. World Health Organization.
4. Wong SL, Leatherdale ST, Manske SR. (2006). Reliability and validity of a school-based physical activity questionnaire. *Medicine and Science in Sports and Exercise*; 38(9):1593-1600.

DIFFERENCES IN ANTHROPOMETRIC PARAMETERS OF LEFT AND RIGHT BODY SIDE IN ATHLETES WHO PRACTICE KARATE AND JUDO

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Purpose: The differences in anthropometric parameters among young athletes could be influenced by the biological development itself or they could appear under the impact of the training stimulus that is characteristic for a certain type of sport. Children at very young age startto practice karate and judo.The aim of this study was to show the differences in anthropometric parameters between left and right body side in athletes who practice karate and judo.

Methods: The research includes 29 selected athletes, members of national team divided in two groups: karate (n1=12, aged 18.39±3.51 years, body height 179.09±5.24cm, body weight 72.87±8.87kg) and judo (n2=17, aged 19.47±3.18 years, body height 185.18±9.32cm, body weight 82.91±17.42kg). All athletes have dominant right body side and practice more than 10 years. Estimated parameters divided in two groups of parameters from left and parameters from right body side. The research was conducted in the laboratory for functional diagnostics in the Serbian Institute of Sport and Sports Medicine. We measured body height, body weight, BMI, body fat % (on Composition Analyzer Type In Body 370). In total, 23 measurements (10 skin folds, 8 circumferences and 4 diameters) were performed within the anthropometric examinations (Jackson/Pollock, Martin, Drinkwater). For comparison of measured parameters, Student's T-test was used.

Results: The comparison between the measured parameters between left and right body side show that in these sports we did not notice any significant differences between left and right body side ($p>0.01$).

Conclusions: These results show that training stimulus is symmetric on right and left side. We can conclude that training in karate and judo is good for young children and does not favor only one side of body like tennis, golf, handball, volleyball.

COGNITIVE RESERVE – INVESTIGATIONS OF PHYSICAL EXERCISE AND COGNITIVE PERFORMANCE THROUGHOUT THE LIFESPAN

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Purpose: Cognitive reserve (CR) is the ability of an individual to cope with advancing brain pathology to minimize age-related symptomatology. Physical activity seems to be one factor which mediates CR. Building up CR throughout the lifespan seems to be important to compensate cognitive decline (Middelton et al., 2010). Current research suggest that elderly people benefit most from physical exercise, when starting in early childhood.

Methods: 44 physical active elderly subjects (50% female) with a mean age of 69,3 years answered a questionnaire assessing the biography of physical activity throughout lifespan (Wollny, 2002). We applied an extensive cognitive test battery that tested attention, processing speed, and memory. We employed the Physical Working Capacity 130 Test (PWC130) to assess endurance related fitness. For statistical analysis we calculated indices for general physical activity and physical exercise in childhood, young and old adulthood.

Results: Spearman correlations revealed a significant correlation in error rates of divided attention for subjects who started to exercise in early childhood ($r_s = -0{,}37$; $p < 0{,}010$). Subjects who started to exercise in young adulthood indicated slower reaction times and information processing speed ($T = 0{,}19$; $p < 0{,}05$).

Conclusions: Physical exercise plays an important role in counteracting age-related degenerations in cognitive function. Although the ability to generate new neurons is preserved in late adulthood, our results suggest that subjects who start in early childhood with physical exercise profit most in buidling up CR to compensate age-deficitis in cognitive function.

Biology & Medicine of Sport and Exercise

References

1. Middleton, L. E., Barnes, D. E., Lui, L.-Y. & Yaffe, K. (2010). Physical activity over the life course and its association with cognitive performance and impairment in old age. Journal of the American Geriatrics Society, 58(7), 1322-1326. doi:10.1111/j.1532-5415.2010.02903.x
2. Wollny, R. (2002). Motorische Entwicklung in der Lebensspanne. Warum lernen & optimieren manche Menschen Bewegungen besser als anderer? Schorndorf: Verlag Karl Hofmann.

A MULTIDISCIPLINARY APPROACH TO SEXUAL DYSFUNCTION IN FEMALE ATHLETES

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Abstract

Purpose: Sexual dysfunction is registered as an ever increasing problem that occurs equally in men and women. In women who are actively involved in sports, sexual dysfunction has so far not been sufficiently studied. Etiology of sexual dysfunction is complex and related to changes in the vascular, neurological, endocrine and muscular system as well as psychological factors. In sports, there are also sports-specific biomechanical factors and fatigue which can predispose to the condition.

Methods: A detailed search on sexual dysfunction in female athletes was performed using Medline/Pub Med, EMBASE, and OvidSP from their inception to January 2017. The search was performd using following terms: "sexual function" OR "sexual dysfunction" AND "female athlete" and it was not limited with respect to trial design and time when article was published. Studies included in this review had to meet the following inclusion criteria: report on the incidence, etiology or pathogenesis of the sexual dysfunction in female athletes, or report on the treatment or preventive strategies for sexual dysfunction in female athletes.

Results: Through database searching 76 articles were identified. Of these, 31 were excluded. After reviewing 45 studies in full text, 17 articles were included in the review. The published data are scarce and only 8 randomized controlled trials were found. Female athletes can have all types of sexual dysfunction. Alongside complex diagnosis and medical treatment, kinesiology-anthropological analyses and physiotherapy process should have also be implemented, which would define the need, type and extent of therapeutic exercises as part of the multidisciplinary treatment. Also, sports and sports-specific biomechanical factors which predispose female athletes to sexual dysfunction are poorly identified which does not allow adequate screening and early diagnosis and treatment.

Conclusions: Lack of research into the presence of sexual dysfunction in female athletes (different types according to the classification of sexual dysfunction) emphasizes the need for additional research. Female athletes have a reduced risk of developing a sexual dysfunction but sports such as cycling and horse riding present a risk. A multidisciplinary approach of sexual dysfunction in female athletes is priority and should be based on standardized classification.

References

1. Nappi PR, Cucinella L, Martella S, Rossi M, Tiranini L, Martini E. Female sexual dysfunction (FSD): Prevalence and impact on quality of life (QoL).Maturitas. 2016 Dec; 94:87-91. doi: 10.1016/j.maturitas.2016.09.013. Epub 2016 Sep 28.
2. Foley S, Wittmann D, Balon R. A multidisciplinary approach to sexual dysfunction in medical education. Acad Psychiatry. 2010 Sep-Oct; 34(5):386-9.
3. Sauer JL, Potter JJ, Weisshaar CL, Ploeg H, Thelen DG. Influence of gender, power, and hand position on pelvic motion during seated cycling. Med Sci Sports Exerc. 2007; 39:2204-11.

HEMATOLOGICAL OXYGEN TRANSPORT BENEFITS OF AEROBIC PHYSICAL ACTIVITY AT ALTITUDES 1250-2000M

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Abstract

It is known that it takes 2-3 weeks of exposure to elevations greater than 1800m for some hematological benefits of an altitude stay to be expressed. Lower altitudes and shorter stays and combination of moderate altitudes and physical activity have not been thoroughly investigated. That is why we hypothesized that the combination of a stay at lower altitude (1300m) and aerobic activity at lower to moderate altitude (1300-2000m) might elicit changes in oxygen transport parameters. The sample comprised of 32 divided into experimental and control group: 17 males (age=21.5±1.07) underwent an intervention- a ski-trip lasting for 10 days while sleeping on 1250 m and performing 5-6 hours of aerobic activity at 1300-2000m altitude; and 15 males (age=21.5±1.06) who stayed at sea-level making the control group. The ferritin levels, reticulocyte and erythrocyte count before and after the trip were measured. Ferritin levels decreased and reticulocyte count increased significantly in experimental group, which suggested that lower altitudes in combination with aerobic activity of longer daily duration, like skiing, might result in hematological benefits e.g. improvements in oxygen transport system.

Key words: *reticulocyte, ferritin, training, erythropoietin, hypoxia, erythrocyte*

Introduction

In response to hypoxic stress, such as ascent to altitude, the increase in RBC production is regulated through the activity of hormone erythropoietin (EPO) and erythropoiesis requires large amounts of iron for hemoglobin (Hgb) synthesis. Therefore, adequate iron stores in organism are mandatory (Dzierzak & Philipsen 2013; Frise & Robbins 2015) and serum ferritin is commonly used as a measure of body iron storage (Kohgo, Ikuta, Ohtake, 2008). During the stages or erythropoiesis, hematopoetic pluripotent progenitor cells (HSCs) undergo series of differentiations, with each succeeding level of differentiation increasing their number and simultaneously decreasing their proliferative potential (Dzierzak & Philipsen, 2013). Iron is assimilated through several stages from proerythroblast on (Finch, 1957) and reticulocytes are the last stage before those cells mature to erythrocytes, with whole process lasting aproximatelly 21 days (Griffiths et al., 2012). High-altitude stay increases the rate of erythropoiesis and lowers ferritin stores in tissues (Piperno et al., 2017, Govus et al., 2015, Gassmann & Muckenthaler 2015, Ryan et al., 2014)

In sports training methodology research, high-altitude stay and its positive effect on sea-level performance or hematological benefits are still a matter of debate (Levine, Stray-Gundersen 1997, 2001, 2002, Garvican et al., 2012). It is commonly accepted that stay at altitudes >2000m for a period of 3-4 weeks (Friedmann-Bette 2008, Wilber, Stray-Gundersen, Levine, 2007) can lead to greatest improvements in sea-level performance, with recommendations for even higher altitudes such as 4000m and time of stay longer than 4 weeks for maximal effects, especially if RBC count is initially high (Rasmussen, 2013). Although not unanimously (Friedmann, 1999), some studies have shown that altitudes lower than 2000m are also effective (Frese, Friedmann-Bette 2010, Garvican-Lewis, 2015). To our findings, no studies have dealt with recreational aerobic activity like skiing at lower to moderate altitudes (1250-2000m respectively), and its effects on blood-oxygen transport system. Since in Croatia approximately 200k people goes on a ski trip lasting 7-14 days each year it was of interest to determine whether such stay had effects in recreational population. The aim of the study was to search for signs of accelerated erythropoiesis, meaning larger reticulocyte count and lower ferritin levels, after 10 days long intermittent hypoxia between 1250m and 2000m with adjacent several hours of aerobic activity. The goal was also to determine the possible link between the relative increase in number of reticulocytes and initial concentration of red blood cells and ferritin, hypothesizing that the larger reserves of ferritin in the body would cause a greater increase in reticulocytes, while the initially higher number of erythrocytes would experience the smaller increase in reticulocytes.

Methods

Each of the 32 participants signed informed consent. The Ethics Committee at Faculty of Kinesiology in Zagreb, approved the study. The experimental group (n=17,M,age=21.5±1.07; moderately physically active, no professional athletes) attended 10 days of field ski classes (1250 m altitude of sleeping and up to 2000m altitude of daily skiing activity). For t test

Before the classes officially commenced, all participants were divided into homogenized groups based on their previous knowledge and went through the same program led by licensed instructors. The lessons were conducted from 9 AM-4.00 PM with mean effective duration of intermittent skiing activity of 5h and 30min.The heart rate monitor data showed that half of the active time was spent in zones between 50-60% of FSmax and almost a half at 60-70% of FSmax with very short intervals of higher intensities (average daily METs =4-4.5). The control group stayed at 120m (n=15,M,age=21.5±1.06, able bodied not professional athletes) and refrained from intensive anaerobic physical activity during the study while they continued with some of their normal aerobic activities. Measurements of erythrocytes (10e12/L), reticulocytes (10e9/L) and ferritin (µg/L) were conducted at biochemistry laboratory of "Breyer Polyclinic" at two time points, initially 30 hours before ski-classes started (day 0) and finally 48 hours after the last class was held (day 14). Both groups were asked to refrain from physical activity 48h before the initial testing.

Results

Shapiro-Wilk test has shown all variables to be normally distributed; therefore, parametric statistic was used in all further analysis. The differences before and after for both groups in ferritin and reticulocyte counts were tested with Student t- test for dependent samples (Table 1).

*Table 1: Age, ferritin levels and reticulocyte count by groups and measurement time (Day 0, Day 14). *-significant difference from D0 measurement (p<0.05)*

	AGE	Ferritin µg/L (D0)	Ferritin µg/L (D14)	Reticulocyte 10e9/L (D0)	Reticulocyte 10e9/L (D14)
Experimental	21.5±1.1	84.1±54.1	64.5±40*	44.5±16.2	67.0±18.4*
Control	21.5±1.1	103.4±45.8	91.7±44.5	54.7±13.5	50.2±13.8

The main interest for our hypothesis was the direction of changes meaning that we speculated that after the treatment the ferritin reserves might diminish while the reticulocyte count would increase. Figure 1A shows that that was the case in 88% of all experimental group subjects while in control group the values changed in all directions. The significance in number of subjects with those changes between the groups was confirmed by chi-square test with Yates correction (chi- squared= 7.971; p=0.005).

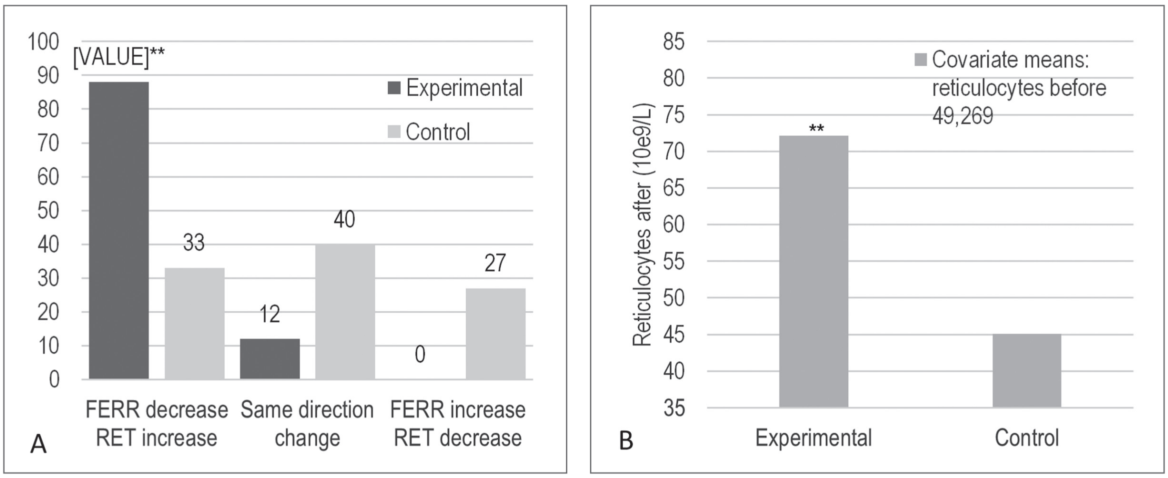

*Figure 1: . A) Direction of changes (in percentages) in ferritin and reticulocytes. Experimental group had significantly greater number of subjects with ferritin decrease and reticulocyte increase. B) Differences in reticulocyte count change between groups. Significantly larger increase in experimental group. (**=p<0.01)*

The differences in reticulocyte count change between the experimental and control group were tested by ANCOVA where the initial values were taken into account as covariates (Figure 1B). The experimental group had significantly larger increase which might be attributed to intervention (Current effect: $F(1, 29)=44{,}952$, $p<0{,}001$).

The final test included searching for the relations between initial ferritin reserves and erythrocyte count and the extent of reticulocyte increase. Erythrocyte count showed to be the good predictor for reticulocyte increase in the whole sample (erythrocyte b=-0.36*, R^2 only 0.14, intercept p=0.025), meaning the ones with lower erythrocyte count prior to the study had the stronger response, which is the normal physiological adaptation and no unexpected novelty. When the same calculations were performed for only experimental group subjects the trend was still visible, but the model was not significant (erythrocyte b=-0.29, R^2 only 0.11, intercept p=0.124). Unfortunately, it seems that the number of experimental group subjects was too small to prove the statistically significant increase of reticulocytes related to initial erythrocyte count.

The post hoc power analysis for significant reticulocyte change achieved power of 0.999, with a very large effect size of 1.95 for experimental group. For control group the effect size was only 0.3 (reticulocytes actually decreased a bit) with unsatisfactory achieved power of 0.306 for that non-significant change.

Discussion

The major finding of this study is that combination of aerobic physical activity at 1300-2000m altitudes, with 10-day stay at 1250m could lead to significant changes related to erythropoietic effect. Reticulocyte count had significantly increased and ferritin levels significantly decreased in experimental group clearly showing that even such short stay (10 days) on moderately low altitude can lead to positive changes in oxygen-transport system. Although ferritin stores usually deplete during ascent to altitude, many dispute concerning iron metabolism still exist in regards to all background mechanisms for successful altitude acclimatization. Firstly, it has been shown that iron depleted runners couldn't achieve increase in RBC during 4 weeks at 2500m (Stray-Gundersen et al., 1992), then others (Govus et al., 2015) had shown that even initially healthy iron stores (>100µg/L) didn't lead to successful erythropoiesis, while third (Ryan et al., 2014) have shown that despite low ferritin stores (<13µg/L) significant Hgb mass increases occurred (studied at 5260m altitude). It seems that there are some, still unknown, mechanisms responsible for iron's delivery to eryhtron, with hepcidin metabolism, increased intestinal iron absorption (Gassman, Muckenthaler 2015, Peeling et al., 2014) and decrease in skeletal muscle iron content (Robach et al., 2007) speculated to be such mechanisms. Also, very high altitude is assumed to have different, EPO-independent, RBC production mechanisms (Li et al., 2011). Our study adds a novelty that ferritin decrease was noticeable after 10 days stay at altitude of 1250m with occasional activity bouts at up to 2000m.

If altitude training is showed to be hematologically beneficial, reticulocyte count will be one of the measures which has increased, as early as on the 5th day of exposure (Garvican et al., 2012). Only few studies showed an increase in reticulocyte count, Hgb mass or performance gains at altitudes lower than 2000m. A study conducted on runners at 1800m showed a significant increase in reticulocyte count after 2 weeks of exposure (Garvican-Lewis et al., 2015). Study on swimmers (Roels et al., 2006) showed that 13 days at altitude of 1200m led to performance gains (faster swimming) but no hematological gains, and conversely 13 days at 1800m, 6 weeks later, showed no performance gains despite reticulocyte count increase. Interesting effect was also shown in a study where two consecutive altitude camps were held with middle-distance runners (Frese, Friedmann-Bette, 2010); first they spent 20 days at 1300m and then 22 days at 1650 meters with 19 day of sea-level stay in between. No effects could be seen after the first camp, but after the second camp total hemoglobin mass was 5.1% higher (Frese, Friedmann-Bette, 2010). One of the reasons for gained hematological benefits in our study, which are in contrast to some other findings, could be that it was conducted on population of recreational athletes. There are more reserves for gaining positive effects with recreational athletes than with already accomplished elite athletes, who probably need stronger stimulus (Ashenden et al., 1999, Rasmussen et al., 2013).

The limitations of the study

The limitations of this study were organizational and financial problems for larger samples and additional blood analysis time points. That seems to be the problem in studies of higher altitude adaptations, as in most published studies the samples are even much smaller and often even lack a control group. Also, the observed changes could not be attributed only to exercise or only to altitude, since we were not able to determine to total physical activity amount within control group and oversee strictly their behavior. Additionally, we only have the range of altitude in which participants were active, not exact altitudes or intensity for each minute of the activity which would ease the study reproducibility.

Conclusions

In conclusion, this study has shown that sleeping at lower altitudes such as 1250m, combined with 5 -6 hours of an extensive aerobic activity at 1300 to 2000m, could lead to the significant changes in blood-oxygen transport system. Ferritin levels decreased and reticulocyte count increased as a proof of thereby started erythropoiesis. Additionally, a lower initial erythrocyte count had led to greater reticulocyte response in all experimental subjects which suggested that high altitude stay could have greater effects in general population than in professional athletes. This study shows potential direction of exploring even lower altitudes and their measurable effect on human health as opposed to completely sedentary lifestyle. Individual genetic variation, individual fitness level, type and duration of hypoxic exposure and finally altitude are all factors in determining what kind of effects an individual will obtain. More controlled studies are needed to get the right picture of these mechanisms.

References

1. Ashenden, M.J., Gore, C.J., Dobson, G.P. and Hahn, A.G., 1999. "Live high, train low" does not change the total haemoglobin mass of male endurance athletes sleeping at a simulated altitude of 3000 m for 23 nights. *European journal of applied physiology and occupational physiology*, *80*(5), pp.479-484.
2. Dzierzak, E. and Philipsen, S., 2013. Erythropoiesis: development and differentiation. *Cold Spring Harbor perspectives in medicine*, *3*(4), p.a011601.
3. Finch, C.A., 1958. The role of iron in hemoglobin synthesis. In *Conference on Hemoglobin, 2-3 May 1957: 2-3 May 1957* (p. 95). National Academy of Sciences-National Research Council.
4. Frese, F. and Friedmann-Bette, B., 2010. Effects of repetitive training at low altitude on erythropoiesis in 400 and 800 m runners. *International journal of sports medicine*, *31*(06), pp.382-388.
5. Friedmann, B., Jost, J., Weller, E., Werle, E., Eckardt, K.U., Bärtsch, P. and Mairbäurl, H., 1999. Effects of iron supplementation on total body hemoglobin during endurance training at moderate altitude. *International journal of sports medicine*, *20*(02), pp.78-85.
6. Friedmann-Bette, B., 2008. Classical altitude training. *Scandinavian journal of medicine & science in sports*, *18*(s1), pp.11-20.
7. Frise, M.C. and Robbins, P.A., 2015. Iron, oxygen, and the pulmonary circulation. *Journal of Applied Physiology*, *119*(12), pp.1421-1431.
8. Garvican, L., Martin, D., Quod, M., Stephens, B., Sassi, A. and Gore, C., 2012. Time course of the hemoglobin mass response to natural altitude training in elite endurance cyclists. *Scandinavian journal of medicine & science in sports*, *22*(1), pp.95-103.
9. Garvican-Lewis, L.A., Halliday, I., Abbiss, C.R., Saunders, P.U. and Gore, C.J., 2015. Altitude exposure at 1800 m increases haemoglobin mass in distance runners. *Journal of sports science & medicine*, *14*(2), p.413.
10. Gassmann, M. and Muckenthaler, M.U., 2015. Adaptation of iron requirement to hypoxic conditions at high altitude. *Journal of Applied Physiology*, *119*(12), pp.1432-1440.
11. Govus, A.D., Garvican-Lewis, L.A., Abbiss, C.R., Peeling, P. and Gore, C.J., 2015. Pre-altitude serum ferritin levels and daily oral iron supplement dose mediate iron parameter and hemoglobin mass responses to altitude exposure. *PloS one*, *10*(8), p.e0135120.
12. Griffiths, R.E., Kupzig, S., Cogan, N., Mankelow, T.J., Betin, V.M., Trakarnsanga, K., Massey, E.J., Parsons, S.F., Anstee, D.J. and Lane, J.D., 2012. The ins and outs of human reticulocyte maturation: autophagy and the endosome/exosome pathway. *Autophagy*, *8*(7), pp.1150-1151.
13. Kohgo, Y., Ikuta, K., Ohtake, T., Torimoto, Y. and Kato, J., 2008. Body iron metabolism and pathophysiology of iron overload. *International journal of hematology*, *88*(1), pp.7-15.
14. Levine, B.D. and Stray-Gundersen, J., 1997. "Living high-training low": effect of moderate-altitude acclimatization with low-altitude training on performance. *Journal of applied physiology*, *83*(1), pp.102-112.
15. Levine, B.D., 2002. Intermittent hypoxic training: fact and fancy. *High altitude medicine & biology*, *3*(2), pp.177-193.
16. Li, P., Huang, J., Tian, H.J., Huang, Q.Y., Jiang, C.H. and Gao, Y.Q., 2011. Regulation of bone marrow hematopoietic stem cell is involved in high-altitude erythrocytosis. *Experimental hematology*, *39*(1), pp.37-46.
17. Peeling, P., Sim, M., Badenhorst, C.E., Dawson, B., Govus, A.D., Abbiss, C.R., Swinkels, D.W. and Trinder, D., 2014. Iron status and the acute post-exercise hepcidin response in athletes. *PLoS One*, *9*(3), p.e93002.
18. Piperno, A., Galimberti, S., Mariani, R., Pelucchi, S., Ravasi, G., Lombardi, C., Bilo, G., Revera, M., Giuliano, A., Faini, A. and Mainini, V., 2011. Modulation of hepcidin production during hypoxia-induced erythropoiesis in humans in vivo: data from the HIGHCARE project. *Blood*, *117*(10), pp.2953-2959.
19. Rasmussen, P., Siebenmann, C., Diaz Molina, V. and Lundby, C., 2013. Red cell volume expansion at altitude: a meta-analysis and Monte Carlo simulation. *Medicine & Science in Sports & Exercise.*, *45*(9), pp.1767-1775.
20. Robach, P., Cairo, G., Gelfi, C., Bernuzzi, F., Pilegaard, H., Vigano, A., Santambrogio, P., Cerretelli, P., Calbet, J.A., Moutereau, S. and Lundby, C., 2007. Strong iron demand during hypoxia-induced erythropoiesis is associated with down-regulation of iron-related proteins and myoglobin in human skeletal muscle. *Blood*, *109*(11), pp.4724-4731.
21. Roels, B., Hellard, P., Schmitt, L., Robach, P., Richalet, J.P. and Millet, G.P., 2006. Is it more effective for highly trained swimmers to live and train at 1200 m than at 1850 m in terms of performance and haematological benefits?. *British journal of sports medicine*, *40*(2), pp.e4-e4.
22. Ryan, B.J., Wachsmuth, N.B., Schmidt, W.F., Byrnes, W.C., Julian, C.G., Lovering, A.T., Subudhi, A.W. and Roach, R.C., 2014. AltitudeOmics: rapid hemoglobin mass alterations with early acclimatization to and de-acclimatization from 5260 m in healthy humans. *PloS one*, *9*(10), p.e108788.
23. Stray-Gundersen, J., Alexander, C., Hochstein, A. and Levine, B.D., 1992. Failure of red cell volume to increase to altitude exposure in iron deficient runners. *Medicine & Science in Sports & Exercise*, *24*(5), p.S90.
24. Stray-Gundersen, J., Chapman, R.F. and Levine, B.D., 2001. "Living high-training low" altitude training improves sea level performance in male and female elite runners. *Journal of applied physiology*, *91*(3), pp.1113-1120.
25. Wilber, R.L., Stray-Gundersen, J. and Levine, B.D., 2007. Effect of hypoxic "dose" on physiological responses and sea-level performance. *Medicine and science in sports and exercise*, *39*(9), pp.1590-1599.

APPLICATION OF INFRARED THERMOGRAPHY IN BASKETBALL

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Abstract

The purpose of this study was to explore the difference in thermographic profile of the body in women basketball players and to detect seasonal changes in skin temperature distributions. Six women basketball players (age 21±0,76) recruited from the basketball club "Student" Niš. Thermal imaging of the participants was performed by the thermovision camera model E30 (FLIR Systems, Sweden) with thermic sensibility of less than 0,1°C, accuracy ±2% from the registered temperature and photo resolution of 160 × 120 pixels. Obtained thermograms were analysed qualitatively and quantitatively. Results didn't show any abnormal asymmetry in collateral regions of interest which lead to the conclusion that players didn't experience any injury during autumn half of season.

Key words: *thermal imaging, injuries, skin temperature, overuse, women*

Introduction

Thermal imaging or Infrared thermography (IRT) is non-invasive and non-contact diagnostic method for exploring changes in skin temperature. Contemporary low-cost cameras for thermal imaging and "user-friendly" software made this method available to sport scientist. Interests for monitoring skin temperature changes as diagnostic tool could be traced back to the Antic period when Hippocrates stated that differences in skin temperature could be the sign of disease. The changes of skin temperature can be caused by numerous factors such as metabolic rate, emotions, skin blood flow, genetic, skin emissivity, hair density, circadian rhythm, anthropometry, age, sex (Fernández-Cuevas et al., 2015; Zaproudina, Varmavuo, Airaksinen, & Närhi, 2008) which scientist define as intrinsic factors (Fernández-Cuevas et al., 2015), as well as group of factors categorized as extrinsic factors such as intake factors, application of some procedures, therapies and physical activity (Fernández-Cuevas et al., 2015). The complexity of skin temperature regulation demand adoption of very strict protocol in recording thermal images. The first modern application of thermovision in medicine was in the early 19th century (Ring, 2007). Process of thermal imaging has been used to describe temperature patterns of the body surface in the diagnosis of pain syndromes (Zaproudina, Ming, & Hänninen, 2006) vascular disorders (Huang et al., 2011), neurological defects (Park et al., 2012), some types of cancer (Arora et al., 2008), muscle and tendon injuries as well as sport injuries and overuse syndromes in sport (Hildebrandt, Raschner, & Ammer, 2010). It is well known that an injury can cause variations in blood circulation and these can affect changes in skin temperature. Damages of deeper tissues can be detected after heat transfer from the inner tissue to the overlying skin (Al-Nakhli et al., 2012). Thermal imaging could be very useful tool in detecting overuse syndrome in sport and preventing sport injuries. Unnatural thermal asymmetry can be the sign of overuse and potential location of injury. In the case of overuse and overtraining the local temperature increase and if detected temperature difference between contralateral body regions overreach 0.7 °C it can be the sign of some issue that deserves attention (Hildebrandt et al., 2010).

The purpose of thermograms use were to diagnose overuse syndrome and to prevent sport injuries within basketball players. The physiological requirements of basketball are high despite the relatively short periods of high intensity interrupted by the periods of low intensity (McInnes et al., 1995; Klusemann et al., 2013). High physiological demands are one of the main causes of injuries. Previous studies show that sports injuries likely result from associations between training patterns, daily stresses, and overtraining (Powell & Barber-Foss, 1999; Almeida et al., 1999). Therefore the objective of this study was to explore the difference in thermographic profile of the body in women basketball players and to detect seasonal changes in skin temperature distributions.

Material and methods

Participants

Six women basketball players (age 21±0.76) recruited from the basketball club "Student" Niš volunteered to participate in this study. They were included in the study if they are involved in competitions, if they trained at least 3 times per week, and if they have at least 3 years of training. All participants were healthy and without any injury that could cause time-loss in competition.

The research has been carried out in accordance with the Helsinki Declaration on human rights. Participants has been informed about the purposes of research and about the procedure of imaging after which they signed out written consent. Prior approval to its conduction was obtained from the Ethics Committee of Faculty of Sport and Physical Education.

Procedure of thermal imaging

Thermal imaging of the participants was performed by the thermovision camera model E30 (FLIR Systems, Sweden) with thermic sensibility of less than 0,1°C, accuracy ±2% from the registered temperature and photo resolution of 160 × 120 pixels. The distance between the participant and the camera was set at 3m, and the emissivity at ε =0,98, and there was neutral background of 1,0x2,0m behind the examinee so as to eliminate the influence of the reflection of the background on the measuring. The room was 25m^2 big and its temperature was of 24°C±1,5°C; the temperature was taken with a manual thermometer type ODT 0302 (Iskra, Slovenia), sensitivity ± 0,1 °C, accuracy ±0,05 °C. The examinee was asked not to engage in exhausting, high-intensity physical activities 24h before the measuring, as well as not to take any alcoholic and caffeine drinks or use creams and tonics which could affect the moisture of the skin. Front and back thermograms were made for the upper and lower extremities, and core, whereas the participant with only the necessary clothes was in the upright standing position. Two measurements were organized (initial measurement was the beginning of season 30.9.2016. and final measurement was at the end of autumn half season 20.12.2016.

Images and data analysis

Thermographic images obtained with the FLIR E30 camera were analyzed with the help of FLIR Tools software package. The temperature of 6 regions of the front side (core, upper arm, forearm, thigh, knee, lower leg) and 8 regions of the back side (core, scapular region, upper arm, forearm, thigh, knee, lower leg, and upper part of the lower leg-calf) was monitored. A Region of Interest (ROI) per each body segment was selected by an operator following physical location based on classical definition of body regions. The final temperature value was calculated as arithmetic mean over the temperature value of all the pixels inside the ROI considered. Average temperature for each region is determined for left and right side of the body. After that, the quantitative differences between the left and the right side of the regions were determined too. Differences between the temperature of the left and right side of the body, as well as between initial and final measurement were calculated in IBM SPSS 21.0. Student's t-tests were calculated to detect systematic difference between each couple of data set.

Results

All obtained thermograms are firstly analised qualitatively by visual analysis of images. Two independent observers were marking the regions of visual color asymmetry caused by the difference in the skin temperature. After that they quantify differences calculating the difference between the maximal, minimal and average temperature between the left and right paired regions of interest. The high value of ICC (.771) shows there was a fair degree of agreement between the observers.

Results in tables 1 and 2 show that in the most regions of interest right side had slightly greater temperature than left side of the body (15 ROI was warmer on the right side, 3 ROI didn't have any difference, and in 10 ROI was warmer on the left side). The results showed significant differences ($p<.05$) between the right and left sides in the following regions of interest: upper arm front ($p=.020$), lower leg front ($p=.043$), core back ($p=.040$).

Statistical analysis of the average skin temperatures obtained at the beginning of the half season (initial measurement) and at the end of half season (final measurement) show significant differences in the following regions: right upper leg front ($p=.007$), left lower leg front ($p=.032$), right lower leg front ($p=.025$), left lower leg back ($p=.013$). Other regions didn't show statistically significant differences. The limitation of this study could be small sample for statistical testisting the changes, but some authors advocate use of t test even with extremly small sample (less then 5 participants) (De Winter, 2013; Sheppard, 1999). To reach stronger statistical power further studies should be carried out with larger sample.

Tabela 1: Differences in average temperatures of the left and right side in front view (N=6)

	Left side (Mean±SD)	Right (Mean±SD)	t value	Sig.
Shoulder front initial	32.7±1.1	33.2±0.8	-2.64	0.06
Shoulder front final	33.0±1.2	33.6±0.9	-1.82	0.13
Upper arm front initial	32.0±0.9	31.7±1.0	3.35	.020*
Upper arm front final	32.3±1.5	32.6±1.4	-2.43	0.06
Forearm front initial	31.5±0.9	31.5±1.0	0.51	0.63
Forearm front final	32.2±1.3	32.1±1.2	0.94	0.39
Core front initial	33.7±0.3	33.7±0.4	-0.40	0.71
Core front final	33.9±1.0	33.9±1.0	0.00	1.00
Upper leg front initial	30.2±0.4	30.0±0.4	1.88	0.12
Upper leg front final	29.6±0.8	29.2±0.8	1.95	0.11
Knee front initial	28.9±0.6	29.0±0.4	-0.59	0.58
Knee front final	27.8±0.9	28.0±1.2	-841.00	0.44
Lower leg front initial	30.1±0.7	30.5±0.6	-2.70	0.04
Lower leg front final	28.7±1.0	28.9±0.9	-1.99	0.10

Tabela 2: Differences in average temperatures of the left and right side in back view (N=6)

	Left side (Mean±SD)	Right (Mean±SD)	t value	Sig.
Shoulder back initial	33.0±0.7	32.8±0.6	1.50	0.20
Shoulder back final	33.4±1.1	33.4±1.2	0.00	1.00
Scapula back initial	33.5±0.7	33.6±0.7	-0.79	0.47
Scapula back final	34.1±1.2	34.1±1.1	0.57	0.60
Upper arm back initial	29.9±1.6	30.0±1.6	-1.11	0.32
Upper arm back final	30.0±1.3	30.5±1.4	-1.51	0.19
Forearm back initial	31.8±0.7	31.7±0.8	0.26	0.80
Forearm back final	32.3±0.8	32.3±1.3	-0.30	0.78
Core back initial	33.1±0.7	32.9±0.8	2.77	0.04
Core back final	33.4±1.1	33.3±1.1	1.05	0.34
Upper leg back initial	29.8±1.2	30.1±0.3	-0.71	0.51
Upper leg back final	28.7±1.1	29.1±0.9	-1.92	0.11
Lower leg back initial	30.0±0.9	29.7±0.5	0.68	0.53
Lower leg back final	28.5±1.9	28.7±0.6	-0.36	0.74

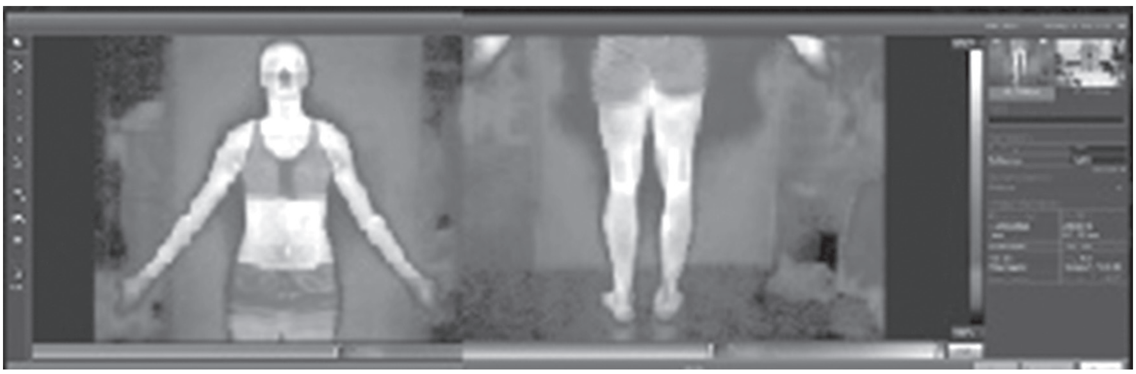

Figure 1: Thermogram of upper body front view and Thermogram of lower legs back view

Discussion

The main finding of this study was the identification of the symmetry in average skin temperature between the most right and left paired regions of interest (ROI) in women basketball players. Previous studies are in line with the study of Hildebrandt et al. (2010) that temperature asymmetry greater than 0.7 °C indicate some issue. Those results support the fact that participants didn't have any diagnosed injury. It is important to monitor because abnormal thermograms can indicate a pathological condition even before the appearance of clinical symptoms (Chudecka & Lubkowska, 2015). Difficulties in interpreting changes in temperature in selected body areas in athletes are associated with the lack of studies. This study is the first study carried out in this way and it is difficult to compare the results with previous similar studies.

Slightly higher skin temperature of the right side regions could be explained by the fact that in all participants right hand is dominant. This results are in accordance with the results of Marins et al. (2014) and Gómez-Carmona et al. (2010) who investigated thermographic profile of soccer players. They have detected small difference between collateral regions with greater temperature on the dominant leg. If we consider that right hand, right leg and right side of back core are dominantly engaged in basketball such results are expected.

Expected greater differences between collateral regions (left and right) caused by the frequent games and accumulated fatigue at the end of half season were not obtained. In a sports setting, this early detection of asymmetry could help in lowering the incidence of injuries from over-exercising sore muscles.

The highest temperatures are registered in the core regions and scapular region. The lowest temperatures were found in the distal parts of the body, especially on the lower limbs which is in accordance with previous studies. Chudecka & Lubkowska (2015) explain that such distribution of temperature may be due to the temperature of internal organs, producing heat during their normal metabolic processes, and also the low thickness of subcutaneous fat. This data confirm the studies of other authors where the skin temperature of the trunk is highest, and the temperature decreases as the distance from the trunk to the extremities increases (Niu et al., 2001; Oerlemans et al., 1999).

Conclusion

Infrared thermal imaging have the potential to be very useful and objective method in monitoring athletes and their injuries. Skin temperature variations followed on the sample of 6 women basketball players didn't show any abnormal asymmetry that could indicate injury. Following studies should be directed toward injured athletes and exploring the phenomena of thermal changes caused by different types of injuries.

References

1. Almeida, S. A., Williams, K. M., Shaffer, R. A., & Brodine, S. K. (1999). Epidemiological patterns of musculoskeletal injuries and physical training. *Medicine and Science in Sports and Exercise, 31*(8), 1176-1182.
2. Al-Nakhli, H.H., Petrofsky, J.S., Laymon, M.S., Berk, L.S. (2012). The Use of Thermal Infra-Red Imaging to Detect Delayed Onset Muscle Soreness. *Journal of visualized experiments* (59), e3551
3. Arora, N., Martins, D., Ruggerio, D., Tousimis, E., Swistel, A. J., Osborne, M. P., & Simmons, R. M. (2008). Effectiveness of a noninvasive digital infrared thermal imaging system in the detection of breast cancer. *The American Journal of Surgery*, *196*(4), 523-526.
4. Chudecka, M., & Lubkowska, A. (2015). Thermal maps of young women and men. *Infrared Physics & Technology*, 69, 81-87.
5. De Winter, J. C. (2013). Using the Student's t-test with extremely small sample sizes. *Practical Assessment, Research & Evaluation*, 18(10), 1-12.
6. Fernández-Cuevas, I., Marins, J. C. B., Lastras, J. A., Carmona, P. M. G., Cano, S. P., García-Concepción, M. Á., & Sillero-Quintana, M. (2015). Classification of factors influencing the use of infrared thermography in humans: A review. *Infrared Physics & Technology*, *71*, 28-55
7. Gómez-Carmona, P. M., Noya, S. J., Fernández-Rodríguez, I., & Sillero-Quintana, M. (2010). Validación de la termografía infrarroja como método de prevención de lesiones en futbolistas profesionales. II Congreso Internacional de Ciencias del Deporte de la Ucam. *Murcia*, *26*, 27-28.
8. Hildebrandt, C., Raschner, C., & Ammer, K. (2010). An overview of recent application of medical infrared thermography in sports medicine in Austria. *Sensors*, 10(5), 4700-4715.
9. Huang, C. L., Wu, Y. W., Hwang, C. L., Jong, Y. S., Chao, C. L., Chen, W. J., ... & Yang, W. S. (2011). The application of infrared thermography in evaluation of patients at high risk for lower extremity peripheral arterial disease. *Journal of vascular surgery, 54*(4), 1074-1080.
10. Klusemann, M. J., Pyne, D. B., Hopkins, W. G., & Drinkwater, E. J. (2013). Activity profiles and demands of seasonal and tournament basketball competition. International journal of sports physiology and performance, 8(6), 623-629.
11. Marins, J. B., de Andrade Fernandes, A., Moreira, D. G., Silva, F. S., Costa, C. M. A., Pimenta, E. M., & Sillero-Quintana, M. (2014). Thermographic profile of soccer players' lower limbs. *Revista Andaluza de Medicina del Deporte*, 7(1), 1-6.

12. McInnes, S. E., Carlson, J. S., Jones, C. J., & McKenna, M. J. (1995). The physiological load imposed on basketball players during competition. *Journal of sports sciences*, *13*(5), 387-397.
13. Niu, H. H., Lui, P. W., Hu, J. S., Ting, C. K., Yin, Y. C., Lo, Y. L., ... & Lee, T. Y. (2001). Thermal symmetry of skin temperature: normative data of normal subjects in Taiwan. *Chinese Medical Journal-Taipei-*, *64*(8), 459-468.
14. Oerlemans, H. M., Graff, M. J., Dijkstra-Hekkink, J. B., de Boo, T., Goris, R. J. A., & Oostendorp, R. A. (1999). Reliability and normal values for measuring the skin temperature of the hand with an infrared tympanic thermometer: a pilot study. *Journal of Hand Therapy*, *12*(4), 284-290.
15. Park, J., Jang, W. S., Park, K. Y., Li, K., Seo, S. J., Hong, C. K., & Lee, J. B. (2012). Thermography as a predictor of postherpetic neuralgia in acute herpes zoster patients: a preliminary study. *Skin research and technology*, *18*(1), 88-93.
16. Powell, J. W., & Barber-Foss, K. D. (1999). Injury patterns in selected high school sports: a review of the 1995-1997 seasons. *Journal of Athletic Training, 34*(3), 277.
17. Ring E.F.J. (2007). The Historical development of temperature measurement in medicine. *Infrared Physics and Technology,* 49(3), 297- 301.
18. Sheppard, C. R. (1999). How large should my sample be? Some quick guides to sample size and the power of tests. *Marine Pollution Bulletin*, 38(6), 439-447.
19. Zaproudina, N., Ming, Z., & Hänninen, O. O. (2006). Plantar infrared thermography measurements and low back pain intensity. *Journal of manipulative and physiological therapeutics*, 29(3), 219-223.
20. Zaproudina, N., Varmavuo, V., Airaksinen, O., & Närhi, M. (2008). Reproducibility of infrared thermography measurements in healthy individuals. *Physiological measurement*, *29*(4), 515.

VALIDATION OF TENSIOMYOGRAPHY FOR SARCOPENIA CLASSIFICATION

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Purpose: Currently, there is no consensus on the assessing of sarcopenia, although there are seven methods to assess muscle mass and function in aging. From altogether seven methods that have been developed for classification of sarcopenia little evidence is on their interexchange reliability. Only 0.2% of all participants were recognized as sarcopenic consistently by all methods (Bijlsma et al., 2013). However, Tensiomyography (TMG) is a non-invasive, selective, and easy to administer tool, which measures muscle belly enlargement during evoked isometric twitch contractions with a means of highly sensitive displacement sensor to assess the atrophy responsive mechanical response of superficial muscles. Pišot et al. (2008) concluded that after 35-day of horizontal bed rest gastrocnemius medialis (GM) atrophied for 15% and TMG amplitude (Dm) increases for 30% with a -0.70 correlation between decrease in muscle thickness and increase in Dm. Later on, Šimunič et al. (2013) presented increase in Dm many days prior anatomical atrophy actually occurred and suggested that Dm might be sensitive enough to assess early atrophic processes (e.g. muscle tone decrease). Therefore, we hypothesized that TMG-derived Dm is a valid skeletal muscle contractile parameter also for classification of sarcopenic muscles.

Methods: We analysed TMG Dm in vastus lateralis (VL), biceps femoris (BF) and GM in 195 participants (75% women), aged between 57–86 years. The presence of sarcopenia was determined according to the consensus by European working group on sarcopenia in older people.

Results: The sarcopenia was confirmed in 40% of all participants. In sarcopenic participants VL Dm increased ($P=.002$; $ES=.46$) and BF Dm increased ($P=.015$; $ES=.35$) but not in GM.

Conclusions: It can be concluded that the TMG-derived Dm is sensitive enough to show the differences between sarcopenic and non-sarcopenic participants. The largest effect was found in postural VL, which experiences highest daily load. Thus we could propose a further evaluation of TMG for precise spatiotemporal characteristics of muscle decline, either due to aging, physical inactivity or disuse.

Acknowledgment

This study was performed in collaboration with prof. Rado Pišot, PhD, head of Science and Research Centre, Koper, Slovenia.

References

1. Bijlsma AY, Meskers CGM, Ling CHY, et al. Defining sarcopenia: the impact of different diagnostic criteria on the prevalence of sarcopenia in a large middle aged cohort. Age. 2013;35:871-81.
2. Pišot R, Narici MV, Šimunič B, et al. Whole muscle contractile parameters and thickness loss during 35-day bed rest. Eur J Appl Physiol. 2008;104(2):409-14.
3. Šimunič B, Degens H, Rittweger J, et al. Tensiomyographic measurement of atrophy related processes during bed rest and recovery. In: Ouwehand L (ed.). Proceedings of Life in space for life on earth, Aberdeen, Noordwijk; ESA Communications, 2013.

50% TO 60% $\dot{V}O_{2MAX}$ RUNNING ON DECREASING CARDIOVASCULAR RISK DURING EXERCISE IN MIDDLE-AGED MEN

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Purpose: Our research aim to explore the effect of 50% to 60% •,VO_{2max} running on decreasing the incidence of cardiovascular risk in 50 to 59 years middle-aged men.

Methods: 247 50 to 59 years old volunteers were recruited and finished GTXs. Finally 45 were classified as the normal group (C group, n=25) and the abnormal group (Y group, n=20). Subjects in C group didn't show any abnormal situations during the GTXs, subjects in Y group happened abnormal situations including ST≥0.2mV and/or SBP≥22-250mmHg, DBP≥110-120mmHg. Every subject experienced running for 3 months, the intensity was 50%-60% •,VO_{2max} and the volume was 300 min a week. Before and after the intervention, •,VO_{2max}, exercise load level, terminate heart rate (HR), terminate blood pressure were assessed in the GTXs. The venous blood samples were taken to examine CK, CK-MB, AST and hs-CRP.

Results: The incidence of abnormal ECG and BP in Y group decreased from 100% to 69.2% after 3 months intervention. Exercise load level in both C and Y group had increased. Compared with baseline, terminate HR and terminate DBP were significantly decreased in Y group ($P<0.05$) after 3-month intervention. There showed no differences in terminate HR, BP in comparison between C and Y group. Before the intervention, CK, AST and hs-CRP in Y group were notably higher than C group ($P<0.05$). After 3-month intervention, CK was significantly decreased in Y group ($P<0.05$). AST and hs-CRP also showed significant decrease in Y group ($P<0.05$) . But CK and AST were still higher than C group after the intervention ($P<0.01$).

Conclusion: 3 months 50%-60% •,VO_{2max} intensity of running can reduce cardiovascular risk incidence and improve the degree of myocardial ischemia and myocardial infarction which in 50 to 59 years middle-aged men. The running exercise prescription also can elevate athletic ability and maximam safety of exercise.

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Biomechanics and Motor Control

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HALF A CENTURY OF ISOKINETICS: EVOLUTION, KEY ACHIEVEMENTS, CHALLENGES

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In the broadest sense, the quest for measuring the mechanical potential of muscles is probably as old as the first sports competitions, probably in ancient Greece, where competitors had to lift and carry heavy stones whose weight was assessed by their shear size or as aggregates of a few similar shaped stones or metal articles. The principal aim of such competitions was to find the strongest person. This method of evaluation remained unchanged until uniform units of measurement became available and weights could be counted discretely when such competitions were held.

On the other hand, interest in muscular weakness (MW), conceptually the opposite yet physically on the same scale of strength, was never an issue until modern medicine and specifically neurologists and physiatrists characterized MW as a major element in quite a number of diseases and disorders. One of the implications of this discovery was the acute need for its assessment, preferably using quantitative means.

In 1915, Manual Muscle Testing, a non-linear ordinal scale of ‘single’ muscle strength, was invented/developed by Martin and Lovett, two US physicians who treated patients afflicted with poliomyelitis, which in those years gathered severe epidemic proportions in N. America. This scale became the standard tool in spite of its many drawbacks (e.g. isometric assessment only) while the desire for its improvement was strongly felt by all researchers and clinical practitioners.

Although some progress has been made with the development of the instrumented grip dynamometer, which could be used exclusively for grip strength, the difficulties in applying MMT as a general tool for assessing MW of different sorts persisted for about 50 years. This situation changed abruptly with the invention and development of the first isokinetic dynamometer (ISD). The principle of operation of the original ISD was *dynamic accommodating resistance*. This means that while a segment is moving along the range its joint motion, the dynamometer offers an opposite and equal resistance to the force (moment) exerted by the muscle operating on the segment, under prescribed angular velocity. As the first generation ISDs incorporated a hydraulic piston that could maintain these characteristics, they could serve only as a passive device namely for measuring concentric and isometric exertions. That said, the first ISDs created a phenomenal surge in muscle mechanical capacity research while driving significant changes in the clinical practice. This surge is currently expressed by around 5200 scientific papers (listed in PubMed) dealing with / involving various aspects of this technology.

With the advent of computerized motion/force control systems, the passive hydraulic piston was replaced by sophisticated AC servo motors which not only allowed much higher flexibility of operation and precision but, for the first time, enabled measurement of eccentric exertions, the other dynamic hallmark of muscle action and probably even more critical, in the latter stages of life. Active ISDs became the industry standard during the late 80’s and 90’s of the last century and continue to be so to this date. Modern ISDs serve thousands of research and clinical facilities around the world where their major impact is most probably felt in orthopedics, rehabilitation including physical therapy and sports medicine for the assessment of MW and its amelioration.

In this presentation I shall refer to three main topic related to isokinetic dynamometry: its evolution as an answer to the dearth of means for evaluating muscle dysfunction; this will be followed by discussion some of the major achievements reached by using this technology. Finally challenges facing those who are seriously involved with isokinetic dynamometry, whether in the lab or in the clinic, will be highlighted.

BIOMECHANICAL KNOW-HOW OF FASCINATING SOCCER-KICKING SKILLS – 3D, FULL-BODY DEMYSTIFICATION OF MAXIMAL INSTEP KICK, BICYCLING KICK & SIDE VOLLEY

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Introduction

The great attraction of soccer is "Goal". Various techniques for gaining goals are sources of the fascination; those breathtaking moments of goals using maximal instep kick, bicycling kick and/or side volley help especially make the game so popular that it places soccer as number 1 in the world of sports [1, 2]. Unfortunately, scientific researches on soccer kicking are not proportional to its popularity [3, 4]. Research articles summarizing the biomechanical fundamentals of kicks' optimization as a guide to coaching are scarcely to be found. Majority of the previous studies on maximal instep kick are either limited to 2D analysis or partial body, 3D analysis [4, 5]. These studies provided only partial perspectives on the skill and, especially, they failed to examine the influence of upper-body movement on the kicks' quality. As for the bicycle kick and side volley, there are hardly any scientific studies existed [6]. Based on the current results obtained from 3D motion capture and full-body biomechanical modeling, the presentation aims to bridge the gap between scientific studies and the application of such research results in practice. The presentation does so by supplying a scientifically-founded, coaching-friendly explanation to identify characteristics and motor-control sequencing that define these skills. Relevant biomechanical factors are particularized in a way that should help coaches better develop training programs and, at the same time, foster better understanding of the skill among athletes. The information of the presentation is targeting on accelerating skill acquisition and minimizing risk of injury during learning and training.

3D Data and Full-body Biomechanics

The demystification of soccer-kicking skills is based on data obtained through a synchronized measurement of 3 data collection systems – 3D motion capture (VICON v8i, 12 cameras, 120 Hz, accuracy < 1.5 mm), video recorder, and sound capture. The VICON system tracked 42 reflective markers (12 mm) on the subjects' body and 3 on the soccer ball [4, 6-9]. The captured data was used to create 3D reconstructions of the movements (Fig.1) and served as inputs to a 15-segment model in order to calculate range of motion of joints and other biomechanical parameters [3, 10]. Video and sound capture permitted a traditional external view of motion analysis.

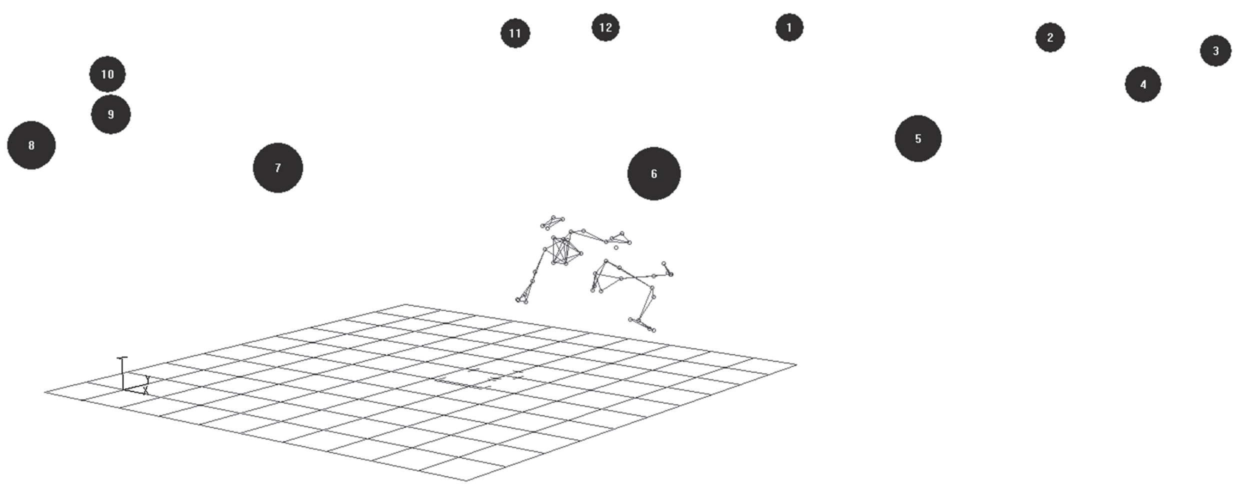

Figure 1: Set-up of 3D motion capture and a sample frame of side volley.

To evaluate the kicks, 3 male groups and 1 female group of college team players (19-26 yrs, over ten-years of experience) were tested. There were 25 (12 males and 13 females) subjects in the test of maximal instep kick, 4 males in bicycle kick and 6 males in side volley. The kicks were conducted on a 2 cm thick wrestling mat (to mimic the grass of a soccer field). An additional mat was used to reduce rebound of the kicked ball, preventing equipment damage. Each subject completed three good kicks using his dominant foot.

Coach-friendly Results

The relevant/fundamental factors identified through 3D motion capture and biomechanical modeling are briefly described below. In the presentation, these factors are visually shown, as such a practitioner without biomechanical knowledge could picture the motor control related to effectively performing the complicated kicks.

Maximal instep kick

The quality of the maximal instep kick depends on the kick accuracy and the kick power. Accuracy measures the precision when driving the kicking foot toward the ball, as well as the foot contact location with the ball. Power is related to the speed and momentum of the kicking-foot. The highest quality of kick is achieved when the ball is struck accurately with full power. However, accuracy and power are non-autonomous variables. Naturally they interact contrarily [11]. Especially for novice learners, power and accuracy can dramatically work against each other. Typically, training initially concentrates on accuracy and afterward aims to enhance power. The approach, supporting foot placement, the positioning of the kicking foot, tension arc (dynamic posture) and gender differences are features during soccer kick which will crucially influence the accuracy and the power [4, 7, 9, 12].

The kick accuracy is influenced by the placement of the supporting foot and the positioning of the kicking foot at ball contact. The supporting foot should be planted in line with the intended ball direction and about a foot from the ball. At the foot-ball contact, the kicking ankle should be positioned at a roughly 45° angle to the horizontal plate for maximizing the kick accuracy as well as power.

The kick power mainly depends on athletes' dynamic posture. The efficient posture is the so-called tension arc. Proper posture during the maximal instep kick forms the tension arc, and its fast release using a whip-like leg movement generates highest power. During the process, the increase in certain muscles' pre-lengthening contributes to an explosively powerful kick. Further, it is found that through training, male and female athletes have developed different techniques, characterized by run-up angle, trunk flexion and the dynamic posture after ball contact [9]. Coaches should take these differences into consideration when designing training programs to accommodate the gender differences in order to increase the training efficiency.

Bicycle kick & side volley

The novelty of bicycle kick and side volley is underscored by the rarity with which players have performed this complex skill during national or international tournaments. The rarity of these occurrences is both a product of perceptions that it is a high-risk, low return skill and by the fact that there is a dearth of scientific research on the biomechanics of the technique. Biomechanically, both skills have control similarities [6], with an obvious difference in starting position: bicycle kick initiates with a position of back-facing the goal, while side volley is performed with a position of side-facing the goal. The 3D quantification has identified elements that govern entrainment of the techniques in 3 phases: jumping, airborne kicking and falling phases of the skill execution. The factors related to kick quality in motor control sequencing during the first two phases are: 1) angle between the player's thighs (humerus bones) upon take-off, 2) the whip-like control of the kicking leg, 3) timing between ball motion and joint coordination and, for side volley, an additional factor 4) rotation of the player's trunk during the jumping phase.

One of the reasons the bicycle kick and side volley is considered to be high risk is that it involves the player necessarily falling to the ground (phase 3). There is realistic fear of injury during the landing phase. Dispersion of energy during falling after the kick should be accomplished by sharing the load using a sequence of partial landings, i.e. the damping mechanism of an arm-hip landing system.

Accurate timing is crucial for a successful kick and can only be achieved through repetitive training. This underscores the need for athletes to use a landing sequence that minimizes risk of injury during practice and execution of the skill.

Collectively, this information could help entrainment of the skill. Virtuosic in appearance, more frequent use of the kick can only enhance the excitement of the game.

Conclusion

Soccer kicks represent a full body, multi-joint coordination. 3D motion capture and full-body biomechanical modeling could help us extract the essence of fascinating soccer-kicking skills for better understanding and coaching as well as improving kicks' quality in practice.

Acknowledgement

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References

1. Hyballa, P., The art of flying. Success in Soccer, 2002. 5: p. 19-26.
2. Reilly, T. and M. Williams, Science and soccer. 2nd ed2003, London: Routledge.
3. Shan, G. and X. Zhang, From 2D Leg Kinematics to 3D Full-body Biomechanics – The Past, Present and Future of Scientific Analysis of Maximal Instep Kick in Soccer. Sports Medicine Arthroscopy Rehabilitation Therapy Technology, 2011. 3: p. 23.
4. Shan, G. and P. Westerhoff, Full-body kinematic characteristics of the maximal instep soccer kick by male soccer players and parameters related to kick quality. Sports Biomechanics, 2005. 4(1): p. 59-72.
5. Lees, A. and L. Nolan, eds. Three dimensional kinematic analysis of the instep kick under speed and accuracy conditions. Science and football IV, ed. W. Spinks, T. Reilly, and A. Murphy2002, Routledge: London. 16-21.
6. Shan, G., et al., Bicycle kick in soccer: is the virtuosity systematically entrainable? Science Bulletin, 2015. 60(8): p. 819-821.
7. Shan, G., et al., Biomechanical analysis of maximal instep kick by female soccer players. Journal of Human Movement Studies, 2005. 49(3): p. 149-168.
8. Shan, G., et al., Regression equations for estimating the quality of maximal instep kick by males and females in soccer. Kinesiology, 2012. 44(2): p. 139-147.
9. Shan, G., Influences of Gender and Experience on the Maximal Instep Soccer Kick. European Journal of Sport Science, 2009. 9(2): p. 107-114.
10. Shan, G. and C. Bohn, Anthropometrical data and coefficients of regression related to gender and race. Applied ergonomics, 2003. 34(4): p. 327-337.
11. Magill, R.A., Motor Learning - Concepts and Applications. 6th ed2001, Boston: Mc Graw Hill.
12. Lees, A., et al., The biomechanics of kicking in soccer: A review. Journal of Sports Sciences, 2010. 28(8): p. 805-817.

COMPARISON OF APROACH RUN-UP VARIABLES BETWEEN MALE LONG AND TRIPLE JUMPERS RELATED TO THE AGE GROUPS

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Purpose

The aim of this study was to determine the differences of run-up velocity parameters between male athletes of long jump (LJ) and triple jump (TJ) according to their age groups.

Methods

The research group was composed by total 467 male Turkish athletes (LJ=283, TJ=184). And the group was divided as U18 (LJ=149, TJ=82), U20 (LJ=56, TJ=69) and senior (LJ=78, TJ=33) in accordance with the IAAF age groups. The results of the athletes have been obtained during the competitions. The photocells which are used to determine running times of athletes have been established 1m, 6m and 11m distance from the take-off board. Velocities for 11m-6m section (V1), 6m-1m section (V2), total 10m (V10) and difference between V2 and V1 (VLoss) were calculated for each jump. Also official jump distances were recorded. General characteristics of the participants were presented as means and standard deviations (±SD). Statistical comparison of the LJ and TJ athletes groups was carried out using independent-sample t test.

Results

The means and SD jump distances were LJ=6.00±0.74m, TJ=13.42± 0.73m for U18; LJ=6.49± 0.72m, TJ=13.87± 1.01m for U20 and LJ=7.00± 0.41m, TJ=14.51± 1.14m for senior. Results of the study showed that, V1, V2 and V10 values of the LJ athletes were significantly higher for U20 and Senior groups ($p>0.05$) while there was no difference between LJ and TJ athletes for any parameters at U18 group ($p>0.05$). When speed loss was taken into consideration, it was observed that only differences between LJ and TJ athletes in U20 group were statistically significant.

Conclusions

There is the similarity of required motor skills for horizontal jump events (Maraj et al., 1998) and our study showed that run-up velocities were similar for U18 LJ and TJ Turkish athletes. On the other hand the horizontal velocity is priority component of the jumping distance of the events, especially long jump (Hay, 1988; Hay & Miller, 1985). Run-up velocities gets higher as the age or jumping distance gets better. In addition, U20 and senior LJ athletes has higher run-up velocities than TJ athletes.

References

1. Hay, J. G. (1988). Approach Strategies in the Long jump. *Int.J.Sport Biomech.*, (4), 114-129.
2. Hay, J. G., & Miller, J. A. (1985). Techniques used in triple jump. *Int.J.Sport Biomech.*, *1*, 185-196.
3. Maraj, B., Allard, F., Elliott, D., Maraj, B., Allard, F., & Elliott, D. (1998). The Effect of Nonregulatory Stimuli on the Triple Jump Approach Run The Effect of Nonregulatory Stimuli on the Triple Jump Approach Run. *Res.Q.Exerc.Sport*, *69*(2), 129-135.

PECULIARITIES OF TIME STRUCTURE AND OF BIOMECHANICAL ORGANIZATION OF A CONSTRUCTION OF MOTOR ACTIONS IN THE HAMMER THROW

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Abstract

The Article defines the criteria of technical reliability that are model biomechanical characteristics as well as structural components of hammer throw technique. In order to determine the criteria of technical reliability in competitive exercise, temporal structure of movements in different components of hammer throw technique was reviewed. It was determined that simultaneously with reduction of runtime of rotations when throwing the hammer, variability in the temporal structure of movements also reduces, which allows to achieve better results in competition.

Key words: *Appliances hammer throwing, educational and training process*

Introduction

Biomechanical analysis of technique of sport exercises had proved its efficiency not only in heavy athletics, gymnastics but also in track and field. In this regard, the definition of the space-time characteristics of hammer throw and the use of the obtained results in the pedagogical process of formation of the rhythmic structure of competitive exercise can significantly improve the efficiency of educational and training process of hammer throwers.

Hammer Throw - speed-strength, complex coordination kind of track and field, requiring a significant manifestation of physical qualities and motor abilities from an athlete. This type of track and field is associated with a significant movement of many biological links and several biological kinematic chains of an athlete in several planes of space. These movements are provided by the manifestation of the maximum and nearly maximum performance of motor capacities of man. It should be noted that a characteristic feature of throwing is the maximum intensity of the working efforts in major phases of the basic motor skill.

Throwing of hammer is the only throwing discipline in which the decisive factor for achieving high rate of release of the projectile velocity is not a final effort (10-20%), but the speed created in corners (80-90%). Therefore, it is extremely important to perform smooth execution of turns, contributing to increase of speed up to the implementation of final effort.

From a biomechanical point of view, the most important criteria of modern technology of hammer throw are:

1. Rhythmic rotational movements with hands with the best possible radius of hammer at an increasing circular path.
2. Beginning of the first turn with a low angular velocity.
3. The gradual increase in speed between the third and fourth turns while preparing for the final effort.
4. The optimal torque between the different phases of an athlete support.
5. Quick final effort to preserve the highest possible speed of flying in of the projectile.
6. The optimal angle of the projectile release is between 42-44 degrees.

At the same time, until now technical reliability criteria were not revealed for the hammer throw by athletes.

Aim of research. Reveal technical reliability criteria were for the hammer throw by sportsmen.

Objectives of research.

1. Identify the features of the temporal structure of the performance of exercise in hammer throw by sportsmen of different qualification.
2. Substantiate the optimal model of the biomechanical organization of construction of motor actions in the hammer throw.

Methods

Criteria of technical reliability of throwing of hummer by sportsmen are inherently model biomechanical characteristics. To obtain main characteristics of hammer throw technique high-speed video filming of competitive exercise was used. High-speed video filming was performed with serial camera Fastvideo500M at 300 frames per second in three dimensions, in accordance with the requirements adopted and regulated in biomechanical studies. Hereinafter, computer processing of materials of high-speed video was used. Video filming of sportsmen throwing hammer was held in the city of Brest and the Olympic sports complex "Stajki" on competitions in the Republic of Belarus. High-speed video filming was performed during the republic tournament in the memory of the honored coach of the USSR E.M. Shukevich during competitions in hammer throw at the Republic of Belarus Cup, international competitions on the "Prizes of Olympic Champions". We studied competitive throws of the strongest participants of these competitions.

To determine the criteria of technical reliability in competitive exercise of hammer throwers a temporary structure of movement in various components of the hammer throw technique was considered. The obtained results served as the basis for the development of mathematical models of the length of the structural components of the hammer throw. Mathematical models were built on the biomechanical characteristics of the movements defined for the whole group of test persons (Hopkins et al., 2009). During the research were measured preliminary unwinding of a hammer and turns with a hammer from the moment of location of the projectile in front on straight hands and before completing a turn in rotation to 360º at the starting point.

Results

During the study, it was found that the temporal structure of the movements in various components of a hammer throw in athletes varies by many parameters. The study results revealed that the time range of the first preliminary unwinding of a hammer is in the range from 1.56 s to 2.34 s (Figure 1).

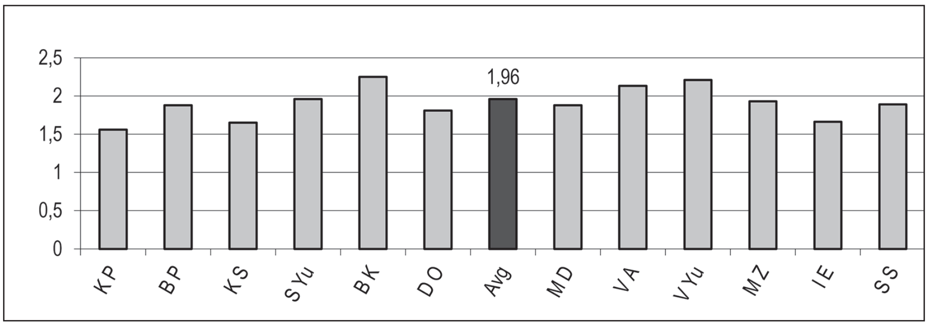

Figure 1: Time of the first preliminary unwinding of the hammer (in sec.)

The arithmetic average of this indicator amounted to 1.96 s. In the second unwinding of a hammer angular velocity of the projectile is gradually increased, thereby reducing the total time of the second cycle of movement. The mean value is 1.56 s (Figure 2).

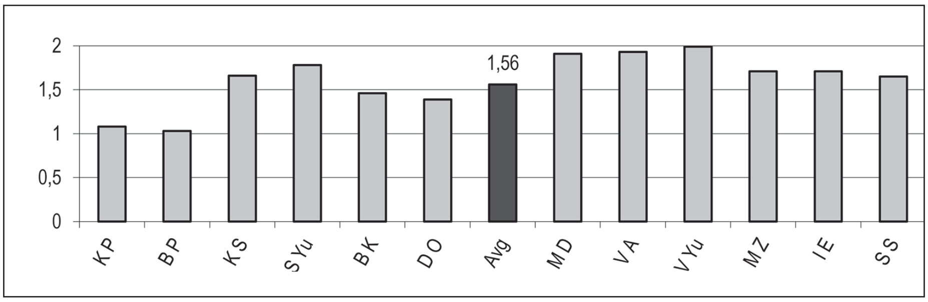

Figure 2: Time of the second preliminary unwinding of the hammer (in sec.)

Compared to the first cycle of movement time of unwinding of a hammer decreased by an average of 0.40, which is quite significant. The lowest value of the reviewed indicator for individual sportsmen was 1.03 s. The largest time of complete cycle of unwinding was consequently 1.99 s. Peak-to-peak swing time of performance of this fragment of a hammer throw, at different sportsmen was 0.96 s, which is significantly more than in the first cycle of unwinding (0.56 s).

Let us find out the time structure of movement of the hammer in the spatial reference system, taking for one turn with a hammer rotation of it on 360^0. It was found that the first turnover, performed for over 0.86 s in average (Figure 3) is the longest one in the cyclic structure of rotations with a hammer.

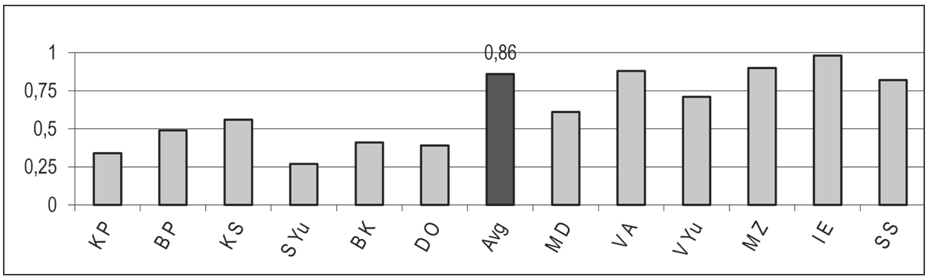

Figure 3: Time of the first turn with a hummer (in sec.)

The scope of the temporal characteristics of the implementation of this part of the hammer throw is 0.27 s, with a minimum time of the first rotation with a hammer equal to 0.71 s, and with a maximum result – 0.98 s.

The second turn with a hammer is performed much faster than the first one. The total turnaround time with a hammer was 0.58 s on average. It was found that the range of variations of turnaround time with a hammer is 0.21 s, with a minimum value of 0.45 s and the maximum value – 0.66 s (Figure 4).

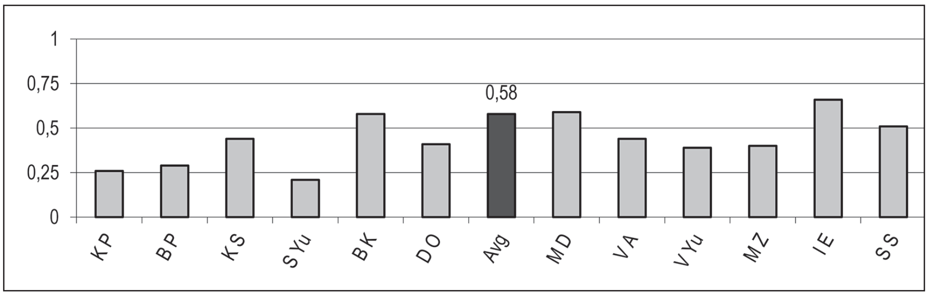

Figure 4: Time of the second turn with a hummer (in sec.)

For the third turn with a hammer is required 0.49 s on average. (Figure 5), fluctuations in the length of the implementation of this part of the hammer throw are 0.42-0.57 s. The oscillation amplitude does not exceed 0.15 s, leading to the conclusion that together with reduction of the execution time of the third turn variability of temporal movement patterns decreases.

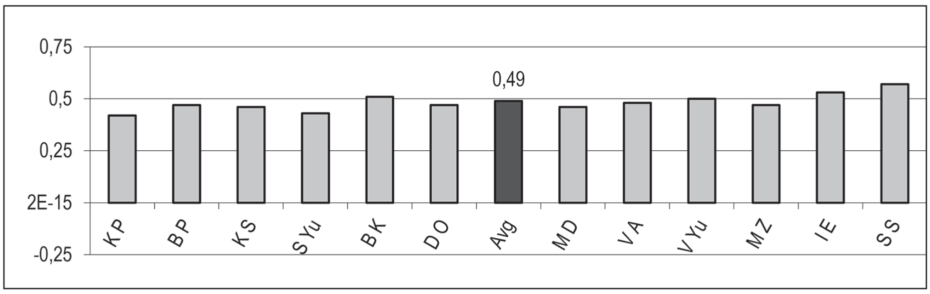

Figure 5: Time of the third turn with hummer (in sec.)

The fourth turn with a hammer is equal to 0.43 s in average (Figure 6). The duration of the implementation of the fourth turn with hammer by athletes ranges from 0.37 s to 0.49 s, and the fluctuation is 0.12 s.

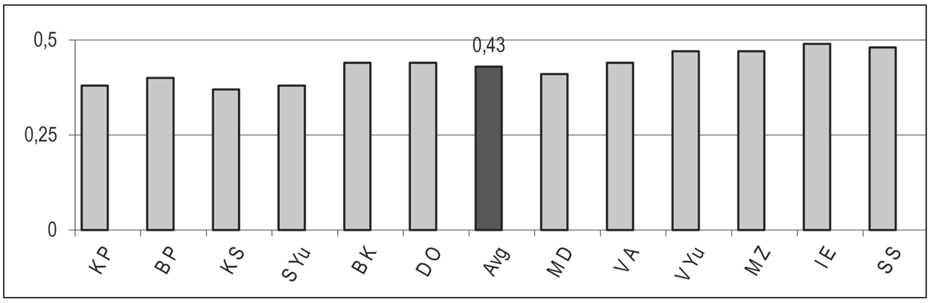

Figure 6: Time of the fourth turn with hammer (in sec.)

All the previous actions of the hammer thrower were directed to create in the final part of the throwing the hammer necessary conditions for flight with the greatest range. The final part of the throwing time lasts for 0.31 s on average (Figure 7).

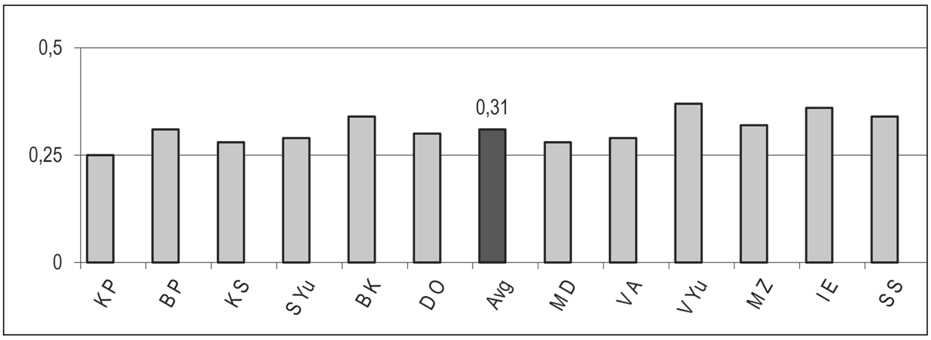

Figure 7: Index of the final part of a hummer throw (in sec.)

The lowest execution time is 0.25 s, the highest – 0.37 s.

Consequently, the rotational speed of the system “thrower-hammer” in the final part of hammer throwing increases. The effectiveness of the final effort depends entirely on good execution of the preceding actions of thrower - preliminary rotations and turns. The final effort is a kind of measure of the throwing techniques in general, and its effectiveness can be judged on by thrower’s stability in the circle after the release of the projectile.

The general trend of the organization of structure of the movement is in the reduction of execution time of each subsequent throwing component (Figure 8).

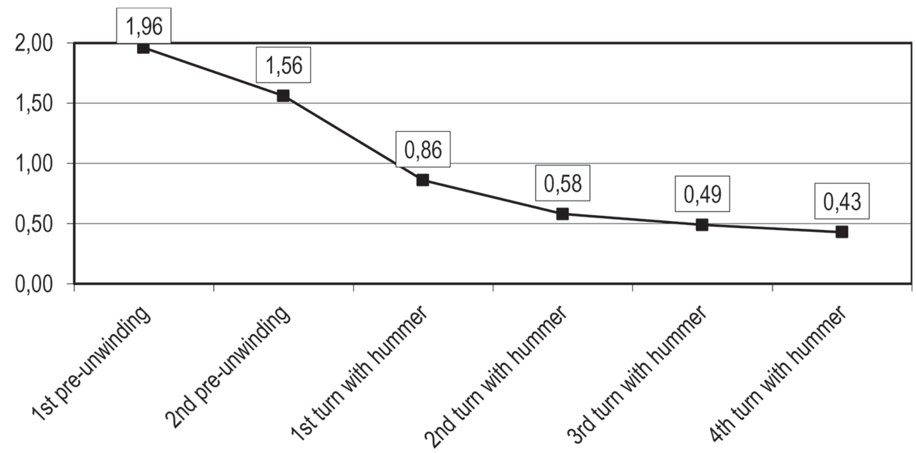

Figure 8: Index of average temporal values of preliminary unwinding and turns with hummer (in sec.)

Conclusion

1. The conducted biomechanical analysis of spatial movements at hammer throwers of different qualifications showed that the criterion of efficiency may be the precise implementation of the kinetic energy of the own body, and choice of the right rhythm by an athlete in the performance of throwing. It is especially important in a final effort, when the thrower makes full use of kinetic energy of the whole system "thrower-projectile" accumulated in turns for the most efficient acceleration of the hammer.
2. Correct body position in separate phases of the preliminary rotations (pelvic girdle radius of rotation should be maximal) and at the beginning of the first turn in the form of a wide and free span contribute to the achievement of optimal speed for hammer throwing. This provides a smooth transition from pre-rotations to turns.
3. During the final movement a large radius of movement of the body should be maintained, that allows to achieve high linear velocity of a hammer throwing at a relatively low angular velocity. You cannot indefinitely increase the speed of rotations. At the same time, maintaining the large radius movement of a hammer a certain reserve of improving the technical skills of highly qualified hammer throwers can be seen.
4. The main criterion for evaluating the effectiveness of technology is stability and variability of parameters such as: active and passive phases in turns and the final, their quantitative characteristic for developing effort and time.
5. The study found that while reducing a span runtime when throwing a hammer, also variability of the temporal structure of the movement is reduced which allows to reach better results.

References

1. Hopkins WG, Marshall SW, Batterham AM, Hanin J (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine & Science in Sports & Exercise* 41, 3-12
2. Malcata RM, Hopkins WG (2014). Variability of competitive performance of elite athletes: a systematic review. *Sports Medicine* 44, 1763-74.

ANALYSIS OF A GENDER AND SIDE-DEPENDENT KINEMATIC STRATEGY TO ADAPT HUMAN GAIT AT DIFFERENT VELOCITIES IN HEALTHY YOUNG PEOPLE

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Abstract

Considering the complexity in the comprehension of gait modulation, we need to follow a wide model to better understand the strategies to adapt motor control with the constraint of speed, differencing by gender and side. We assessed kinematic parameters on 33 healthy young adults by a 3D-optoelectronic system, related to the treadmill gait at 3.5, 4.5 and 5.5 Km/h, analyzing s/t parameters, angular kinematics, markers trajectories, CoM (Center of Mass) kinematics. We found an improvement in variability, instability and asymmetry at slower velocities; the highest values in marker trajectories and joint excursions at higher velocities are due to greater step length, except for arm swing. Males are more variable, unstable and asymmetric, with an ampler torso sway, while females have ampler hip movements in sagittal and coronal planes. Swing time is longer on the left side, but we don't consider it as a fixed characteristic. We suggest to collect many data for the definition of a wide gender-specific reference, and to expand this model comprising the variable of lateral dominance and the sub-phases of gait cycle.

Key words: *Variability, stability, symmetry, motor control, posture*

Introduction

There remain several blurry parts and misunderstandings about the comprehension of the human gait; two important variables affecting the gait modulation are gender (Bruening et al., 2015) and velocity, with faster gaits eliciting a more regular pattern (Schaefer et al., 2015).

For a better definition of gait modulation, we can focus on the three aspects: symmetry, sensible to mechanic load, cognitive tasks and sensorial alterations (Plate et al., 2015); variability, which reflects age-related or pathological alterations in motor control (Gouelle et al., 2013); stability, verifiable mainly with CoM (Center of Mass) movements (Carty et al., 2012).

The gait modulation tends to minimize energetic cost and to maintain balance (Bertram, 2005), and healthy young people have better neurological and biomechanical properties to do it. It's not completely defined, yet, how spatio-temporal gait characteristics, symmetry, variability, stability and joint movements interact in this process. Consequently, with this work, I want to detect a model to evaluate the motor control alterations through velocity constraints, as like as Bovi et al. (2011), focusing on kinematics and assessing healthy young people to better understand this topic avoiding any age (Kang & Dingwell, 2008) or pathological effects. Additionally, I want to assess if there are some gender and side differences, eventually speed-dependant, and to assess relative movement dispersion and spatial symmetry – and CoM trajectory. Defining an integrated knowledge can increase our understanding about biomechanics and neurological dynamics, as well as proposing useful references to define pathological alterations.

Methods

Inclusion criteria were: age (18 – 40 y); BMI (18.5 – 25 kg/m^2); low or moderate cardiovascular risk (Thompson et al., 2013); absence of neurological or musculoskeletal pathologies or any medical conditions potentially affecting typical gait; stable weight (changes < 2.5 Kg in last six months); not to be a sport federation athlete. All subjects were informed about procedures and released their full written consent before their participation.

Table 1: Descriptive characteristics of study population

	Overall (33)	Males (n=17)	Females (n=16)
Age (Years)	26.5±0.8	27.1±1.2	25.9±1.1
Mass (Kg)	65.7±1.9	73.1±1.8	57.2±1.8
Height (m)	1.72±0.02	1.80±0.02	1.63±0.02
BMI (Kg/m^2)	22.1±0.4	22.7±0.5	21.5±0.5
PWS (Km/h)	5.6±0.1	5.6±0.2	5.5±0.2

Questionnaires, anthropometric measurements, PWS (Preferred Walking Speed) assessment and medical examinations were made at the Applied Exercise Physiology Laboratory, Università Cattolica del S.Cuore, Milan, and kinematic analysis of treadmill walk at the Laboratory of Functional Anatomy of the Locomotor System, Università degli Studi di Milano, on different days.

Every subject had to respect additional indications before the test: food, drink, medication and smoke restriction for the last 3 hours; avoiding vigorous activity for the last 48 hours.

Body mass and height were recorded with a mechanical stadiometer (SECA 201, Deutschland). PWS was assessed with Racetime 2 Light Radio kit (Microgate, Italy), on an athletic track during clement weather. Subjects were instructed to walk six times along a 70-m section line at a comfortable walking pace; to obtain PWS, we averaged the central 50 m of the last five trials.

Gait analysis was made on a motor driven treadmill (525ex, ProForm, USA); considering our PWS values, higher than literature references (Bohannon & Williams Andrews, 2011), we chose three commonly repeatable measures under this value, with substantial differences of 1 Km/h (3.5 – 4.5 – 5.5 km/h) . Kinematic data were captured with an optoelectronic system (Smart-E, BTS, Italy) consisting of 9 infrared, LED array-surrounded cameras, allowing the 3D reconstruction of 23 retro-reflective body markers plus 4 markers positioned on the treadmill. Accuracy < 0.04 mm; frequency: 60 Hz; working volume: 1650 x 2200 x 1320 mm.

For each subject, the gait acquisition lasted about 50 minutes comprising: 10 minutes standing on treadmill (to adjust camera's thresholds and provide orthostatic references), 10 minutes walking at 3.5 km/h, 5 minutes sitting, 10 minutes walking at 4.5 km/h, 5 minutes sitting and 10 minutes walking at 5.5 km/h; we captured 25 gait cycles after the 5th minute of each speed.

We analyzed tracked files using the SMART Analyzer program, filtering 3D tracks with a Butterworth low-pass filter (cut off frequency of 8 Hz) and calculating: spatio/temporal parameters, angular kinematics, markers trajectories, CoM kinematics.

Normality of the distributions was assessed by the Jarque-Bera test; for the effect of gait speed on outcome parameters we used one-way ANOVA or Friedman test; for post-hoc significance we used Tukey-HSD test or Wilcoxon signed rank test; for the effect of sex or side and speed on outcome parameters, we used two-way repeated measures ANOVA or Friedman test and Mann-Whitney test; statistical significance was set at a p-value ≤ 0.05, considering Bonferroni correction for multiple comparisons.

Results

At slower velocities we found increased stride time, step time, stance and double stance percentage times, arm swing time, arm semi-swing time, and reduced step length ($p<0.01$). We found greater stride time, step time, arm swing time, arm semi-swing time (p<0.01) and step width ($p=0.017$) in males. We found greater right stance percentage time (but not stance time) and left step length ($p<0.01$). The percent increases to enhance gait speed were greater in length than in frequency ($p<0.01$), without gender differences.

At slower velocities the CV significantly increased stance time (only for males, and only in 3.5 vs. 5.5 Km/h comparison), arm swing time and arm semi-swing time (respectively, $p < 0.01$, $p=0.016$, $p < 0.01$, $p < 0.01$). About gender differences, we found greater step time CV and stride time CV in males ($p<0.01$). No side effects were found.

At slower velocities, we found: increased CoM excursion on X and Z axes; reduced CoM excursion in Y azis and CoM accelerations on all three axis. After normalization on step length, significant increments remained in CoM X and Z-axis excursions, and reductions in CoM Y-axis acceleration and excursion, while CoM Z-axis acceleration increased and CoM X-axis acceleration was not significant. Considering the normalization on step length, we found: greater CoM excursion on Z axis and CoM trajectory in males; greater CoM acceleration on X axis in females.

At slower velocities, we found reduced values in all angular joint excursion, except for hip rotation; after normalization on step length, reduction remains only for elbow flexion – extension, while ankle flexion-extension, knee flexion-extension, hip flexion-extension, hip rotation and torso sway increased (for all the previous comparisons, $p<0.01$). About gender differences, we found greater ankle rotation excursion and torso inclination excursion in males ($p<0.01$); greater hip flexion-extension and elbow flexion-extension in females ($p<0.01$); the same results of gender differences remain normalizing on step length ($p<0.01$).

At slower velocities, we found reduced values in all the marker trajectories; normalizing on step length, these remains only for ulna styloid process (only in 3.5 Km/h velocity), while the values of acromion (emphasized in males), humeral lateral epicondyle (only for left side), ASIS ($p=0.012$), femoral lateral epicondyle, lateral malleolus, heel and toe increased. We found greater values in trago, acromion, knee, lateral malleolus, heel, toe in males and ulna styloid process in females, without normalization on step length effect ($p<0.01$), except for knee. We found greater left values in humeral lateral epicondyle and ulna styloid process data ($p<0.01$). Post-hoc analyses reveal generally statistical changes comparing 3.5 Km/h and 4.5 Km/h with 5.5 Km/h, and not in the comparisons between 4.5 Km/h and 5.5 Km/h.

At slower velocities, we found increased asymmetry in arm semi-swing time (only for males) and greater trochanter movement (emphasized in males) ($p<0.01$). We found greater arm semi-swing time asymmetry in males ($p<0.01$). We found a greater right arm semi-swing time ($p<0.01$). No significant results were found for other parameters.

Considering joint excursions and marker trajectories, we noted 31% of the subjects to switch, at least once, own side "predominance", without gender effect.

Discussion

In agreement with Brach et al. (2008), we consider step width an unsuitable parameter in the comparisons of gait analyses, because of its inadequate reliability.

Young healthy people becomes more unstable, variable and asymmetric at slower speed; however, they don't adopt elder people strategies to improve stability, like an ampler arm swing (Punt et al., 2015) or a gender-independent ampler step width, and not even shorter step length, probably because younger have a better neuromuscular control and don't perceive little instability as worry of falling, as demonstrated for growing adolescents (Bisi & Stagni, 2016), or in contextual execution of "modern" task in young adults (Agostini et al., 2016).

We found a widespread asymmetry in our population, gathering, in accord with Smith et al. (2013), that symmetry isn't strictly necessary for gait; considering also the not-rare switch in side "predominance", we gather asymmetry to be a not fixed physiological characteristic.

Marker trajectories and joint excursions increased with velocities, but this is generally an effect of greater step length: after normalization, we mainly noted movement dispersion and hence a less efficient movement. The exception to this rule was in the arms: there are biomechanical noteworthy effects of other joints, from support part to terminal part of an open kinetic chain; thus, we consider arm swing almost totally passive in healthy gait.

Focusing on hip, we noted that local strategy to follow the increase of gait velocity is the enhancement of sagittal and coronal plane movements; hip rotation changes are significant only after normalization on step length, hence we conclude that its increase at slower velocities is a speed-dependent change, reflecting a totally active control of this movement.

In the combination between boosts in pace frequency and length to adapt gait speed, percent changes are overall greater in length.

Males are more variable, asymmetric and unstable, with more remarkable gait velocity effects: we suppose to reduce these effects they react increasing torso movements, and consequently augmenting the step width. Specific characteristics of male gait are greater stride time and step length (due to anthropometric differences), joint excursions in ankle rotation and torso sway, movements of head, shoulders, ankles, heels and toes; those ones of female gait are: greater joint excursions in hip flexion-extension and adduction-abduction, elbow flexion-extension and movements of wrists, arms and greater trochanters. An observational tip to discriminate gender during gait is about torso and hip movements: males have a greater torso sway and females have greater hip adduction-abduction and flexion-extension.

Swing time was longer on the left side; this result is supported by a longer left step length and a more long-lasting arm semi-swing in right side (it counterbalances left step). We gather greater elbow and wrist movements in left side to be a passive consequence of longer left step (arm movement follows its same-side leg movement). However, we noted over velocities, about 50% of the subjects to switch, at least once, the side "predominance" in step length, hence we conclude that the side effects on gait can't be yet considered as fixed characteristics.

Conclusion

The "dynamism" of variability, stability and simmetry in healthy gait is physiological because postural processes need to be continuously re-calibrated on the basis of kinetic alterations.

We suggest to use CoM excursion on three axis, temporal parameters of gait analysis and side comparisons between markers and main joint angles to establish valid and useful protocols. It should be interesting to evaluate the side differences basing on lateral dominance and to expand the strategic model of healthy people in specific walking phases and sub-phases. Finally, more data on young, healthy people are needed to create a normal data range of symmetry, variability, stability, and spatio-temporal characteristics of gait, preferably divided by race and gender. This will allow the establishment of a solid reference for comparisons in clinics.

Acknowledgment

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References

1. Agostini V., Lo Fermo F., Massazza G. & Knaflitz M. (2015). Does texting while walking really affect gait in young adults? *Journal of NeuroEngineering and Rehabilitation, 12*
2. Bertram J.E. (2005). Constrained optimization in human walking: cost minimization and gait plasticity. *Journal of Experimenatal Biology, 208,* 979–91
3. Bisi M.C. & Stagni R. (2016). Development of gait motor control: what happens after a sudden increase in height during adolescence?. *BioMedical Engineering OnLine, 15*, 47
4. Bohannon R.W. & Williams Andrews A. (2011). Normal walking speed: A descriptive meta-analysis. *Physiotherapy, 97,* 182–9
5. Bovi G., Rabuffetti M., Mazzoleni P. & Ferrarin M. (2011). A multiple-task gait analysis approach: kinematic, kinetic and EMG reference data for healthy young and adult subjects. *Gait & Posture, 33,* 6–13
6. Brach J.S., Perera S., Studenski S. & Newman A.B. (2008). The Reliability and Validity of Measures of Gait Variability in Community-Dwelling Older Adults. *Archives of Physical Medicine and Rehabilitation, 89,* 2293–6
7. Bruening D.A., Frimenko R.E., Goodyear C.D, Bowden D.R & Fullenkamp A.M. (2015). Sex differences in whole body gait kinematics at preferred speeds. *Gait & Posture, 41*, 540–5
8. Carty C.P., Cronin N.J., Lichtwark G., Mills P.M. & Barrett R.S. (2012). Mechanisms of adaptation from a multiple to a single step recovery strategy following repeated exposure to forward loss of balance in older adults. *PLOS ONE 2012, 7,* 3–8
9. Kang H.G. & Dingwell J.B. (2008). Effects of walking speed, strength and range of motion on gait stability in healthy older adults. *Journal of biomechanics, 41,* 2899–905
10. Punt M., Bruijn S.M., Wittink H. & van Dieën J.H. (2015). Effect of arm swing strategy on local dynamic stability of human gait. *Gait & Posture, 41,* 504–9
11. Schaefer S., Jagenow D., Verrel J. & Lindenberger U. (2015). The influence of cognitive load and walking speed on gait regularity in children and young adults. *Gait & Posture, 41,* 258–62
12. Smith J.D., Royer T.D. & Martin P.E. (2013). Asymmetrical loading affects intersegmental dynamics during the swing phase of walking. *Human Movement Science, 32,* 652–67
13. Thompson P.D., Arena R., Riebe D. & Pescatello L.S. (2013). ACSM's new preparticipation health screening recommendations from ACSM's guidelines for exercise testing and prescription, ninth edition. *Current Sports Medicine Reports, 12,* 215–7

BIOMECHANICAL ANALYSIS ON THE EFFECT OF THE KNEE BRACE OF PATELLA SUPPORT DURING A SINGLE LEG HOP

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Purpose

A Knee brace for the prevention of sports injuries has been developed. This system must support the knee joint while simultaneously not must disturbing leg movement. The knee brace which reinforces support of the patella was marketed to the public. The verification of the patella support brace was lack of relevant research. Therefore, verification of the function in use with the knee brace was necessary through biomechanical analysis. The aim of this study was to analyze the biomechanical difference before and after wearing the knee brace during a single leg hop.

Methods

We selected two knee braces which are a type of patella support (the J shaped; Donjoy@ and the O shaped; Medi@) and one knee brace without a patella pad. We evaluated four test conditions, including non-wearing of the knee brace using a 3D motion analysis system and included four healthy subjects. The measured outcomes were hop performance distance (HPD), lower limb joint angle, moment and power. The single leg hop activity was analyzed in two phases, which were divided into takeoff and landing. For each test condition, we performed more than five trials and analyzed their average value. Our test procedure proceeded after informed consent.

Results

The HPD(cm) was similar between the brace condition with the patella pad (Medi@) and the non-brace condition (90.7±6.0cm vs. 90.2±5.2cm). It showed to decrease the lower limb joint angle, moment and power under conditions of wearing a knee brace versus that of someone not wearing a knee brace. The knee brace with the O shaped and the J shaped patella pad in the knee joint moment 20%, 10% decreased respectively compared to the non-brace condition (2.0±0.5Nm/kg).

Conclusions

We were able to verify that knee joint moment was decreased more when wearing a knee brace than under conditions of a non-brace and showed to not disturb the lower limb motion during a single leg hop. Particularly, the knee brace with the O shaped patella pad was more effective than the J shaped patella pad in both aspects of increase of HPD and decrease of knee joint moment. Our study results were based on the biomechanical analysis that will be utilized for the development and the design of the knee brace.

Reference

1. Augustsson, Jesper, et al. "Single-leg hop testing following fatiguing exercise: reliability and biomechanical analysis." Scandinavian journal of medicine & science in sports 16.2 (2006): 111-120.

EFFECTS OF CURING TIME OF LACROSSE BALL ON HARDNESS

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Abstract

Objective: Lacrosse is one of popular sport events in the world. The lacrosse balls are made by rubber. The curing process is an essential procedure during making lacrosse balls. The curing is defined as chemical process for converting natural rubber or related polymers into more durable materials. It modifies the polymer by forming cross-links (bridges) between individual polymer chains. However, the period of the curing process if affects the hardness of lacrosse ball is still unclear. The purpose of this study was to investigate the hardness of lacrosse ball after 12 weeks of the curing process.

Methods: 24 lacrosse balls were measured weight, circumference and hardness. All balls were required to do conditioning control at 22±2°C of temperature and 50±10% of relative humidity for 24 hours before measurements. The hardness of lacrosse ball was measured by following ASTM F1888 standard test method for compression-displacement.

Results: The lacrosse balls were 145.15 ± 1.99 g in weight, 19.84 ± 0.13 cm in circumference, 93.52 ± 4.03 kg in compression-displacement. After pair t-test, the compression-displacement was significantly increased after 12 weeks of the curing process. ($p < .05$).

Conclusions: The period of the curing process significantly affects the lacrosse ball's hardness. The hardness of lacrosse ball was highly related to the risk of impact-related injury. Therefore, the finding suggested that the period of the curing process was one of critical factors for reducing the risk of injury. (Grant number: MOST 105-2622-H-845-001-CC3)

Biomechanics and Motor Control

ARE ENERGY COST, MECHANICAL WORK AND EFFICIENCY OF WALKING INFLUENCED BY A 14DAYS PERIOD OF BED REST AND THE FOLLOWING PHYSICAL TRAINING?

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Purpose: Physical inactivity and/or bed rest (BR) have several negative effects especially on the musculoskeletal system leading to dramatic reduction in the ability to produce force which is one of the most important requirements to perform everyday tasks. Elderly people are particularly vulnerable to any acute loss in muscle function mainly because of sarcopenia. We therefore want to investigate: 1) the effects of bed rest and a following training program on the energy cost (CW), mechanical work and efficiency (EFF) during walking in young and elderly people; 2) the reasons why elderly (E) individuals have an higher CW than young (Y) ones.

Methods: Twenty-three healthy male subjects (E: n°16, 59.6±3.4 years; Y: n°7, 23.1±2.9 years) participated in this study. The subjects spent 14 days of BR without any physical exercise and/or other countermeasures after which they underwent to a 14 days of physical training (PT). CW, mechanical work, EFF and co-contraction time(CCT) (at the level of thigh and ankle) were measured during walking at 0.83, 1.11, 1.39, 1.67 $m \cdot s^{-1}$ before BR (pre-BR), after BR (post-BR) and after PT (post-PT).

Results: No effects of BR and PT were observed on the parameters analyzed in both groups . Elderly subjects showed higher CW (at each speed, by mean 25.6%, $P<0.001$), CCT of proximal muscles (at speeds of 0.83, 1.11 and 1.67 $m \cdot s^{-1}$ by 52.3, 25.2% and 24.2% respectively, $P<0.05$) as well as CCT of distal ones (at each speeds by 157.7, 165.7, 89.1% and 28.5% respectively, $P<0.05$) than Y subjects. The E group had lower EFF (among all speeds by mean of -18.5%, $P<0.05$) than the Y group.

Conclusions: The absence of changes in CW, mechanical work and CCT values observed post-BR and post-PT could be related to the healthy status of the participants especially the E ones (Kortebein, Symons et al., 2008, Coker, Hays et al., 2015) or the relative short duration of the BR. Even if the E performed the same mechanical work as the Y subjects during walking, the former showed higher CW than the latter. This may be explained, at least partially, by the higher co-contraction time of lower limb muscles seen in E than in Y (Grabiner, Biswas et al., 2001).

References

1. Kortebein, P., T. B. Symons, A. Ferrando, D. Paddon-Jones, O. Ronsen, E. Protas, S. Conger, J. Lombeida, R. Wolfe and W. J. Evans (2008), J Gerontol A Biol Sci Med Sci 63(10): 1076-1081.
2. Grabiner, P. C., S. T. Biswas and M. D. Grabiner (2001), Arch Phys Med Rehabil 82(1): 31-35.

PEDOBAROGRAPHIC ASSESSMENT OF MALE HANDBALL PLAYERS' GAIT

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Abstract

Background: Main objective was to assess pedobarographic features of handball players gait using FDM1.5 pressure measuring device - within complete gait analysis

Methods: Protocol was standardized for descriptive and inferential statistical methods (63 quantitative variables). Participants characteristics (n=24; male team handball players): average age 22±4 yr., Body weight 81,34±9,03kg, Body height 174,97±19,43cm, BMI 26,89±3,07 kg/m^2 with minimum of 5 years of regular handball training activities.

Results: Protocol output was consistent for repeated measurement of an individual. Tested differences between left and right foot revealed significance in: *Foot rotation, degree (GFR_d t=-4,05; p<0.01), Time to change heel to FF, sec (LT_d t=2,460210; p<0.05), and Contact time H, % (CH_d t=2,229428; p<0.05).*

Conclusions: Differences between left and right foot in foot rotation degree, percentage of contact time with heel, and time to change heel to forefoot were probably normal in general population, but by extensive and intensive unilateral loads in regular handball training and competition, as well.

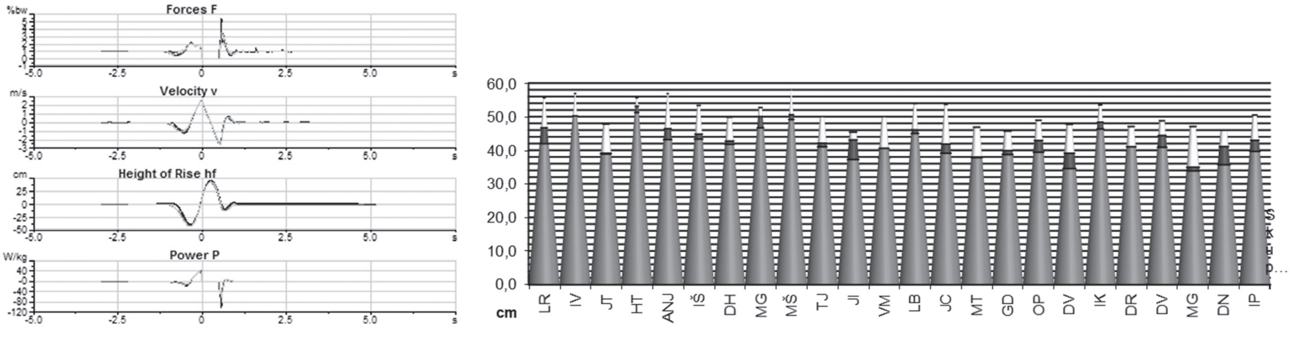
Key words: *team handball, unilateral, pedobarography, gait, biomechanics*

Introduction

Handball match is activity in which players during contact with ground, ball, opponents etc., actively produce events - offering excitement for the viewer, rivalry for opposing coaches, fans etc, - which can be assessed, recorded and later analysed by different tools, protocols, methods (for pedobarography, e.g. in Giacomozzi, 2010, Pomarino and Pomarino 2014, etc.). Intensity of players contact with ground, supra-summed by unilaterality of playing and training load represent main motivation for bringing pedobarography into analysis of handball players health, and fitness.

During the match, handball players cover on average a distance of 4800m (-7% to +6%; Perš et al., 2002), in sprints 7% of the playing time, 25% in fast running, 31% in slow running and 37% in walking or standing still. Karcher&Buchheit later (2014) confirmed that and calculated average running pace (53 ± 7 to 90 ± 9 m·min^{-1}) during handball games. In terms of gender differences, Michalsik&Aagaard revealed (2015) that male players were performing more high-intense, strength-related playing actions and high-intensity running (7.9 % of total distance covered compared to 2.5%) than female players. Conversely, female players covered a greater total distance (4693±333 m and demonstrated a higher relative workload than male players (3945±538 m). Furthermore, MP performed more high-intense technical playing actions per match (36.9±13.1) than FP (28.3±11.0, P<0.05). Michalsik et al. (2015) found that male players showed 36.9 ± 13.1 high-intense technical playing actions per match with a mean total effective playing time of 53.85 ± 5.87 minutes. In offense, each player performed 6.0 ± 5.2 fast breaks, received 34.5 ± 21.3 tackles in total, and performed in defense 3.7 ± 3.5 blockings, 3.9 ± 3.0 claspings, and 5.8 ± 3.6 hard tackles. Modern elite team handball match-play demands many short-term, high-intense intermittent technical playing actions. Handball can be considered (Michalscik et al., 2015) an intense activity for all players, because of the large number of repeated high-intensity actions occurring throughout the game (e.g., jumps, sprints, changes of direction, duels, contacts). Additionally, the substantial number of body contacts likely increases neuromuscular load, both during and following games.

Unilateral load while jumping, shooting (stance-shot/jump-shot, defensive contacts, etc) in terms of take-off and landing forces (Gruić, 2006, Graph 1), concentric, eccentric and elastic component of take–off (Gruić, 2014), kinematic parameters of specific take off (i.e. unilateral jump-shot, e.g. in Pažin et al., 2016) pedobarographic parameters (i.e. plantar pressure distribution in Gruić et al., 2015, 2016), may produce different outcomes (score, scoliosis, injury..).



Graph 1: Concentric, eccentric and elastic component of take–off of handball players (Force, Velocity, Height of rise and Power on left; Concentric - black/white, concentric with eccentric - black tip, and with elastic component coloured tip with white on the right), Gruić, 2006.

Those increases in neuromuscular loads often lead to injuries. Increase in the number of injured young handball players and handball, primarily knee injury and ankle (Olsen et al., 2006), comes from the fact that unilateral load with increased training intensity and volume are often not followed by adequate compensatory, bilateral, cyclic or alternating loads. Given the specific requirements of the handball sport, primarily in the form of abrupt changes in direction of movement, frequent jumps and unpredictable landings, handball players usually injure lower extremity (by Olsen et al., 2006) - mostly anterior cruciate ligament injuries and a sprained ankle joint (Peterson et al., 2005). Intrinsic risk factors also participating in the development of injury ACL, among other, is anatomical deviation such as the low medial arch of the foot etc (Renström et al., 2008, Gruić et al., 2009). The emergence of the knee injury involves external (extrinsic) risk factors too, such as inadequate shoes, the level of competition, frequent change of substrate and climatic factors (Renström et al., 2008; Olsen et al., 2003). Gruić 2014 confirmed hypothesis of existing differences in average concentric power between male and female subjects, or broadly and concentric, eccentric and elastic component of take-off., And in Gruić et al., 2015, differences in pedobarographic profile was also found (also when results were partialized for body volume).

Among different kinematic and kinetic models for foot analysis (figure 1.), Gruić et al., 2015, evaluated methods for assessment of pedobarographic features of gait using FDM 1.5 PMD, incl*uding device reliability, protocol stability,* and *power of data analysis tools*. Within this research, convergence of kinematics, kinetics and EMG (within traditional biomechanical research in general) was followed by assessment of FDM1.5 PMD.

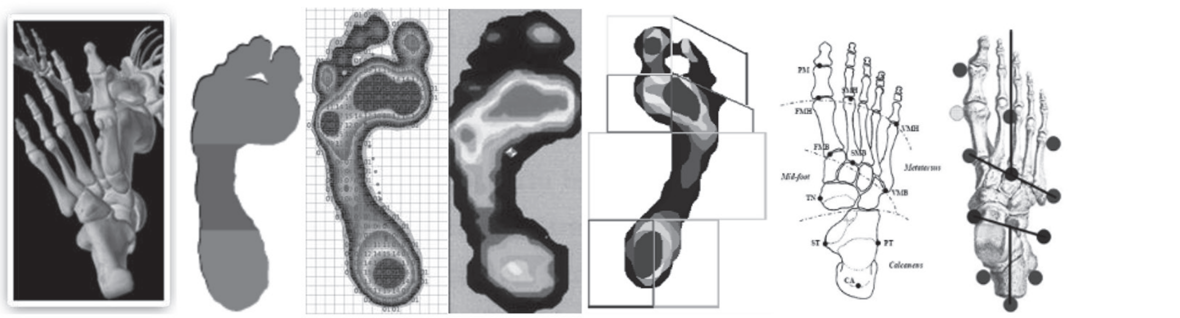


Figure 1: Examples of kinematic&kinetic models for foot analysis (Zebris: ref 22., Peharec, 2002; Tekscan: Cousins et al., 2012.; Rizzoli: Leardini et al., 2007.; Oxford: Stebings et al., 2006.)

Therefore, main objective of this paper was to produce pedobarographic profile of handball players, to test differences between parameters for left and right foot, mostly regarding to unilaterality of training and competition load. Second important objective was to bring closer different reductionist approaches into quantitative, measurable scope of handball players performance analyses.

Methods

Subjects were team handball players age (Mean±StandardDeviation) 22±4years, Body weight 81,34±9,03kg, Body height 174,97±19,43cm, BMI 26,89±3,07 kg/m^2.

Table 1: Sample of variables - Pedobarographic variables (within Zebris protocol)

code	description, unit, (L/D)	code	description, unit, (L/D foot)	code	description, unit, (L/D foot)
GFRL	Foot rotation, degree L	BLL	Length of gait line, mm L	MHL	Maximum force H, N L
GFRR	Foot rotation, degree D	BLR	Length of gait line, mm D	MHR	Maximum force Hl, N D
GSLL	Step length, cm L	BSL	Single support line, mm L	MAXPFL	Max pressure FF, N/cm² L
GSLR	Step length, cm D	BSR	Single support line, mm D	MAXPFR	Max pressure FF, N/cm² D
GSL	Stride length, cm	BAP	Ant/Post position, mm	MAXPML	Max pressure MF, N/cm² L
GSW	Stride width, cm	BLS	Lateral symmetry, mm	MAXPMR	Max pressure MF, N/cm² D
PSTPL	Stance phase, % L	FMF1L	Maximum force1, N L	MAXPHL	Max pressure H, N/cm² L
PSTPR	Stance phase, % D	FMF1R	Maximum force1, N D	MAXPHR	Max pressure H, N/cm² D
PSTLRL	Load response, % L	FTMF1L	Time maximal force1, % L	TMAXFL	Time max force FF, %L*
PSTLRR	Load response, % D	FTMF1R	Time maximal force1, % D	TMAXFR	Time max force FF, % D *
PSTMSL	Mid stance, % L	FMF2L	Maximum force2, N L	TMAXML	Time max force MF, %L*
PSTMSR	Mid stance, % D	FMF2R	Maximum force2, N D	TMAXMR	Time max force MF, % D *
PSTPSL	Pre-Swing, % L	FTMF2L	Time maximal force2, % L	TMAXHL	Time max force H, %L*
PSTPSR	Pre-Swing, % D	FTMF2R	Time maximal force2, % D	TMAXHR	Time max force H, % D *
PSWPL	Swing phase, % L	LTL	Time to change heel to FF, sec L	CFL	Contact time FF, %L*
PSWPR	Swing phase, % D	LTR	Time to change heel to FF, sec D	CFR	Contact time FF, % D *
PDSTP	Double stance phase, %	LTPL	Time to change heel to FF, % L	CML	Contact time MF, %L*
TSTL	Step time, sec L	LTPR	Time to change heel to FF, % D	CMR	Contact time MF% D *
TSTR	Step time, sec D	MFL	Maximum force FF, N L	CHL	Contact time H, %L*
TST	Stride time, sec	MFR	Maximum force FF, N D	CHR	Contact time H, % D *
TC	Cadence, steps/min	MML	Maximum force MF, N L	TVIS	*Body height*
TV	Velocity, km/h	MMR	Maximum force MF, N D	ASIS	*Leg height*

(*% of stance time; FF-Forefoot, MF-Midfoot, H-Heel)

Measurement protocol (Gruić et al., 2015): from initial standing position (barefoot), subject walks over the trackway 9,5 m long (with centrally positioned 158 cm long and 60,5 cm wide platform - FDM1.5, ZEBRIS medical, Gmbh; sensor area 149,0x54.2 cm – L x W, sampling rate 100 Hz, optional 200 Hz/300 Hz), to the end of the trackway, turns around and goes back (6 times). During the gait, subject should be instructed to develop and reach velocity normal for aiming him/herself towards ordinary activity/duty when there are no disturbing gait aspects (late for meeting, uncomfortable footwear, company etc.). Measurements on platform are supported by 11264 capacitive sensors with density of 1.4 sensors/cm^2, with measuring range 1-120 N (accuracy ±5% FS). Protocol was standardized for descriptive and inferential statistical methods. Normality of distributions of results was tested with K-S test, reliability with Cronbach alpha: 0.99 (Standardized alpha: 0.99), homogeneity with Average inter-item corr.: 0.99.

Data processing: Reports (Zebris Medical FDM software for qualitative and quantitative analysis; for reliability Zebris refer to Giacomozzi, 2010) offer 63 quantitative variables within groups (table 1): pressure plots, gait parameters (geometry, phases, timing) COP analysis, force and pressure parameters and curves, three foot zone analysis (Zebris model, Gruić et al., 2015). Collected data were processed within descriptive analysis, K-S normality tests, t-test, in Statistica for W/12.0

Results

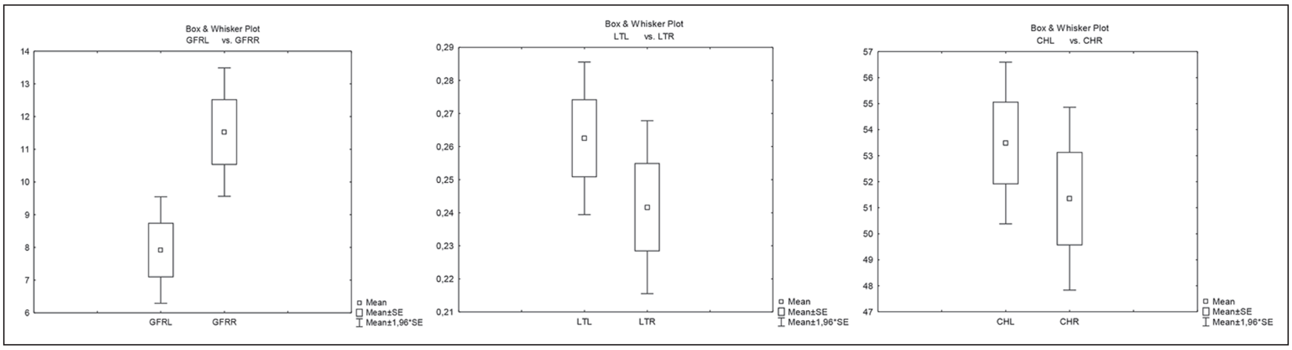
Table 2: Descriptive statistics of pedobarographic parameters of left/right foot (valid N=24; normality for all variables K-S d, p> .20), of left/right foot differences, and T-test

Code	Mean±Std.Dev	Difference L/R Mean ± Std. Dv.	t (df=23)	p	Code	Mean±Std.Dev	Difference L/R Mean ± Std. Dv.	t (df=23)	p
GFRL	7,92±4,07	-3,61±4,36	-4,05	0,00	LTL*	0,26±0,06	0,02±0,04	2,46	0,02
GFRR	11,53±4,91				LTR**	0,24±0,07			
GSLL	70,54±5,95	0,13±3,31	0,19	0,86	LTPL	35,69±5,40	0,96±3,81	1,24	0,23
GSLR	70,41±6,56				LTPR	34,73±5,87			
PSTPL	62,10±2,15	-0,00±2,10	-0,01	0,99	MFL	804,41±84,23	-5,63±28,26	-0,98	0,34
PSTPR	62,10±2,51				MFR	810,08±93,51			
PSTLRL	11,50±2,70	-0,34±2,14	-0,77	0,45	MML	158,93±67,29	-18,06±45,0	-1,97	0,06
PSTLRR	11,84±2,28				MMR	176,98±76,16			
PSTMSL	38,52±2,55	0,38±1,91	0,98	0,34	MHL	565,37±58,84	10,65±32,10	1,63	0,12
PSTMSR	38,14±2,36				MHR	554,72±67,91			
PSTPSL	12,21±2,35	0,15±3,21	0,24	0,82	MAXPFL	43,04±6,74	-0,84±8,33	-0,50	0,63
PSTPSR	12,06±2,84				MAXPFR	43,88±10,05			
PSWPL	37,90±2,14	-0,00±2,09	-0,004	1,00	MAXPML	15,26±9,60	0,12±5,67	0,10	0,92
PSWPR	37,90±2,51				MAXPMR	15,14±8,03			
TSTL	0,57±0,04	-0,00±0,03	-0,08	0,94	MAXPHL	36,52±8,97	0,27±4,82	0,28	0,79
TSTR	0,57±0,04				MAXPHR	36,25±9,39			
BLL	237,30±11,02	-0,40±7,78	-0,28	0,80	TMAXFL	74,75±1,70	-0,25±1,58	-0,76	0,45
BLR	237,70±8,86				TMAXFR	74,99±1,35			
BSL	138,24±14,56	1,73±11,43	0,75	0,47	TMAXML	43,08±11,19	2,93±6,95	2,06	0,05
BSR	136,50±13,53				TMAXMR	40,15±10,10			
FMF1L	805,38±103,45	-9,63±33,79	-1,40	0,18	TMAXHL	18,43±2,94	0,28±1,73	0,78	0,44
FMF1R	815,01±101,57				TMAXHR	18,15±3,69			
FTMF1L	13,92±2,26	0,04±1,66	0,12	0,90	CFL	90,24±2,03	-0,15±1,31	-0,58	0,57
FTMF1R	13,88±2,07				CFR	90,40±1,65			
FMF2L	831,84±102,14	1,93±30,71	0,31	0,76	CML	71,19±4,32	0,62±3,75	0,82	0,43
FMF2R	829,91±105,90				CMR	70,57±4,98			
FTMF2L	46,08±1,67	-0,04±1,66	-0,12	0,90	CHL	53,49±7,77	2,14±4,70	2,23	0,04
	46,13±1,80				CHR	51,35±8,78			

* K-S d=,3259, p<,01; **K-S d=,3214, p<,01

Table 3: Descriptive Statistics of gait parameters (valid N=24)

	Mean	Minimum	Maximum	Range	Std.Dev.	Skewness	Kurtosis	K-S
GSL	140,92	121	175	54	12,14	0,81	1,41	d=,08484, p> .20
GSW	13,45	8	18	10	2,78	0,19	-0,54	d=,14705, p> .20
PDSTP	24,25	16	32,50	16,50	4,13	-0,47	0,16	d=,15530, p> .20
TST	1,13	0,97	1,27	0,30	0,08	-0,13	-0,31	d=,08981, p> .20
TC	106,58	95	124	29	7,12	0,57	0,21	d=,10085, p> .20
TV	4,54	3,60	6,50	2,90	0,65	1,11	2,32	d=,11336, p> .20
BAP	147,70	132,80	166,50	33,70	8,82	0,25	-0,47	d=,09982, p> .20
BLS	-1,10	-7,50	6,00	13,50	3,23	0,40	-0,14	d=,16145, p> .20



Graph 2: Differences between left and right foot in Foot rotation, degree L/R, Percentage of contact time with L/R Heel, and Time to change heel to FF

Discussion

Maximum force in the moment of heel strike of left and right foot (FMF1L /R) produced by handball players gait was higher (Left: 805,38±103,45 N; Right: 815,01±101,57 N) compared to normal active (Gruić et al., 2015) population (Left: 679.59±187.11 N; Right: 684.57±186.33 N) as well as in *Maximum force at the end of stance phase* of left and right foot (FMF2L/R) where handball player also produced greater forces (Left: 831,84±102,14 N; Right: 829,91±105,90 N) compared to normal active population (Left: 705.23±213.29 N; Right: 711.08±199.45 N). *Maximum force forefoot*, (MFL/R) produced by handball players was higher (Left: 804,41±84,23 N; Right: 810,08±93,51 N) compared to normal population (Left: 694.84±196.64 N; Right: 700.46±193.24 N), as well as in *Maximum force heel* (MHL/R) where handball player also produced greater force (Left: 565,37±58,84 N; Right: 554,72±67,91 N) compared to normal active population (Left: 490.35±119.63 N; Right: 476.80±108.42 N). Those differences were mostly proportional to body weight and height. *Partialization* (Milas, 2009, Gruić, 2016.) of results, i. e. excluding the part of variance related to a volume of participants, would offer better insight of these differences. Differences in *Foot rotation*, expressed in degrees are not mainly dependant on subjects voluminosity, therefore difference in absolute (GFR_d* 4,40±3,52) which was followed by real (-3,61±4,36, are later confirmed by t-test. There are statistically significant differences in *Foot rotation*, degree (GFR_d t=-4,05; p<0.01), *Time to change heel to FF*, sec (LT_d t=2,460210; p<0.05), and *Contact time* H, % (CH_d t=2,229428; p<0.05)

Conclusions

Differences between left and right foot in foot rotation degree, percentage of contact time with heel, and time to change heel to forefoot were probably normal in general population, but by extensive and intensive unilateral loads in regular handball training and competition, as well. Decision mechanisms in terms of motor control probably alter automatic and somatic mechanisms. It can be assumed that specific footwear already influences neuromuscular and motor control(learning) 'decision mechanisms'. However, partialization offer deeper insight into the phenomena on the homogeneity/heterogeneity verge - between genders, age, longitudinal skeletal dimensionality, barefoot and footwear gait, complexity of kinesiological activity etc.

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References

1. Cousins, S. D., Morrison, S.C. & Drechsler, W.I, (2012). The reliability of plantar pressure assessment during barefoot level walking in children aged 7-11 years, *Journal of Foot and Ankle Research,* 2012, 5:8.
2. Giacomozzi, C. (2010). Appropriateness of plantar pressure measurement devices: A comparative technical assessment. *Gait posture*, Vol.32, Issue 1: 141-144.
3. Giacomozzi, C., (2010). Performance of plantar pressure measurement devices (PMD): update on consensus activities (commentary), Ann 1st Super Sanita 2010, vol. 46, No 4:343-348
4. Gruić, I. (2006). Handball (teaching material). Zagreb: Faculty of Kinesiology.
5. Gruić, I. (2014). Concentric Power Differences during Take-off between Young Male and Female Team Handball Players. In (Ed: Ian Cabri) Book of abstracts of icSPORTS2014 International Congress on Sport Sciences Research and Technology support, Rome, Italy, October 24-26, 2014.

6. Gruić, I., (2016). Pattern Recognition, Evaluation and Generalization of Kinesiological Phenomena from Heterogenous Sample via Method of Partialization of Variance in Book of Abstracts of the ISCCRO International Statistical Conference in Croatia "New Challenges of Official and Applied Statistics in European Union", Croatian Statistical Association, ISSN:1849-9864, Vol.1, No.1, pp.73., 5th-6th May 2016, Zagreb, Croatia.
7. Gruić, I., Ohnjec, K., Trošt Bobić, T. (2009). Programi treninga i natjecanja u vrhunskom ženskom rukometu u Hrvatskoj – incidencija ozljeđivanja kao posljedica neusklađenosti trendova i mogućnosti. U F.Gracin i B. Klobučar (ur.) Zbornik radova VIII. konferencije o sportu Alpe-Jadran, Zagreb: MZOŠ, 86-96.
8. Gruić, I., Cebović, K., Radaš, J., Bolčević, F. & Medved., V. (2015). Pedobarographic Features of Gait Measured by FDM1.5 PMD. In Proceedings of the 3rd icSPORTS2015. SCITEPRESS - Science and Technology Publications, pp. 66-71.
9. Gruić I., Cebović K. and Medved V. (2016). Comparison of Pedobarographic Profile in Young Males with Left and Right Scoliotic Posture.In Proceedings of the 4th International Congress on Sport Sciences Research and Technology Support - Volume 1: icSPORTS, ISBN 978-989-758-205-9, pages 89-95.
10. Karcher, C. & Buchheit, M. (2014). On-court demands of Elite Handball, with special reference to playing positions *Sports Med* (2014) *44*(6), 797-814, doi:10.1007/s40279-014-0164-z
11. Leardini A, Benedetti, M.G., Berti, L., Bettinelli Nativo, D.R., & Giannini, S., (2007). Rear-foot, mid-foot and fore-foot motion during the stance phase of gait. *Gait Posture*, 2007, 25:453-462.
12. Milas, G. (2009). Research methods in psychology and other social sciences. Zagreb: Slap.
13. Michalsik , L. B., Aagaard, P(2015) Physical demands in elite team handball: comparisons between male and female players *J Sports Med Phys Fitness*, 2015;55:878-91.
14. Michalsik, LB, Madsen, K, and Aagaard, P. (2015) Technical match characteristics and influence of body anthropometry on playing performance in male elite team handball. *J Strength Cond Res*, 29(2): 416-428, 2015.
15. Olsen, O.E., Myklebust. G., Engebretsen, L. i Bahr, R. (2006). Injury pattern in youth team handball: a comparison of two prospective registration methods. *Scandinavian Journal of Medicine & Science in Sports*, 16(6), 426-432.
16. Pažin, K., Bolčević, F & Gruić, I. (2016). Kinematička analiza tehnike u rukometu, U Zborniku radova 14. godišnje međunarodne konferencije Kondicijska priprema sportaša. UKTH, Kineziološki fakultet, National Strength and Conditioning Association, str. 63-67, 26. i 27. veljače 2016., Zagreb, Hrvatska.
17. Peharec, S. (2002). Pedobarographic analysis of gait and running in top athletes (master thesis). Zagreb: Faculty of Kinesiology, University of Zagreb.
18. Perš, J., Bon,M., Kovačić, S., Šibila, M., & Dežman, B. (2002) Observation and analysis of large-scale human motion. *Human Movement Science,* 21 (2002) 295-311.
19. Petersen, W., Braun, C., Bock, W., Schmidt, K., Weimann, A., Drescher, W., EIling, E., Stange, R., Fuchs, T., Hedderich, J & Zantop, T. (2005). A controlled prospective case control study of a prevention training program in female team handball players: the German experience. *Arch of Orthopaedic and Trauma Surgery*, 125(9), 614-62.
20. Pomarino, D, Pomarino, A. (2014). Plantar Static Pressure Distribution in Healthy Individuals: Percentiles for the Evaluation of Forefoot Loading. *Foot Ankle Spec*. 2014 Apr 21; 7(4):293-297.
21. Renstrom, P., Ljungqvist, A., Arendt, E., Beynnon, B., Fukubayashi, T., Garrett, W., Georgoulis, T., Hewett, T.E., Johnson, R., Krosshaug, T., Mandelbaum, B., Micheli, L., Myklebust, G., Roos, E., Roos, H., Schamasch, P., Shultz, S., Werner, S., Wojtys, E. i Engebretsen, L. (2008). Non-contact ACL injuries in female athletes: an International Olympic Committee current concepts statement. *British journal of sports medicine*, 42(6), 394-412.
22. Specifications and operating instructions/software User manual, Zebris Medical, Gmbh.
23. Stebbins J, Harrington M, Thompson N, Zavatsky A, Theologis T (2006). Repeatability of a model for measuring multi-segment foot kinematics in children. *Gait Posture*, 2006, 23:401-410.

THE EFFECT OF AGING ON STRATEGY OF STATIC POSTURAL CONTROL AND NEURAL PROCESSING

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Postural control or balance maintenance is a complex motor skill, attained by the interaction of multiple sensorimotor processes working together. Postural control is an extremely important skill for daily life as the inability to maintain the postural control is the fifth biggest cause of death among adults over 65 years of age. The strategies to maintain postural control vary with the aging as the ability to maintain balance reduces.

The objective of this study is to find out the impact of aging on strategies of static postural control and on neural processing.

The test for static postural control was performed on 20 young students aged 25±2.5 years and 20 seniors aged 68±5 years using Balance Master NeuroCom® in this study. Also 32 channel wireless MOVE EEG 10/20 system was used to measure the EEG activity during test. The ocular correction with independent component analysis was applied to blink marker channel and data was exported to SPSS 22 for statistical analysis.

The young participants demonstrated a significant better ability ($p<0.05$) of controlling static posture. Moreover, they have used the more ankle strategy whereas seniors have used more hip strategy to maintain balance. The mu rhythm (7-11 Hz) was found lower on sensorimotor cortex in senior participants, which indicates the intense neural activity of other band frequencies in sensorimotor cortex (Arroyo et al.,1993), when seniors use more hip strategy to maintain balance. The maintenance of static postural control is challenging for seniors even though their sensorimotor cortex is more active than of young participants. This study helps to understand the effect of aging on neural processing on varying strategy of static postural control.

Key words: *Postural control, mu rhythms, Sensorimotor cortex, Aging, Strategies*

References

1. Arroyo, S., Lesser, R. P., Gordon, B., Uematsu, S., Jackson, D., & Webber, R. (1993). Functional significance of the mu rhythm of human cortex: an electrophysiologic study with subdural electrodes. *Electroencephalography and Clinical Neurophysiology*, *87*(3), 76-87. http://doi.org/10.1016/0013-4694(93)90114-B

GAIT ANALYSIS OF TRANS-FEMORAL AMPUTEES DURING UPSLOPE AND DOWNSLOPE WALKING

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Purpose: Human walking plays an important role in daily activities, so it has been widely studied about level walking for normal subjects. In fact, the grounds surrounding us are not even and the heights also varies. Thus, studies of walking sloped surfaces are also needed [Lay AN et al., 2006]. Unlike normal subjects, lower limb amputees undergo functional limitations when walking on the upslopes and downslopes. However, the researches of slope walking for lower limb amputees are being lack so far. The purpose of this study was to determine the gait characteristic of lower limb amputees during upslope and downslope walking.

Methods: Three trans-femoral amputees participated in this study. Before the gait analysis, the subjects' age, height, and weight were measured, and helen-hayes full body marker set was applied to the subjects. All participants walked at a self-selected velocity on a walkway with 6-m slope of 7°. During walking, a three-dimensional motion capture system (Eagle4, Motion Analysis, USA) with 11-infrared cameras was used to record marker trajectories.

Results: During upslope walking, both prosthetic limb and non-affected limb showed increased hip joint flexion angle compared to level walking in initial contact. Knee joint angle in non-affected limb was enlarged during initial contact, and maximum flexion angle during swing phase was reduced as well as in prosthetic limb. During downslope walking, hip joint angle revealed a sharp decrease in extension angle compared to level walking in prosthetic limb. Furthermore, maximum flexion angle was founded at early mid swing phase in prosthetic limb. Also, maximum knee flexion angle during swing phase in prosthetic limb was remarkably reduced.

Conclusion: In this study, the results showed several adjustment strategies during upslope and downslope walking. Due to the lack of samples, it has been hard to determine the influence of the diverse prosthetic devices. Despite of this limitation, the results above could be an useful information in prosthetic design and lower limb amputee's rehabilitation training.

References

1. Lay AN, Hass CJ, and Gregor RJ, "The effects of sloped surfaces on locomotion: a kinematic and kinetic analysis." *Journal of biomechanics,* 39.9 (2006): 1621-1628.

THE EFFECTS OF EQUAL VOLUME ISOTONIC AND ISOKINETIC KNEE EXTENSORS TRAINING ON STRENGTH GAINS

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Abstract

Purpose: The aim of this study was to compare the effects of equal volume isotonic and isokinetic training on muscle strength measured by an isokinetic dynamometer in physically active healthy men.

Methods: Kinesiology students (n=150; aged 19.6 ± 1.38 years) were divided into 3 groups. During an eight-week procedure experimental groups 1 and 2 had isotonic (EX 1) and isokinetic (EX 2) knee extensors training. Overall training volume was expressed by the number of sets (3) and repetitions (5-15). Changes between the initial and final measurements in each group were analyzed using paired samples T-test whilst the effects size difference was determined using ANOVA.

Results: Statistically significant difference occurred in both experimental groups. Gains in individual groups differed at non-dominant leg.

Conclusion: 8-week isokinetic strength training results in larger strength gains than equal volume isotonic training in healthy physically active male population. We can encourage practitioners to utilize isokinetic dynamometry in early phase of strength training for greater strength gains.

Key words: *Knee, Peak Torque, Strength training*

Introduction

Strength training is one of the most applied and researched types of human physical fitness. It includes the systematic use of maximal and submaximal contractions with the aim of overcoming various types of resistance. This type of exercise increases muscle strength and power, and, in addition, improves functional motor performance (Marković, 2004). It is therefore significantly utilized in many fields of applied kinesiology.

The basic muscle function is force generation, which is among all other things necessary to initiate and sustain movements (Zawadski et al., 2010). Therefore, except its immense use in sports, strength training is important for recreational and therapeutic purposes (Westcott, 2012).

Resistance training implies a constant level of load or a constant angular velocity (Guilhem et al., 2010). Earlier sources primarily refer to two types of dynamic training: isokinetic and isotonic. The ability of maximal voluntary contraction can be increased with either method, provided that the intensity is greater than the normal everyday muscle stimulus (Komi, 1986).

Isokinetic resistance is also known as “accommodating resistance” during which the muscle can produce maximal force during the entire range of motion (Smith and Melton, 1981), while isotonic requires balance (inertia) alteration in order to make movement (Rosentswieg & Hinson, 1972). The difference between these two training types has been the subject of many earlier studies. Some authors stated that training effect are equal (Hudson, 1985; Smith & Melton, 1981; Koutras et al., 2012), while others believe that it is better to use isokinetic (Pipes & Wilmore, 1975; Stevens, 1980) or isotonic training (Hunter & Culpepper, 1988; Kovaleski et al., 1995). Although some earlier studies have included different load equalization methods (total work, etc.), the results were unclear and ambiguous. Therefore, the answer to which type of training results in better effects still remains elusive.

The limitations of earlier studies lie primarily in the fact that load equalization is a complex and time-consuming process (Guilhelm al., 2012), and is, therefore, avoided by practitioners. Due to aforementioned, the aim of this study was to maintain simplicity and compare these two types of training by balancing the number of sets and repetitions. This method does not accurately quantify total work but it is less time-consuming and allows training or rehab protocols creation primarily determined by the overall training load.

Methods

Sample

After the Human Ethics Board approval and participants agreeing to a written consent, 150 students from the Faculty of Sports and Physical Education (aged 19.6 ± 1.38 years; height 184 ± 8.9 cm; weight 88.3 ± 8.9 kg) were randomly divided into 3 equal groups. After the randomization process, participants with documented lower extremity injury within the last two years were excluded from the sample. After the randomization procedure, the control group had 50, while the experimental groups consisted of 40 subjects each. Participants were required not to sustain from additional strength training until the experimental procedure was carried out. The total sample consisted of participants who attended min. 85% of the experimental procedure.

Experimental procedure

During an eight-week experimental procedure, all three groups performed physical activities related to the curriculum, but experimental groups 1 and 2 had additional knee extensors training. EX 1 carried out isotonic, while the EX 2 carried out isokinetic training. Overall training volume, which was expressed by the number of sets (3) and repetitions (5-15), was equal during the whole experimental procedure.

Participants in the isotonic group performed unilateral knee extension training on a Technogym (Technogym, Gambettola, Italy) machine with an adjustable load (2.5 kg). Training load ranged between 5 and 15 reps (5RM - 15RM - to failure), three sets each. When the number of repetitions increased ~20% (1 for 5RM; 3 for 15RM), the load was increased so as to maintain the number of repetitions performed. Isokinetic training group performed the same number of concentric-eccentric repetitions, but utilizing two different angular velocities. They performed 5 repetitions at 60°/s and 15 repetitions at 180°/s, three sets each. Both groups were given maximum 2 minutes of rest between the sets. The rest period between workouts was 2-5 days.

Instrumentation

The isokinetic peak torque was measured using a Biodex System 3 isokinetic dynamometer (Biodex, USA). The highest single repetition peak torque was analyzed. Knee evaluation using isokinetic dynamometry reliability and validity was assessed earlier (Sole et al., 2007). Before testing, a standard warm-up procedure was carried out consisting of cycling (5 minutes), dynamic stretching (3–5 minutes) and three sub-maximal and one maximal concentric isokinetic contraction on a dynamometer.

Stabilization straps were placed over the chest, hips and distal thigh at tested leg. The lateral femoral condyle was aligned with the dynamometer's axis. Gravitational correction was applied at leg angle of 30°. Participants were instructed to keep their hands crossed on their chest and to perform at 100% effort during 5 repetitions CON-ECC protocol at 60°/s. Dominant leg, defined as preferred for kicking (eg, Abazović et al., 2015) was always tested first.

Data and statistical analyses

Results were analyzed using "SPSS 21" for Windows. Normality of the findings was analyzed using the Kolmogorov Smirnov (KS) test. Initial between group differences were determined using ANOVA. Changes between the initial and final measurements were analyzed using paired samples T-test. Effects size (post-pre) comparison was conducted using ANOVA with Bonferroni post-hoc test. The level of significance was set at $p<0.05$.

Results

The results of the KS test have shown that none of the variables deviated significantly from the expected normal distribution ($p>0.20$). There were no significant inter-group differences at the initial measurement.

Table 1 shows that both types of training produced significant ($p<0.01$) effects. In addition, the results indicate that both the isotonic and isokinetic training resulted in statistically significant larger effects when compared to the control group, and that the experimental groups differ from one another only in the variable END – non-dominant leg extension.

Table 1: Initial and final state descriptive statistics, paired samples t-test and ANOVA on effect size variables ([a] - effects differ from the control group; [b] - effects differ from the isotonic group)

Group	Variable	Initial	Final	Mean	Std. Deviation	t value	% Change	Sig.
Isotonic	ED	214.44 ± 38.96	246.56 ± 37.24	32.13	35.41	5.88	14.98[a]	.000
	END	215.61 ± 40.57	251.42 ± 37.16	35.81	27.71	8:37	16.6[a]	.000
Isokinetic	ED	213.77 ± 46.98	260.10 ± 41.22	46.32	36.80	7.96	21.67[a]	.000
	END	213.62 ± 47.17	266.17 ± 41.37	52.55	25.41	8.13	24.60[a, b]	.000
Control	ED	218.02 ± 36.20	217.76 ± 35.70	-0.26	25.94	-0.08	-0.12	936
	END	224.43 ± 36.68	219.18 ± 38.94	-5.24	19.75	-2.16	-2.34	.035

Discussion

Given that the purpose of this study was to compare the effects of isotonic and isokinetic training of equal volume on muscle strength measured by isokinetic dynamometer in physically active healthy men, and that the effects which were documented in the control group are very small and practically insignificant (~-2% - ~4%) when compared to experimental groups (~15% - ~23%), the discussion is focused primarily on two experimental groups.

Although statistically significant differences occurred in both groups, they differed partially. END effects were larger in EX2 than in EX1. Support for these results can be found in a recent study by Golik Perić et al. (2011) who concluded that both training types increase the con H/Q ratio, but a greater increase occurred in the isokinetic group. This could be explained by some previous research. For example, considering that total work declines and fatigue increases during one set of isokinetic repetitions (Komi & Tesch, 1979) as opposed to isotonic training (Enoka, 1997), and that fatigue causes changes (Rooney et al, 1994), it is reasonable that the isokinetic training caused greater strength gains.

More specifically, peak torque and work decrease during isokinetic repetitions (Komi and Tesch, 1979), while remaining constant during isotonic repetitions (Enoka, 1997). Therefore, isokinetic training allows maximal force generation. Thus, for example, Knight et al. (2001) recorded a 21% peak torque drop between first and last three repetitions during multiple repetitions, while no changes occurred during isotonic repetitions. Knight et al. (2001) observed that the force generated in the first three repetitions is 8% higher during isokinetic, and 15% higher during the last three isotonic repetitions.

These changes could be also due to training specificity. It is possible that the isokinetic group had bigger gains because of the testing procedure. For example, in a study by Tsaklis & Abatzides (2002) isokinetic group performed better during isokinetic, while the isotonic group performed better during isotonic testing. Therefore, these two contraction types stimulate muscles in different ways (Guilhem et al., 2010) and, additionally, result in different neuromuscular adaptation, torque-angle and torque-velocity changes (Remaud et al., 2010). Due to lever mechanics, isotonic training demands higher initial activation, while isokinetic allows maximal force generation through the entire range of motion.

The only difference between this and previous studies is that the difference between groups emerged only at non-dominant limb. Reasons for this single exception can be found in the bilateral deficit phenomenon which occurs when comparing unilateral and bilateral contraction. In fact, when comparing the amount of force generated between these two types of contractions (Hay et al., 2006) bilateral force generated is less than the sum of two unilateral contractions. Since this phenomenon has been observed and explained (Henry & Smith, 1961), it was confirmed in different populations (Kuruganti and Seaman, 2006; Kuruganti & Murphy, 2008; Khodiguian et al., 2003; Hakkinen et al., 1996) and muscle groups (Khodiguian et al., 2003; Hay et al., 2006; Kuruganti & Murphy, 2008). However, underlying mechanisms are not clear.

Although this has not been empirically verified, strength training could affect dominant and non-dominant limb differently. It has not yet been investigated whether the limb fatigability or EMG signal strength is correlated with limb dominance but some authors recorded different EMG activity (Kuruganti & Murphy, 2008) in dominant and nondominant limb. This could be due to neural inhibition (Rejc et al., 2010 Hakkinen et al., 1996).

One thing that is certain is that due to neural adaptation (Gabriel et al., 2006) greater load is superior and causes greater gains in the initial training stages (Rhea et al., 2003). Generally, in the beginning, neural adaptation is more important than structural (Blazevich et al., 2007) and this further emphasizes the advantage of isokinetic training in initial training phase.

Questions like protocol structure (sets, reps, etc.) have not been unequivocally answered; however, isokinetic exercise has great safety advantage over all other exercise types (Gür et al., 2002; Tagesson et al., 2008). Because of that, isokinetic training is more used in rehabilitation because it provides a safer environment and allows resistance and speed adjustment (Guilhem et al., 2012 i 2010). More importantly, isokinetic dynamometer can be completely stopped if the trainee feels he/she is not able to perform full movement.

Conclusion

The process of increasing strength is complex and lengthy regardless of performed exercise. Results of this study indicate that 8-week isokinetic strength training results in larger strength gains than equal volume isotonic training in healthy physically active male population. It should be noted that the effects were different in dominant and non-dominant leg which indicates that in addition to bilateral training, regardless of its purpose, additional unilateral exercises should be performed. Furthermore, we can encourage practitioners, both strength and conditioning coaches and clinicians, to utilize isokinetic dynamometry in the early phase of strength training.

References

1. Abazović E, Kovačević E, Kovač S, and Bradić J. The effect of training of the non-dominant knee muscles on ipsi-and contralateral strength gains. Isokinetics and Exercise Science 23: 177-182, 2015.
2. Blazevich AJ, Gill ND, Deans N, and Zhou S. Lack of human muscle architectural adaptation after short-term strength training. Muscle & nerve 35: 78-86, 2007.
3. Enoka RM. Neural adaptations with chronic physical activity. Journal of biomechanics 30: 447-455, 1997.
4. Gabriel DA, Kamen G, and Frost G. Neural adaptations to resistive exercise. Sports Medicine 36: 133-149, 2006.
5. Golik-Peric D, Drapsin M, Obradovic B, and Drid P. Short-term isokinetic training versus isotonic training: effects on asymmetry in strength of thigh muscles. Journal of human kinetics 30: 29-35, 2011.
6. Guilhem G, Cornu C, and Guével A. Neuromuscular and muscle-tendon system adaptations to isotonic and isokinetic eccentric exercise. Annals of physical and rehabilitation medicine 53: 319-341, 2010.
7. Guilhem G, Cornu C, and Guével A. A methodologic approach for normalizing angular work and velocity during isotonic and isokinetic eccentric training. Journal of athletic training 47: 125, 2012.
8. Gür H, Çakın N, Akova B, Okay E, and Küçükoğlu S. Concentric versus combined concentric-eccentric isokinetic training: effects on functional capacity and symptoms in patients with osteoarthrosis of the knee. Archives of physical medicine and rehabilitation 83: 308-316, 2002.
9. Hakkinen K, Kallinen M, Linnamo V, Pastinen UM, Newton RU, and Kraemer WJ. Neuromuscular adaptations during bilateral versus unilateral strength training in middle-aged and elderly men and women. Acta physiologica Scandinavica 158: 77-88, 1996.
10. Hay D, de Souza VA, and Fukashiro S. Human bilateral deficit during a dynamic multi-joint leg press movement. Human movement science 25: 181-191, 2006.
11. Henry FM and Smith LE. Simultaneous vs. separate bilateral muscular contractions in relation to neural overflow theory and neuromoter specificity. Research Quarterly American Association for Health, Physical Education and Recreation 32: 42-46, 1961.
12. Hudson VJ. A comparison of isotonic and isokinetic training methods for the development of leg strength and power. University of Florida, 1985.
13. Hunter G and Culpepper M. Knee extension torque joint position relationships following isotonic fixed resistance and hydraulic resistance training. Athletic Training 23: 16-20, 1988.
14. Khodiguian N, Cornwell A, Lares E, DiCaprio PA, and Hawkins SA. Expression of the bilateral deficit during reflexively evoked contractions. Journal of applied physiology (Bethesda, Md : 1985) 94: 171-178, 2003.
15. Knight KL, Ingersoll CD, and Bartholomew J. Isotonic contractions might be more effective than isokinetic contractions in developing muscle strength. Journal of Sport Rehabilitation 10: 124-131, 2001.
16. Komi P. Training of muscle strength and power: interaction of neuromotoric, hypertrophic, and mechanical factors. International Journal of Sports Medicine: 10-15, 1986.
17. Komi PV and Tesch P. EMG frequency spectrum, muscle structure, and fatigue during dynamic contractions in man. European Journal of Applied Physiology and Occupational Physiology 42: 41-50, 1979.
18. Koutras G, Letsi M, Papadopoulos P, Gigis I, and Pappas E. A randomized trial of isokinetic versus isotonic rehabilitation program after arthroscopic meniscectomy. International journal of sports physical therapy 7: 31, 2012.
19. Kovaleski JE, Heitman RH, Trundle TL, and Gilley WF. Isotonic preload versus isokinetic knee extension resistance training. Medicine and science in sports and exercise 27: 895-899, 1995.
20. Kuruganti U and Murphy T. Bilateral deficit expressions and myoelectric signal activity during submaximal and maximal isometric knee extensions in young, athletic males. European journal of applied physiology 102: 721-726, 2008.
21. Kuruganti U and Seaman K. The bilateral leg strength deficit is present in old, young and adolescent females during isokinetic knee extension and flexion. European journal of applied physiology 97: 322-326, 2006.
22. Marković G. Influence of sprint-and plyometric-training on quatitative and qualitative changes in certain motor and morphological characteristics. Faculty of Kinesiology, Univeristy of Zagreb, 2004.
23. Pipes TV and Wilmore JH. Isokinetic vs isotonic strength training in adult men. Medicine and science in sports 7: 262-274, 1975.
24. Rejc E, Lazzer S, Antonutto G, Isola M, and di Prampero PE. Bilateral deficit and EMG activity during explosive lower limb contractions against different overloads. European journal of applied physiology 108: 157-165, 2010.
25. Remaud A, Cornu C, and Guével A. Neuromuscular adaptations to 8-week strength training: isotonic versus isokinetic mode. European journal of applied physiology 108: 59-69, 2010.

26. Rhea MR, Alvar BA, Burkett LN, and Ball SD. A meta-analysis to determine the dose response for strength development. Medicine and science in sports and exercise 35: 456-464, 2003.

27. Rooney KJ, Herbert RD, and Balnave RJ. Fatigue contributes to the strength training stimulus. Medicine & Science in Sports & Exercise: 1160-1164, 1994.

28. Rosentswieg J and Hinson MM. Comparison of isometric, isotonic and isokinetic exercises by electromyography. Archives of physical medicine and rehabilitation 53: 249-252, 1972.

29. Smith MJ and Melton P. Isokinetic versus isotonic variable-resistance training. The American journal of sports medicine 9: 275-279, 1981.

30. Stevens R. Isokinetic versus isotonic training in the development of lower body strength and power. Scholastic Coach 49: 74-101, 1980.

31. Tagesson S, Öberg B, Good L, and Kvist J. A comprehensive rehabilitation program with quadriceps strengthening in closed versus open kinetic chain exercise in patients with anterior cruciate ligament deficiency a randomized clinical trial evaluating dynamic tibial translation and muscle function. The American journal of sports medicine 36: 298-307, 2008.

32. Tsaklis P and Abatzides G. ACL rehabilitation program using a combined isokinetic and isotonic strengthening protocol. Isokinetics and exercise science 10: 211-219, 2002.

33. Westcott WL. Resistance training is medicine: effects of strength training on health. Current sports medicine reports 11: 209-216, 2012.

34. Wojtys EM, Huston LJ, Taylor PD, and Bastian SD. Neuromuscular adaptations in isokinetic, isotonic, and agility training programs. The American journal of sports medicine 24: 187-192, 1996.

35. Zawadzki J, Bober T, and Siemienski A. Validity analysis of the Biodex System 3 dynamometer under static and isokinetic conditions. Acta of bioengineering and biomechanics / Wroclaw University of Technology 12: 25-32, 2010.

COMPARISON OF METHODS TO CALCULATE CONTINUOUS RELATIVE PHASE BETWEEN JOINTS DURING GAIT; PORTRAIT METHOD AND ANALYTIC SIGNAL METHOD

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Purpose: The aim of this study was to compare portrait method (PM) with analytic signal method (ASM) for calculating continuous relative phase (CRP) between joints to evaluate joint coordination[1].

Methods: Joint angle during a gait in the 18 female elderly was captured by motion capture system. Then joint angular velocity was calculated for PM, while analytic signals was generated by Hilbert transform. Next, phase between joint angle and its velocity or between the real part and the imaginary part of analytic signals were calculated. Finally CRP between hip and knee or between knee and ankle was calculated at stance or swing phase by 2 methods.

Results: Higher cross-correlation coefficient and a negative correlation between the methods were shown. Bland-altman plot showed a higher agreement between 2 methods.

Conclusions: These results implied less differences between PM and ASM to calculate CRP.

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Reference

1. P.F. Lamb and M Stöckl, 29, 484-493, Clinical Biomechanics (2014)

CHANGES OF GAIT PATTERN IN THE ELDERLY WITH COMPRESSION GARMENT

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Abstract

Purpose: To investigate the changes of gait pattern in the elderly with or without compression garment.

Methods: Twenty healthy elderly persons (age: 65-74 yrs) voluntarily participated in this study. Each participant wore the normal and compression garments with random order, and was asked to walk at self-selected speed. A three dimension motion capture system was used to capture the locomotion of lower extremities during walking. The gait cycle for analysis was defined as right heel strike to touch the ground again after three steps. The paired t-test was used to compare the speed, step length, frequency and the angle of lower extremities between the different garments.

Results: Elderly who wore the compression garment had greater maximum hip flexion angle than the normal garment ($p<.05$). However, no significant difference was found in speed, step length and frequency between the two wearing conditions ($p>.05$).

Conclusions: Elderly who wore the compression garment increased hip flexion angle, but still kept the same walking speed. The findings suggested that the compression garment might advantage the elderly to cross a block, to go upstairs, and to get on the buses and to finish other daily activities. Furthermore, wearing the compression garment might reduce the risk of fall in the elderly.

Key words: *lower extremity, hip flexion, fall*

ASSESSMENT OF GROUND REACTION FORCE OF PREGNANT WOMEN DURING WALKING

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Abstract

Purpose: The purpose of this research was to analyse kinematic changes in gait patterns in anteroposterior and vertical plane of GRF between weeks 27 and 36 of pregnancy.

Methods: Pregnant women (n=8) completed 5 gait trials on a walkway (4,8 m) at a self-selected velocity of gait, where force and temporal characteristics of gait were sampled and displayed by Simi Motion (version 9.0.5) as force-time curves for both lower limbs.

Results: All GRF peaks in anteroposterior and vertical plane for both feet increased in the comparison between the 1st and 2nd measurement. We can register just only one variable, in which we revealed decreased force (F2 – right foot: 10.56 N). More important are changes occur in the time to reach these GRFs peaks. In the right foot, there are F1 and F2 shifts for the anteroposterior plane and F3 and F4 for the vertical plane closer to midfoot. In the left foot there are shifts F1 and F3 closer to the edge of the heel and F2 and F4 closer to midfoot.

Conclusion: Kinetic changes of GRF are observed here, but generally it will not cause substantial and visible differences in the gait patterns within this focus group. Walking is mildly slower and more careful because of changes in mass distribution and biomechanical changes.

Key words: *Ground reaction force, pregnancy, gait pattern*

Introduction

One of the most significant changes is body mass gain (Berdzik, Bacik & Kukowska, 2009; Ogamba, Loverro, Laudicina, Gill & Lewis 2016). For a normal weight, the body mass increases by a mean of 11 to 16 kg during pregnancy (Kjærgaard, Ottesen, Damm, Hegaard, 2012). Especially, body mass gain starts morphological processes which cause changes in the gait pattern (Aguiar, Santos-rocha, Branco, Vieira, & Veloso, 2014). Most of the anatomical changes related to pregnancy take place between the second and third trimesters (Branco, Santos-Rocha, Vieira, Aguiar, Veloso, 2016). Hormonal activity during a pregnancy is an important factor which can influence the gait pattern, for example the hormone relaxine decreases stiffness and increases ligamentous laxity, causing excessive mobility and instability and it can have a major impact on gait pattern, because of kinematic changes especially in the hip, knee and ankle joint areas (Dehghan, Haerian, Muniandy, Yusof, Dragoo & Salleh, 2014; Bertuit, Feipel, Rooze, 2015). Biomechanical analysis of gait employs various methods used in kinematic and kinetic analysis, but kinetic analysis based on the assessment of the ground reaction forces (GRF) is one of the most used methods (Vaverka, Elfmark, Svoboda & Janura, 2015).The purpose of this research was to analyse changes in gait patterns in the anteroposterior and vertical planes of GRF between the 27th and 36th weeks of pregnancy

Materials and Methods

Participants

Eight pregnant women (30.80±5.56 years of age), body height (167.42±16.5 cm) participated in this study. The inclusion criterion was a low-risk pregnancy and the period before the third trimester, whereas the exclusion criteria included any orthopedic or neurological disorders that could influence the gait. The measurements were conducted in the beginning of week 27 of gestation and in week 36 of gestation. The average values of body mass were collected at the same time. This is shown in Table 1.

Table 1: Mean body mass at 27 weeks of gestation and 36 weeks of gestation

	27th week of gestation	36th week of gestation
Mean body mass	67,14±10,16	72,45±11,96

Prior to the study, participants were informed about the measurement procedure and they signed an informed consent. The protocol was approved by the local ethical committee of the Faculty of Sports Studies, Masaryk University, Brno, Czech Republic.

Materials

All GRF parameters were registered by Bertec walkway (Bertec force plate FP6012-15, USA, length: 120 cm, width: 60 cm). Overall, the walkway is 4.8 m long (4 force plates consecutive). As the subject walks over the platform, the sensors enable collection of GRF parameters. Data is sampled at frequencies for three directions: Fz (vertical direction) 360 Hz; Fx (mediolateral direction) and Fy (anteroposterior direction) 400 Hz. The force and temporal characteristics of gait are displayed by Simi Motion (version 9.0.5). Data were collected at the Laboratory of Kinanthropological Research on the campus of Masaryk University of Brno, Czech Republic.

Methods

Before performing the motor task, anthropometric data (age, weight and height) were registered for each subject. The motor task consisted of 5 gait trials. The participants started walking 1 m ahead of the walkway and finished the trial 1 m after the end of the walkway in order to preserve acceleration and deceleration in gait. Participants walked at their own preferred velocity, but first contact with the force plate was always with the right foot. Data was collected from a third trial, where averages of all steps by the right foot and all steps by the left foot were created. Averages were created also from individual strides.

Data processing

For the data processing, Microsoft Office Excel 2016 (Microsoft Corporation) was used. The Excel script was created based on knowledge of the shape of the curves of the forces of progress step on two levels (mediolateral, anteroposterior). Data is analysed as a comparison of force-time differences between the 1st and 2nd measurement in the anteroposterior (Fy) and vertical (Fz) planes of right foot and between the 1st and 2nd measurement in the anteroposterior and vertical planes of the left foot. The following variables were analysed: Fy - anteroposterior components: F1 = braking peak, t1 = time to braking peak, F2 = propulsive peak, t2 = time to propulsive peak; Fz - vertical component: F3 = loading response peak, t3 = time to loading response peak, F4 = terminal stance peak, t4 = time to terminal stance peak. For t3, t4, a percentage expression was created marked as t3 [%] and t4 [%], where 100% always indicates duration from the first contact of the first foot with the ground to the first contact of the second foot on the same force plate; tGS = duration of stride; weight (Vaverka, Elfmark, Svoboda & Janura, 2015).

Statistical analysis

We found out data didn't come from normal distribution, so we used a nonparametric test for further statistical analysis. To compare differences between the first and second measurement, a Wilcoxon t-test was used, together with an assessment of the effect size of using Cohen's d. The level of statistical significance we determined was a = 0.05. The level of effect size we determined was d > 0.20 for a small effect size, d > 0.50 for a medium effect size, and d > 0.80 for a large effect size (Cohen, 1977). Cohen d variables are expressed in absolute value. All statistical procedures were conducted using Statistica 10 software for Windows.

Results

Wilcoxon t-test of force-time values

The Wilcoxon t-test mostly didn´t reveal statistically significant differences between GRF peaks and time to reach these peaks between the 1st and 2nd measurements for the right foot and between the 1st and 2nd measurements for left foot between weeks 27 and 36 of pregnancy. A statistically significant difference was found only in time to reach F2 for the right foot in the anteroposterior plane (p = 0.035). Values of Wilcoxon t-test are expressed in tables 3 and 4.

The effect size of force-time values

Results of the effect size by Cohen's d revealed more significant differences than the Wilcoxon t-test of statistical significance. Values of the effect size are expressed in tables 3 and 4.

Comparison of 1st and 2nd measurements (right foot)

Fy – anteroposterior plane

The large effect size is located in time to reach F2 (d = 0.87); there is a decrease of time to reach F2 (0.06 s). This means there is a shift of F2 closer to midfoot, but the difference in F2 is registered with a small effect size (d = 0.46). Decrease of force of F2 (10.56 N).

Fz – vertical plane

The medium effect size is located in percentage expression t3 [%] of time to loading response peak (d = 0.64) for right foot, but t3 is considered as the small effect size with just a small difference (d = 0.49). There is a negligible shift of F3 to closer to the midfoot, where F3 registered increase of force (32.81 N) with a medium effect size (d = 0.61).

Table 2: Force and time variables of 1st and 2nd measurements for the right foot expressed at a level of statistical significance (p<.05000) of Wilcoxon t-test (Bürkner, Doebler, Holling, 2016) and Cohen's d values, d > 0.20 small, d > 0.50 moderate, d > 0.80 large significance (Cohen, 1977)

Pairs of force-time Variables	Wilcoxon Matched Pairs Test Marked tests are significant at p<.05000				
	Valid N	T	Z	p-value	Cohen´s d
F1 [N] (1) & F1 [N] (2)	8	15.00000	0.420084	0.674424	0.29
t1 [s] (1) & t1 [s] (2)	8	18.00000	0.000000	1.000000	0.20
F2 [N] (1) & F2 [N] (2)	8	9.00000	1.260252	0.207579	0.46
t2 [s] (1) & t2 [s] (2)	8	3.00000	2.100420	0.035693	0.87
F3 [N] (1) & F3 [N] (2)	8	7.00000	1.540308	0.123486	0.61
t3 [s] (1) & t3 [s] (2)	8	10.00000	1.120224	0.262619	0.49
t3 [%] (1) & t3 [%] (2)	8	10.00000	1.120224	0.262619	0.64
F4 [N] (1) & F4 [N] (2)	8	7.00000	1.540308	0.123486	0.34
t4 [s] (1) & t4 [s] (2)	8	12.00000	0.840168	0.400815	0.28
t4 [%] (1) & t4 [%] (2)	8	15.00000	0.420084	0.674424	0.09

Comparison of 1st and 2nd measurements (left foot)

Fy – anteroposterior plane

The large effect size (d = 0.82) was revealed in the change of size of F2. There is an increase of force (13.96 N). There is a negligible decrease of time to reach F2 without the effect size (d = 0.09) and an insignificant shift of F2 closer to the edge of the heel. The medium effect size is located in F1 (d = 0.51), but increase of force is slight (2.06 N).

Fz – vertical plane

The small effect size was revealed in F3 (d = 0.47), but there is a big rise of force (73.35 N). Time to reach F3 is without the effect size (d = 0.14) and significant shift of F3 was not registered. The small effect size we can observe also in F4 (d = 0.22) and t4 (d = 0.28). There is increase of force of F4 (25.21 N) and decrease of time to reach F4, where an insignificant shift closer to midfoot was observed.

Table 3: Force and time variables of 1st and 2nd measurements for the left foot expressed in the level of statistical significance (p<.05000) of Wilcoxon t-test (Bürkner, Doebler, Holling, 2016) and Cohen's d values, d > 0.20 small, d > 0.50 moderate, d > 0.80 large significance (Cohen, 1977)

Pair of Variables	Wilcoxon Matched Pairs Test Marked tests are significant at p <.05000				
	Valid N	T	Z	p-value	Cohen´s d
F1 [N] (1) & F1 [N] (2)	8	8.00000	1.400280	0.161430	0.51
t1 [s] (1) & t1 [s] (2)	8	7.00000	1.183216	0.236724	0.17
F2 [N] (1) & F2 [N] (2)	8	6.00000	1.680336	0.092893	0.82
t2 [s] (1) & t2 [s] (2)	8	12.00000	0.840168	0.400815	0.09
F3 [N] (1) & F3 [N] (2)	8	6.00000	1.680336	0.092893	0.47
t3 [s] (1) & t3 [s] (2)	8	14.50000	0.490098	0.624065	0.14
t3 [%] (1) & t3 [%] (2)	8	15.00000	0.420084	0.674424	0.06
F4 [N] (1) & F4 [N] (2)	8	12.00000	0.840168	0.400815	0.22
t4 [s] (1) & t4 [s] (2)	8	13.00000	0.700140	0.483840	0.28
t4 [%] (1) & t4 [%] (2)	8	16.00000	0.280056	0.779435	0.01

Comparison of 1st and 2nd measurements of duration of stride and weight

The medium effect size was revealed for weight (d = 0.62) and for duration of stride (d = 0.57). There is an average increase of weight (5.46 Kg), where according to the Wilcoxon t-test we can also register statistical significance (p = 0.005). In case of duration of stride, we can say there is an average decrease of time (0.17 s). See table 4.

Table 4: Weight and duration of stride variables of 1st and 2nd measurements expressed in the level of statistical significance (p<.05000) of Wilcoxon t-test (Bürkner, Doebler, Holling, 2016) and Cohen's d values, d > 0.20 small, d > 0.50 moderate, d > 0.80 large significance (Cohen, 1977)

Weight and duration of stride variables	Wilcoxon Matched Pairs Test Marked tests are significant at p <.05000				
	Valid N	T	Z	p-value	Cohen´s d
tGS (1) & tGS (2)	8	11 .00000	1 .362402	0 .173072	0.57
weight (1) & weight (2)	8	0 .00000	2 .803060	0 .005062	0.62

Discussion and conclusion

The purpose of this research was to analyse changes of gait patterns in anteroposterior and vertical GRF between the 27th and 36th weeks of pregnancy. All GRF peaks in the anteroposterior and vertical planes for both feet were increased in the comparison of the 1st and 2nd measurements. We can register just only one variable in which we revealed decreased of force (F2 – right foot). McCrory, Chambers, Daftary, Redfern (2011) also confirm this finding. Overall weight gain between weeks 27 and 36 was 5.46 Kg. More important are changes of time to reach these GRF peaks. In the right foot, there are shifts F1 and F2 for the anteroposterior plane and F3 and F4 for the vertical plane, closer to midfoot. This can mean that a step by the right foot is faster and smaller (Bertuit, feipel, rooze, 2015). Increased walking speed is conditioned by shortened contact times and larger peak forces (Nilsson, Thorstensson, 1989). In left foot, there are shifts F1 and F3 closer to edge of heel, and F2 and F4 closer to midfoot. This probably means that the heel strike of the left foot starts earlier than the right foot. This may be related to the shorter duration of the two steps for improved gait safety by focusing on dynamic stability (Błaszczyk, Opala-Berdzik, Plewa, 2016). Duration of stride was decreased (0.17 s). Added anterior mass decreased cycle time and stride length (Gill, Ogamba, Lewis, 2016). Kinetic changes of GRF are observed here, but generally do not cause substantial and visible differences in gait pattern within this focus group. Walking is mildly slower and more careful because of changes in mass distribution and biomechanical changes, which balance women's natural adaptative mechanisms (Berdzik, Bacik & Kukowska, 2009). The specificity of this study is a small group of participants, therefore results of the effect size were more significant than the results of statistical significance. This study will serve as a pilot program for far more comprehensive research including a greater amount of data.

References

1. Aguiar, L., Santos-Rocha, R., Vieira, F., Branco, M., & Veloso, A. (2014). Biomechanical model for kinetic and kinematic description of gait during second trimester of pregnancy to study the effects of biomechanical load on the musculoskeletal system. *Journal of Mechanics in Medicine & Biology*, 14, 1-16
2. Aguiar, L., Santos-Rocha, R., Vieira, F., Branco, M., & Veloso, A. (2016). Three-dimensional kinematic adaptations of gait throughout pregnancy and post-partum. *Acta of Bioengineering and Biomechanics,* 18, 153-162.
3. Bertuit, J., Feipel, V., Rooze, M. (2015). Temporal and spatial parameters of gait during pregnancy. *Acta of Bioengineering & Biomechanics*, 17, 93-101.
4. Błaszczyk, J., W., Opala-Berdzik, A., Plewa, M. (2016). Adaptive changes in spatiotemporal gait characteristics in women during pregnancy. *Gait & Posture*, 43, 160-164.
5. Bürkner, PC., Doebler, P., Holling, H. (2016). Optimal design of the Wilcoxon–Mann–Whitney-test. *Biometrical Journal*.
6. Cohen, J. (1977). Statistical power analysis for behavioral sciences (Revised Ed.). New York: *Academic Press*, 474p.
7. Dehghan, F., Haerian, B., S., Muniandy, S., Yusof, A., Dragoo, J., L., & Salleh, N. (2014). The effect of relaxin on the musculoskeletal system. *Scandinavian Journal of Medicine & Science in Sports*, 24, 220-229.
8. McCrory, J.L., Chambers, A.J., Daftary, A., & Redfern, M.S. (2011). Ground reaction forces during gait in pregnant fallers and non-fallers. *Gait & Posture,* 34, 524-528.
9. Nilsson, J., Thorstensson A. (1989). Ground reaction forces at different speeds of human walking and running. *Acta Physiol Scand*, 136, 217-227.
10. Ogamba, M., I., Loverro, K., L., Laudicina, N., M., Gill, S., V., & Lewis, C., L. (2016). Changes in Gait with Anteriorly Added Mass: A Pregnancy Simulation Study. *Journal of Applied Biomechanics,* 32, 379-387.
11. Opala-Berdzik, A., Bacik, B., Kurkowska, M. (2009). Biomechanical changes in pregnant women. *Physiotherapy,* 17, 51
12. Rode, L., Kjærgaard, H., Ottesen, B., Damm, P., Hegaard, H., K. (2011). Association Between Gestational Weight Gain According to Body Mass Index and Postpartum Weight in a Large Cohort of Danish Women. *Maternal and Child Health Journal*, 16, 406-13
13. Rode, L., Kjærgaard, H., Ottesen, B., Damm, P., Hegaard, H., K. (2011). Association Between Gestational Weight Gain According to Body Mass Index and Postpartum Weight in a Large Cohort of Danish Women. *Maternal and Child Health Journal,* 16, 406-13
14. Vaverka, F., Elfmark, M., Svoboda, Z. & Janura, M. (2015). System of gait analysis based on ground reaction force assessment. *Acta Gymnica*, 45, 187.

FALL ANALYSIS FOR AN ACTIVE BRAKING SYSTEM IN A NEW SPORT AND DANCE ROLLATOR

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Abstract

The influence of lifestyle factors on the aging process and quality of life is a current focus of research.. A lot of factors influence the quality of life for example, health situation, nutrition, daily movement, social interaction, and so on. Nevertheless falls are often, about a third of the over 65-year-old fall over at least once a year (McElhinney et al., 1998). In this context a fall is understood to mean an event that causes a person to lie unintentionally on the ground or a deeper level (Kellogg International Work Group on the Prevention of Falls by the Elderly, 1987). Preventative measures against falls are becoming increasingly important. In the current market, standard walking aids offer mobility solutions for people with mobility problems. Sporting events like dancing have used standard rollators as part of movement therapy in Germany since 2011 (HA, 2015). The Institute for Sports Science at the Otto-von Guericke-University Magdeburg aims to design and construct a sports and dance rollator. With a prototype, two measurement methods were analyzed during a falling simulation. The investigation aimed to determine whether a threshold between a normal sports and dance movement and a camber movement can be determined. The crash analysis carried out is the basis for an active braking system of the sport and dance rollator. Later, an automatic braking system will detect the fall movement and by activating the brakes, the braking system can reduce the user's fall and thus prevent the cause of a major injury. In two different crash situations (stumbling and collision), seven subjects were tested. They carried out various forms of movement from the field of sport and dance. Both tests used inertial sensors and force sensors, with results indicating no clear threshold value between the minimum extreme values of stumbling and collision were above the maximum extreme values of normal motion. However, differences in the data between sports and dance movements are recognizable against a camber movement. Thereby, a second type of threshold value over this normal range of movement [20.66 m / s; 74.77N] was established. The overlying values would then lead to brake activation and thus avoid using heavy supports.

Introduction

The importance of regular movement and exercise in the later years of life and their impact on the aging process has recently been investigated in the context of life quality (Mechling, 2005). Despite the new evidence concerning the impact of movement on age-related changes, there are many seniors who have motor limitations. Therefore, many use a standard-walker to perform daily tasks and to preserve a little independence. In addition to the age-related degradation of the sensory system, medication, disease, muscle atrophy and loss of strength also contribute to an increased risk of falling. Above all the muscle weakness of the lower extremities has a great influence on loss of balance and thus on gait (Freiberger & Schöne, 2010, p.11). In the current market, standard walkers (DIN EN ISO 11199-2:2005-07, 2005) offer mobility solutions for people with mobility problems during tasks such as walks, shopping or medical visits. Even sporting events such as dancing with standard rollators have already been part of movement therapy in Germany since 2011 (HA, 2015). However, the standard walker as well as all other commercially available walker-type models allow only limited movements in their handling. Due to the standard design, only forward and no sideways movements are possible. The reverse movement with the standard walker is very cumbersome. As a result, the muscle groups of the leg abductors regress. These in turn are, jointly responsible for the stabilization of gait movements and lead to a higher risk of falling in the event of a regression (Suica et al., 2015). The positive effects of physical and mental training have been known for some time by medical specialists, sports scientists, therapists and dance instructors through special movement therapy (e.g., dancing). Motion programs, e.g. "dance classes with the rollator" by the German Dance Teaching Association (ADTV) (Ärzte Zeitung, 2014; RP Online, 2011; T-Online, 2011), currently cannot be performed in a good way with a suitable commercial device (Gesundheitsportal Onmeda, 2014). The Institute for Sports Science at the Otto-von-Guericke-University Magdeburg is concerned with the construction of a more functional sports and dance walker. This is intended to give motorized and cognitively restricted seniors the opportunity to promote their physical and mental abilities so as to maintain their independence in everyday life. With respect to the application of the new sports- and dance rollator, three ergonomic product features will be discussed. Firstly, the increase in the possibility of movement with the walker was considered, secondly the support behaviour for an upright body position was taken into account, and thirdly, a sitting possibility was conceived, which on the one hand offers a recreation possibility and on the other hand allows movement exercises while sitting. The aim of this pilot project was to create a new innovative sport device, in which the seniors with motor and mental limitations could perform various sports including dancing.

Methods

Two methods based on inertial sensors and strain gauges were used to enable an automatic fall detection of the sports and dance rollator for an automatic braking system. The inertial sensors attached to the walker determine the change in the acceleration of the rollator between a sport and dance movement and an initiating camber movement. Four strain gauges are attached to the subject at hip height for measuring the change of the force between a sport and dance movement and an initiating camber movement. A differentiation valid for all test persons between a normal movement (for sports and dance) and an initiating camber movement (stumbling, collision), which is valid for all test persons, would lead to a threshold value. The following dance movements were tested in the sport- and dance rollator prototype: forward, backward, cross step to the left and right, change step to the left and right, diagonal step forward to the left and to the right, rotation by means of two steps by 180° and with at least two steps before and after the rotation (180°). Seven subjects (mean age ± 21yrs) performed the movements with closed eyes. Given an acoustic signal (stroke 100 bpm), the movements of all subjects were performed at almost the same speed. Two crash situations were carried out for each movement: the stumbling - the leg was pulled with a rope and collision - in this case, the subject moves with the rollator against an object which is located on the ground and prevents further rolling. The time of the crash-simulating action was unknown to the participants.

Figure 1: Sport- and Dance Rollator Design-Prototype

Results

Figure 2 shows the extreme values of inertial sensors which are relevant for determining the threshold value. The maximum values for a normal motion pattern [20.66 m/s²] as well as the minimum values for stumbling [11.63 m/s²] and during collision [10.57 m/s²] in the diagram are indicative of the total mean values of the movement patterns of all subjects.

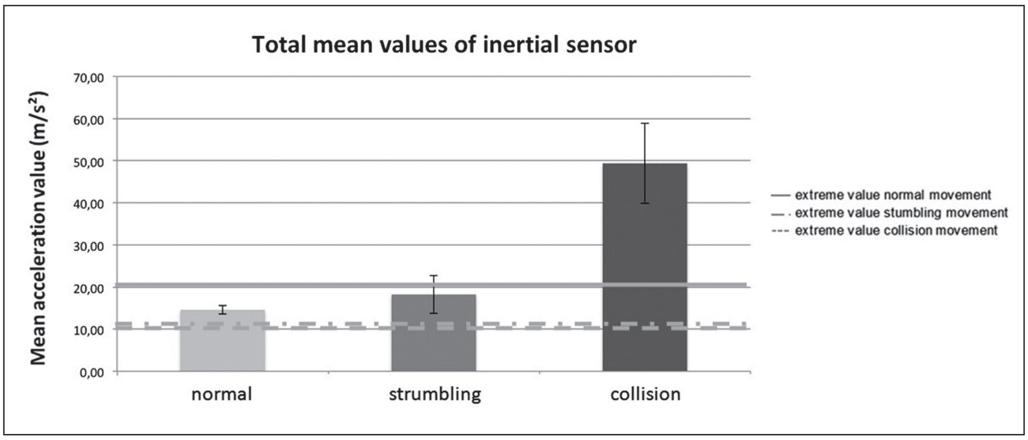

Figure 2: Mean and extreme value of inertial sensor for the individual subject

Fig.ure 3 indicates total mean values of force sensors (strain gauges) for all subjects, corresponding to the action. Furthermore, the extreme values which are relevant for the threshold value determination are drawn in. The maximum values for normal motion patterns [74.77 N] as well as the minimum values for stumbling [56.22 N] and during the collision [42.50 N] were indicated in the diagram of the mean values of the movement patterns of all subjects. A simulated bout of weakness is also included for comparison.

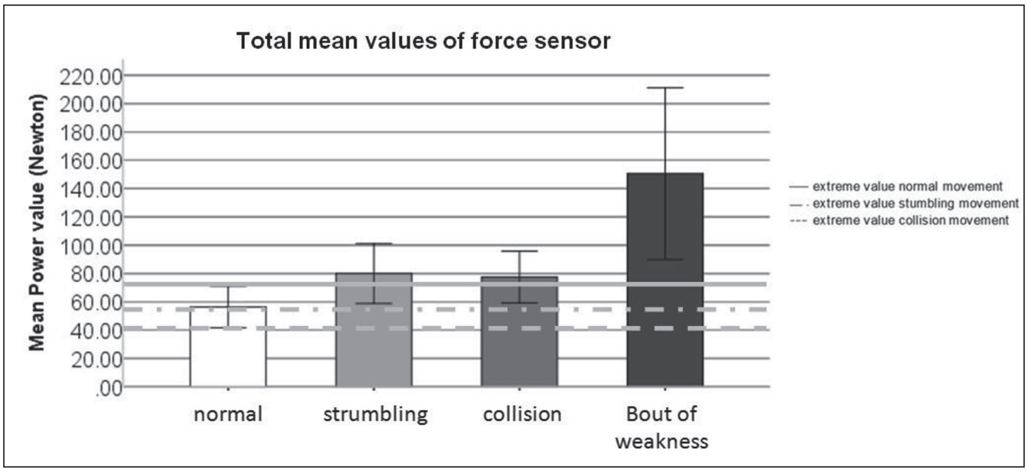

Figure 3: Total mean values of force sensor (strain gauges) for all subjects

Discussion

Using inertial sensors and force sensors (strain gauges) for both tests, no clear threshold value could be determined between normal movements and camber movements. A clear distinction would be apparent if the minimum extreme values of stumbling and collision were above the maximum extreme values of normal motion. When stumbling, it was noticeable that the mean values of stumbling are very close to the mean values of normal movement. One reason for the low mean values of the acceleration during the stumbling can be the support behaviour of the subject. Qualitative analysis showed that the subjects were very strongly supported by the forearms on the rollator during stumbling and the inertial sensors did not register any significant acceleration changes. After a first consideration of the total mean values, the acceleration data of the collision differ significantly from the acceleration values of a normal movement. In this respect, a better differentiation of the stumbling values by means of force sensors was shown. The advantage of the strain gauge based method is that it can also detect a muscle weakness. Therefore, a hybrid solution of force (strain gauges) and inertial sensors is a safe method of detecting falls. The type of application of force sensors between the user and the rollator is decisive for data quality. Therefore, it cannot be excluded that the data quality is improved by changing the position or connection. Difficulties in the detection of collisions occurred when the randomly placed collision object occurred between two steps, a moment characterised by reduced balance. In these cases, the speed of movement was so low that no difference could be detected between the normal movement and the braking acceleration. The subjects did not know the exact time of the stumbling or the collision stimulus, but knew that they would occur at an arbitrarily chosen time in the respective passage. The notes of the investigators indicate that the subjects were more reluctant to move in the corresponding passages. The assumption suggests that this behaviour has lowered the acceleration peaks. The subjects of the present study were sports students between the ages of 20 and 22 years. However, the target group of the sports and dance auditors are seniors. It can be assumed that the acceleration values for seniors are low, considering gait changes in the course of a human life (Klauser, 2009).

Conclusion

A threshold as previously defined could not be determined. Nevertheless, there are differences in the data between sports and dance movements compared to a falling movement. On the current data basis, it is possible to see in which measuring range the normal movement takes place. As a result, a threshold value over this normal range of motion [20.66m/s²; 74,77N], and the values above would then lead to brake activation. Thus, heavy support at high speeds or higher loss of balance might be avoided. In order to improve the validity of this threshold, the selection of subjects is important besides the confidence interval.

References

1. Ärzte Zeitung (2014). *Rollatortanz im Altenheim*, Zugriff am 03.04.2014 unter: http://www.aerztezeitung.de/panorama/article/856023/reportage-rollatortanz-altenheim.html.
2. DIN EN ISO 11199-2:2005-07. (2005). Gehilfen für beidarmige Handhabung - Anforderungen und Prüfverfahren - Teil 2: Rollatoren.
3. Freiberger, E., & Schöne, D. (2010). *Sturzprophylaxe im Alter - Grundlagen und Module zur Planung von Kursen*. Köln: Deutscher Ärzte-Verlag.
4. Gesundheitsportal Onmeda (2014). *Tanzlehrer lernen Rollatortanz*, Zu-griff am 04.04.2014 unter: http://www.onmeda.de/g-fit/rollatortanz-2688.html.
5. Kellogg International Work Group on the Prevention of Falls by the Elderly: The Prevention of falls in later life. Dan Med Bull. 1987; 34(Suppl 4). S.1-24.
6. HA, Flotter Foxtrott mit der Gehhilfe, Hamburger Abendblatt (24.10.2015) unter http://www.abendblatt.de/hamburg/von-mensch-zu-mensch/article206320181/Flotter-Foxtrottmit-der-Gehhilfe.html [abgerufen am: 20.01.2016).
7. McElhinney J., Koval K.J., Zuckerman J. (1998). Falls and the Elderly. *Archives of the American Academy of Orthopaedic Surgeons,* Vol. 2, Nr. 1, S.60-65
8. Mechling, H. (2005). Körperlich-sportliche Aktivität und erfolgreiches Altern. *Bundesgesundheitsbl- Gesundheitsforsch-Gesundheitsschutz 48*, S. 899-905.
9. RP Online (2011). *Rollator-Tanz soll Senioren fit machen*, Zugriff am 03.04.2014 unter:
10. http://www.rp-online.de/nrw/staedte/duesseldorf/rollator-tanz-soll-senioren-fit-machen-aid1.1209131.
11. Suica, Z., Romkes, J., Tal, A., & Maguire, C. (2015). Walking with a four wheeled walker (rollator) significantly reduces EMG lower-limb muscle activity in healthy subjects. *Journal of Bodywork and Movement.* S.1-9.
12. T-Online (2011). Rock'n'Rollator: Dieser Tanz hält Gehbehinderte fit, Zu-griff am 03.04.2014 unter:http://www.t-online.de/lifestyle/gesundheit/id_44132938/rollatortanz-haeltgehbehinderte-fit.html.

BILATERALLY ASYNCHRONOUS ONLINE CONTROL OF BALANCE RECOVERY

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Purpose: Tripping is one of the main causes of falls [1] in the elderly, who often take inappropriate recovery steps. Therefore, adjusting trip recovery steps might be beneficial for fall prevention. We have previously shown such adjustments are possible in young adults (YA) without threatening balance recovery [2]. Here we investigate the underlying neural mechanisms.

Methods: Sixteen YA walked over a walkway equipped with hidden obstacles that could cause a mid-swing trip. Participants were tripped 10 times in between a random number of normal walking trials; 5 trips included a forbidden landing zone (FZ, 30x50 cm), forcing step adjustments. We analyzed bilateral kinematic (foot position, ankle, and hip joint angles) and electromyographic data of gastrocnemius medialis (GM), tibialis anterior (TA), rectus femoris (RF), and biceps femoris (BF) for seven subjects (24.6±3.2 years) consistently successful at step shortening. After subtracting average normal walking activity, three trips performed at the start of the experiment were compared to five trips with a FZ using wavelet based functional ANOVA [3].

Results: Distance from the foot to the FZ at landing increased by 0.42 m during trips with a FZ. Step adjustments started in the tripped leg ~110 ms after trip onset by suppression of GAM, followed by longer latency changes leading to step shortening (BF 236 ms, GM 107 ms, TA 171 ms). Support leg muscle activity changes lagged by ~110 ms compared to the tripped leg and consisted of BF (299 ms) and GM (236 ms) inhibition and TA facilitation (300 ms), consistent with less need for propulsion.

Conclusions: Online control of foot trajectory during tripping is possible and starts in the tripped leg at latencies shorter than expected for voluntary activation. In contrast to simultaneously bilateral muscle activity during tripping, support leg adjustments occur with a delay. Hence, online control of trip recovery appears to be primarily a reaction of the tripped leg, quickly followed by support leg adjustments, probably to meet the new mechanical requirements of a shortened recovery step.

References

1. Robinovitch et al., Lancet, 2013
2. Potocanac et al., ExpBrainRes, 2014
3. McKay et al, J Neurophysiol, 2013

COMPARISON OF YOUNG SOCCER PLAYERS AND PHYSICAL EDUACATION STUDENTS AMONG THE SELECTED PRE-PLANNED AND NON-PLANNED AGILITY TEST

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Purpose: Agility can be defined as pre-planned or non-planned, depending on whether the movement structure is known in advance or not. Non-planned, agility is more common in actual sporting situations. The purpose of the study is to examine the differences between physical education students and young soccer players in pre-planned and non-planned agility test named “Global agility test - GLA”.

Methods: The time-based parameters for pre-planned and non-planned agility tests were determined using the Fit Light Trainer, a wireless training system which is comprised of seven led-powered lights and controlled via an Android application. The sample of subjects comprised 58 physical education students and 36 young soccer players.

Results: The results obtained were then statistically processed using the SPSS software package. Basic descriptive parameters were calculated for all the testing protocols. The differences between the pre-planned and non-planned test versions were evidenced by an independent T-test. The results of the study showed statistically significant differences in selected tests of pre-planned (non-reactive) ($p<0.01$) and non-planned (reactive) agility ($p<0.01$) between both sub-samples. In generally soccer player were significant faster in selected test of pre-planned (13.1%) and non-planned agility (14.3%). Significant differences were also observed in the reactive ($p<0.05$) and non-reactive agility test ($p<0.01$) for men as well as women.

Conclusions: The administered tests were found to be a useful diagnostic tool for assessing certain types of agility movement structures. The differentiation of the pre-planned and non-planned agility pointed to different bio motor abilities which evidently define the performance of athletes.

References

1. Young, W., & Willey, B. (2010). Analysis of a Reactive Agility Field Test. *Journal of Science and Medicine in Sport,* 13 (3), 376-378.
2. Krzepota J, Zwierko T, Puchalska-Niedbał L, Markiewicz M, Florkiewicz B, Lubiński W. (2015). The Efficiency of a Visual Skills Training Program on Visual Search Performance. *Journal of Human Kinetics*. 46(3), 231-240.

KINEMATIC ANALYSIS OF "UNDERSWING" ACTION ON HIGH BAR AND PARALLEL BARS AS METHOD OF SKILLS TRAINING PROGRESSION ESTABLISHMENT

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Purpose: The analysis of kinematics and electrical muscle activity of gymnasts performing clear circle to handstand on the high bar and "Basket" to hang on the parallel bars was carried out to establish the optimal kinematic parameters of performance, as well as the continuity and interaction in the learning process. Both skills have the same way of performance called the "underswing".

Methods: To determine the biomechanical parameters the hardware-software complex "Qualisys" was used. The electromyogram (EMG) was registered from 6 pairs of the upper limbs and trunk muscles (16-channel telemetry electromyograph "Megaemg"). The study involved 4 gymnasts of different level at the age of 12 to 24. Each gymnast performed on 5 attempts of the test exercises. As a result, the skills model kinematic parameters have established and that was confirmed by expert evaluation.

Results: The mutual positive effect of skills was revealed based on common athletes' EMG and angular kinematics data in the implementation phase. It was detected that the preparatory phase of the two movements in high qualified gymnasts performance 20-40% shorter than that of low-skilled gymnasts. That indicates the difference in the power of the exercise. This is confirmed by EMG and evaluation of the execution. The kinematics of the joint angles in the shoulder and hip joints indicates a higher energy intensity of high qualified gymnasts movements compared to younger gymnasts. At the same time highly skilled gymnasts have more stable kinematic and EMG data, which indicates the stability of formed skills.

Conclusions: The similarity of kinematics and dynamics of the two studied skills allows us to conclude the existence of the mutual positive effect in the training. At the same time, lower energy consumption performance of "Basket" to hang on the parallel bars in comparison with the more energy-intensive execution of a clear circle to handstand may be considered as the basis for establishing the continuity and consistency in the training of two given exercises.

References

1. Hiley, M.J., Wangler, R. and Predescu, G. (2009). Optimisation of the felge on parallel bars. Sports Biomechanics, 8(1), 39-51.
2. Yamada, T., Nishikawa, D., Sato, Y. and Sato, M. (2010). Effect of the velocity of the center of mass in performing the basket with half turn to handstand on parallel bars. Proceedings of the 28th conference of the international society of biomechanics in sports, 763-764.
3. Veličković S. et al., The kinematic model of the basket to handstand on the parallel bars. Journal of Physical Education and Sport, Vol. 9, No 1, 2011; 55-68.

NEURAL CORRELATES OF THE MOTOR SKILLS: A SHORT REVIEW

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Abstract

The acquisition of motor skill is characterised with an improvement of performance, automaticity and with the reduction in the variability of performance. Recent studies suggesting that distinguishable neural networks are recruited during different phases of motor learning and the role of some brain regions like M1, PFC, DLPC, basal ganglia and cerebellum were overviewed. Also the function of synaptic plasticity and motor memory in skill acquisition was emphasized.

Key words: *motor skill, automaticity, primary motor cortex, basal ganglia, synaptic plasticity, motor memory*

Introduction

Almost every voluntarily motor act we perform daily may be considered as a motor skill. They are all learned through repetitive practice, performed in order to reach a certain goal and with the intention to be accurate and/or quick. Some of them, like reaching for a cup of coffee, or handling the computer mouse, are very simple, while some, like performing a tennis serve or playing a violin are very complex. Motor skill learning according to Willingham (1998) is the process by which movements are executed more quickly and accurately with practice.

Lefebvre et al. (2015) recently refined the definition of motor learning according to the new insights and accomplishments in the field and described it as a training induced acquisition and improvement of motor performance (i.e., skills), persisting over time and characterized by a shift of the speed/accuracy trade-off, *automatisation* and reduction of performance variability.

"Automaticity", referred to by Poldrack et al. (2005), *as* a feature of human behavior of performing well practice task with little effort or cognitive control, may be considered as the main characteristic of the "*skill*". Recent neurobiology literature usually recognizes *fast* (or "*early*") and *slow* (or "*late*") phase (Dayan & Cohen, 2011; Doyon et al., 2003; Qian et al., 2015) in motor skill learning. Initial, or *fast* phase, is characterized by rapid improvement in performance what is followed by a *slow* phase of more gradual improvements as the skills consolidate and performance asymptotes (Yin et al., 2009; Floyer-Lea & Matthews, 2005; Dayan & Cohen, 2011). Therefore training for risky and challenging occupations demands intensive drill in order for motor and cognitive skills to be fully mastered. Thus, in high stress situation, when overall functioning declines because of the high level of arousal, a trained person will manage to successfully accomplish the assigned motor task.

The network which supports the acquisition of motor skills has been researched extensively, it comprises the primary motor cortex (M1), supplementary motor area (SMA), premotor cortex (PM), dorsolateral prefrontal cortex (DLPFC), cerebellum and basal ganglia (Lefebvre et al. (2015) and parietal areas (Doyon et al., 2003). However, Floyer-Lea and Matthews (2005) suggested that different phases of motor learning activates different networks, for example it seems that short-term learning primarily activates cortical network specific for particular movements, while long-term learning of motor skill increase the activation of bihemispheric cortical-subcortical network.

Involvement of different brain regions in motor skill learning

Learning of the motor skills includes interactions of different cortical and subcortical circuits which are important for some cognitive requirements in skill acquisition, particularly in the fast phase of learning (Doyon et al., 2003). The key region in all phases of motor learning is M1 (Dayan & Cohen, 2005), which contains somatotopic representation and is crucial for the executing of the movement. Further important structure is the prefrontal cortex (PFC), which is a collection of interconnected neocortical areas that sends and receives projections from virtually all cortical sensory systems, motor systems, and many subcortical structures (Miller & Cohen, 2001). The PFC has long been suspected to play an important role in cognitive control, in the ability to orchestrate thought and action in accordance with internal goals (Groenewegen, Uylings, 2000; Miller & Cohen, 2001). The cerebellum was traditionally assumed to be a motor structure involved in balance and coordination, while the DLPFC was thought to be critical for the most complex cognitive abilities (Diamond, 2000). It seems, however, that the cerebellum is important for the very same cognitive functions for which the DLPFC is critical, on the other hand, most cognitive tasks that require the DLPFC also require the neocerebellum (Diamond, 2000).

Further important structure in the acquisition of skill are the basal ganglia - nuclei in the forebrain that include the striatum (i.e., putamen and caudate nucleus), the globus pallidus, the amygdala, the substantia nigra and subthalamic nucleus, they are extensivelly connected with the thalamus, cortex and the midbrain structures, and have an important role in the cognitive control of motor sequencing (Harrington & Haaland, 1998). The recognition that Parkinson's disease (progressive disorder of the nervous system that affects movement, characterized by stiffness, tremors and difficulties in movement initiation) is primarily basal ganglia disorder, provided evidence of the important role of this region in motor behavior (Packard & Knowlton, 2002). (Packard & Knowlton, 2002). The largest input in basal ganglia is the striatum, which receives signals from the entire neocortex and projects processed information to the areas of frontal cortex which are implicated in motor planning and execution (Calabresi et al., 2007; Graybiel & Kimura, 1994). Many human, but also animal studies, confirmed that the striatum is an important node in the cortico-striatal circuitry in the acquisition of motor skills (Dayan & Cohen, 2011; Doyon et al., 2003).

Changes of activity in different brain regions during different tasks or phases of learning

Several studies examined the changes in activity of different brain regions during the acquisition of motor skills. Poldrack et al. (2005) investigated activation during different task conditions including single and dual-task performance. They found that, in single novice serial reaction time task with working memory load, the network comprising ventral premotor cortex and inferior prefrontal gyrus (PMv/IFG), DLPFC and the right caudate body, was activated, which suggested the involvement of these regions in cognitive control during early learning. Other areas, like dorsal premotor cortex and SMA were activated during all task conditions, disregarding secondary task, which indicates their involvement in motor programming. The development of the automaticity during practise leads to decreased activation in the PMv/IFG, DLPFC, and the right caudate regions (Poldrack et al., 2005). They also found that, during training, the activity of basal ganglia regions (putamen, globus pallidus, and caudate head) was lowered over the sequential trials but not for random trials, which proves that these regions are involved in the learning of motor sequence (Poldrack et al., 2005).

As summarized in Yin et al. (2009), during motor and procedural learning, changes occur in the activation of the striatum, in such a way that different regions of the striatum are differentially involved in motor learning. While dorsomedial or associative striatum (caudate in primates), was active in initial visuomotor learning, dorsolateral or sensorimotor striatum (putamen in primates) was involved in habits learning or automaticity acquiring. For instance, lesions of dorsolateral striatum in rodents disrupt forming and maintaining habitual responding (Yin et al., 2004).

Karni et. al. (1995) found increased activation of primary motor cortex after 3 weeks of motor sequence training, which indicated the possible enlargement of the M1 functional representation specific for the sequence. Nudo et al. (1996) also found that behavioral experience altered motor cortex showing in complexity and in the cortical areas dedicated to the representations of specific movements important for the learned motor skill.

Many other animal behavioral studies also revealed that motor skill learning generates functional changes in M1. As quoted in Qian et al. (2015), learning of novel reaching task in rats was associated with distal forelimb representations in M1, accompanied with structural changes in white matter, synaptogenesis, and spine formation.

During fast learning of sequential motor tasks, Floyer-Lea and Matthews (2005) observed modulated regional brain activity in DLPFC, M1, and presupplementary motor area (preSMA) where the activity decreased with progress of learning. Contrary, PM, SMA, parietal regions, striatum, and the cerebellum, showed increased activation with learning progression (Floyer-Lea & Matthews, 2005). Similar results were found in Shadmehr and Holcomb (1997), i.e. shortly after initial learning (within 6 hours), the brain engages new regions to perform the task; there is a shift from prefrontal regions to the premotor, posterior parietal, and cerebellar cortex structures.

The role of cerebellum in motor learning is still not quite clear, it seems that the cerebellum is most actively involved in early sequence learning (Doyon et al., 2003) due to its employment in the adjustment of movement kinematics to generate the motor output according to the sensory inputs. However, Krebs (1998) argues that cortico-striatal circuit is more important for early motor adaptation, whereas the cortico-cerebellar circuit is more critical during late adaptation learning. Regardless of that, researchers mostly agree that with the improvement of performance cerebellum activity decreases, which supports the notion of cerebellum involvement in error detection and correction (Doyon et al., 2003).

Memory and synaptic plasticity in the acqusition of skill

Memory is usually considered as composed of two major systems in the brain: *declarative* (explicit) and *procedural* (implicit or nondeclarative; Kandel, 2009; Willingham, 2002). Declarative memory is the memory for facts and events- for people, places, and objects, it requires medial temporal lobe and the hippocampus, while procedural memory is the memory for perceptual and motor skills and other forms of nondeclarative memory which involve numerous brain systems like cerebellum, the striatum, the amygdala, and sometimes even simple reflex pathways (Kandel, 2009). Procedural memory is gained without conscious awareness of the rules being learned whereas declarative memory is characterized by conscious awareness of the facts or events being learned (Willingham, 2002), the memory of "*how to do things*" may, after the consolidation, last for a lifetime for well-learned skills (Yin et al., 2009). Procedural learning, which is learning by doing (Willingham et al., 2002), is considered neurally independent of declarative memory, as evidenced in neuropsychological studies in which amnesic patients demonstrated intact perceptual skill learning despite seriously damaged declarative memory (Cohen & Squire, 1980). The prominent role in declarative memory have a hippocampus and medial temporal lobe, respectivelly, (Willingham, 2002) although is recently shown that hippocampus was active in motor sequence learning irrespective of whether the sequences were explicitly or implicitly acquired (Schendan et al., 2003).

Research studies of the mechanisms of memory storage include several approaches but probably the most influential is derived from Cajal's idea that learning results from changes in the strength of the synapse which was later renamed as *synaptic plasticity* (Kandel, 2009). Acquisition, consolidation and retention of motor skills is strongly linked with neuronal plasticity at the cortical and subcortical levels that evolves over time and engages different spatially distributed and interconnected brain regions (Dayan & Cohen, 2011). The ability of the brain to convert the experiences into memories is mediated by long-lasting, activity dependent synaptic changes which represent cellular model of processes of learning and memory (Calabresi et al., 2007). Two main forms of synaptic plasticity are long-term potentiation (LTP) and long-term depression (LTD), and they are expressed throughout the brain at excitatory synapses. For both processes, in regard to motor skill learning, dopamine (DA) is critically important. For example, in the PFC and in the striatum DA is involved in the synaptic plasticity by modulating the amount of LTP and LTD of the glutamatergic synapses (Molina-Luna et. al., 2009; Calabresi et al., 2007) while the elimination of dopaminergic terminals in M1 impaired motor skill acquisition, which was restored upon DA substitution. Interestingly, when M1 dopaminergic terminals were destroyed, after the task was acquired, there was no impact on the task, indicating that dopamine is necessary for the acquisition but not for the execution of the skill (Molina-Luna et al., 2009). However, neither the destruction of DA terminals in M1 nor DA receptor antagonists terminated learning completely, which means that DA in M1 probably modulates skill learning, but other modulators, such as acetylcholine, serotonin and GABA, may partially compensate.

Xu et al. (2009) observed rapid synapse formation during LTP *in vitro*, and they found that synapse formation in the neocortex begins immediately as animals learn a new task (within 1 h of training initiation). They concluded that stabilized neuronal connections are the foundation of durable motor memory. Shadmehr and Holcomb (1997) suggested that the acquired internal model (i.e. skill) becomes resistant to behavioral interference within 5 hours, that is, it consolidates. The *underlying mechanism* is not known but after the initial acquisition and with practice, activation moves to more posterior regions where the cerebellum assumes the greater role and is the possible site of motor memory (Shadmehr & Holcomb, 1997). Nevertheless, in regard to sequential motor skills, Doyon et. al. (2003) stated that long lasting retention depends on striato-cortical rather than cerebello-cortical networks.

Because of the importance of understanding the development of motor skills and both factors, those which lead to perfection, as well as those interfering with performance, further growth in neuroscience research may be anticipated, particularly due to the significant expansion of brain imaging methods.

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References

1. Albouy, G., Sterpenich, V., Balteau, E., Vandewalle, G., Desseilles, M., Dang-Vu. T., et. al. (2008). Both the hippocampus and striatum are involved in consolidation of motor sequence memory. *Neuron*. 58(2):261-272.
2. Calabresi, P., Picconi, B., Tozzi, A., and Di Filippo, M. (2007). Dopamine-mediated regulation of corticostriatal synaptic plasticity. *Trends in Neurosciences*. Vol.30 No.5
3. Cohen, N. J., & Squire, L. R. (1980). Preserved learning and retention of pattern analyzing skill in amnesia: Dissociation of knowing how and knowing that. *Science*, 210, 207-209.
4. Dayan, E., and Cohen, L. G. (2011). Neuroplasticity subserving motor skill learning. *Neuron*, 72, 443-454. doi: 10.1016/j.neuron.2011.10.008
5. Diamond, A. (2000). Close interrelation of motor development and cognitive development and of the cerebellum and prefrontal cortex. *Child Development*, Vol 71, pp. 44-56
6. Doyon, J., Penhune, V., Ungerleider L. G. (2003). Distinct contribution of the cortico-striatal and cortico-cerebellarsystems to motor skill learning. *Neuropsychologia*, 41 252-262
7. Floyer-Lea, A., and Matthews, P.M. (2005). Distinguishable brain activation networks for short- and long-term motor skill learning. *Journal of Neurophysiology*. 94, 512-518.
8. Foerde, K., and Shohamy, D. (2011). The role of the basal ganglia in learning and memory: Insight from Parkinson's disease. *Neurobiology of Learning and Memory*, 96, 624-36.

9. Graybiel,A., M. and Kimura, M. (1994).The Basal Ganglia and Adaptive Motor Control. *Science*. Vol. 265, 1826-183.
10. Groenewegen, H.J., Uylings, H.B. (2000). The prefrontal cortex and the integration of sensory, limbic and autonomic information. *Progress in Brain Research*. 126:3-28.
11. Harrington, D.L. and Haaland, K.Y. (1998). Sequencing and timing operations of the basal ganglia. In T*iming of behavior: Neural, psychological and computational perspectives*, (eds. D.A. Rosenbaum and C.E. Collyer), pp. 35-61. MIT Press, Cambridge, MA
12. Hasher, L. & Zacks, R.T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General*, 108, 356-388.
13. Kandel, E.R. (2009). The Biology of Memory: A Forty-Year Perspective. *The Journal of Neuroscience*. 29: 12748-12756.
14. Karni, A., Meyer, G., Jezzard, P., Adams, M.M., Turner, R., Ungerleider, L.G. (1995). Functional MRI evidence for adult motor cortex plasticity during motor skill learning. *Nature*. 377:155-8.
15. Krebs, H.I., Brashers-Krug, T., Rauch, S.L., Savage, C.R., Hogan, N., Rubin, R.H., et al. (1998). Robot-aided functional imaging: application to a motor learning study. *Human Brain Mapping*; 6:59-72.
16. Lefebvre, S., Dricot, L., Laloux, P., Gradkowski, W., Desfontaines, P., Evrard, F., Peeters, A., Jamart, J. and Vandermeeren, Y. (2015). Neural substrates underlying motor skill learning in chronic hemiparetic stroke patients. *Frontiers in Human Neuroscience*, 9:320. doi: 10.3389/fnhum.2015.00320
17. Molina-Luna, K., Pekanovic, A., Röhrich, S., Hertler, B., Schubring-Giese, M., et al. (2009). Dopamine in Motor Cortex Is Necessary for Skill Learning and Synaptic Plasticity. *PLoS ONE*, 4(9): e7082. doi:10.1371/journal.pone.0007082
18. Nudo, R.J., Milliken, G.W., Jenkins, W.M., Merzenich, M.M. (1996). Use-dependent alterations of movement representations in primary motor cortex of adult squirrel monkeys. *The Journal of Neuroscience*, 16:785-807.
19. Poldrack, R.A., Sabb, F.W., Foerde, K., Tom, S.M., Asarnow, R.F., Bookheimer, S.Y., Knowlton, B.J. (2005). The neural correlates of motor skill automaticity. *The Journal of Neuroscience*, 5(22):5356-5364
20. Packard, M.G. and Knowlton, B. J. (2002). Learning And Memory Functions Of The Basal Ganglia. *Annual Review of Neuroscience*. 25:563-93
21. Qian, Y., Forssberg, H., Diaz Heijtz., R. (2015). Motor Skill Learning Is Associated with Phase-Dependent Modifications in the Striatal cAMP/PKA/ DARPP-32 Signaling Pathway in Rodents. *PLoS ONE*, 10(10): e0140974. doi:10.1371/journal.pone.0140974
22. Schendan, H.E., Searl, M.M., Melrose, R.J., Stern, C.E. (2003). An fMRI study of the role of the medial temporal lobe in implicit and explicit sequence learning. *Neuron*. 37:1013-1025.
23. Shadmehr, R., Holcomb, H.H. (1997).Neural correlates of motor memory consolidation. *Science*. 277(5327):821-5.
24. Yin, H. H., Knowlton, B. J., & Balleine, B. W. (2004). Lesions of dorsolateral striatum preserve outcome expectancy but disrupt habit formation in instrumental learning. *European Journal of Neuroscience*, 19(1), 181-189.
25. Yin, H.H., Mulcare, S.P., Hilario, M.R., Clouse, E., Holloway, T., Davis et. al. (2009). Dynamic reorganization of striatal circuits during the acquisition and consolidation of a skill. *Nature Neuroscience*. 12, 333-341.
26. Xu, T., Yu, X., Perlik, A.J., Tobin, W.F., Zweig, J.A., Tennant, K., Jones, T., Zuo, Y. (2009). Rapid formation and selective stabilization of synapses for enduring motor memories. *Nature*. 462(7275):915-9.
27. Willingham, D.B. (1998). A neuropsychological theory of motor skill learning. *Psychological Review*. 105, 558-584.
28. Willingham, D. B., Salidis, J., Gabrieli, J.D.E. (2002). Direct Comparison of Neural Systems Mediating Conscious and Unconscious Skill Learning. *Journal of Neurophysiology*, 88: 1451-1460.

EXERCISES BASED ON NEUROPLASTICITY PRINCIPLES INCREASE MOBILITY IN ELITE SENIOR FOOTBALL PLAYERS

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Abstract

To achieve adequate range of movement in joints is an important determinant of training status in football. It enables a biomechanically correct performance of certain movement structures and contributes to the prevention of sports injuries. The Feldenkrais method offers the possibility of learning and optimization of movement, which, consequently, through inhibition of redundant muscular activity may enable an increase in the range of movement (ROM). Previous studies have shown contradictory results on the influence of Feldenkrais method on increase of ROM. The goal of this research has been to compare and quantify the influence of work according to Feldenkrais method and classic stretching exercises on ROM in top-level football players. Subjects were randomly placed into 3 groups: Group I practiced Feldenkrais method and had an average initial value of Reach 1=0.57±11.4 cm, and of final Reach 2=6.1±10 cm; Group II practiced stretching exercises and achieved an average initial value of Reach 1=5.1±3.1 cm, while the final Reach was 2=6.9±3.3 cm; and the Control group (Group III) had an average initial value of Reach 1=3.9±4.3 cm, and the final value of Reach 2=5.1±4 cm.

Key words: *Feldenkrais method**,** football**,** neurophysiology, 3D kinematics, stretching*

Introduction

Football is a complex sports game including a large number of different movements, which by its integration makes what is called a football skill (Andrzejewski et al., 2013). Among other characteristics, skill is described as a quality of movement. It can be judged from the perspective of biomechanical performance of a certain element, and also through interrelationship of stability and mobility of particular body segments of importance for this element. Freedom of movement is the prerequisite for efficient transfer of forces through the skeleton, which may represent a basis for good biomechanical performance. Mobility, i.e. the range of movement, often identifies with flexibility, both in diagnostics and in the training procedures (Knudson, 2007). Therefore, an established praxis for increasing the range of movement in football players often is a training of passive and active stretching. This kind of approach, however, does not usually produce long-term results. The explanation for this phenomenon might be that the cause for shortened muscle may be in the nervous system action, i.e in motor programs. The information coming from the neural system is the one that activates or inhibits a muscle. The phenomenon found most often in bad organization of movement is redundancy of muscular activity and development of motorics through inhibition. Feldenkrais method by its approach to learning through awakening, direction of attention, and slow performance offers a basis for corresponding changes. (Feldenkrais, 1990).

Chinn at al. (1994) researched the effects of one Feldenkrais intervention on 23 examinees divided into two groups. The experiment was quantified by the level of perceived exertion and by the hook-lying functional reach task, noted pre and post-treatment. The group that practiced Feldenkrais significantly improved in the perceived exertion but not in the reach task, while the group that practiced sham Feldenkrais treatment did not improve in both tasks. James et al. (1998) researched 48 students, divided into 3 groups: Feldenkrais, relaxation, and control group. The Active knee extension test was performed prior to the first session, prior to the forth and after the final session of intervention. There were no significant differences between groups in the hamstring length. Hopper et al. (1999) investigated the influence of Feldenkrais method on 79 healthy examinees allocated into two groups: Feldenkrais and control group. Flexibility was estimated by the Sit&Reach test, perceived exertion by Borg's scale and hamstring length by the Active knee extension test. After one lesson examinees were tested again. The Feldenkrais group significantly improved flexibility and no significant differences were found in the perceived exertion or hamstring length. Dunn and Rogers (2000) investigated the effect of the Feldenkrais method on only one side, and then compared two sides of the body. The study included 12 examinees (age 18-28 yrs) who made the Sit&Reach test before and after intervention. 10 of them reported better sensation on one side, for 8 the second test was indeed better on that side. Stephens et al. (2006) researched 33 examinees who were assigned randomly into two groups: Feldenkrais and control group. The experimental group practiced for 3 weeks. The hamstring length was measured by using the Active knee extension test, before and after the intervention. The experimental group showed significantly better results compared to the control group.

Functionally and neurophysiologically speaking, mobility can be linked to balance i.e. reliable support. A timely inclusion of agonists and exclusion of antagonists in motion - reciprocal inhibition is also important (Knudson, 2013; Hall, 2016). The muscle activity can be activated at will, as well as unintentionally due to variously acquired habits.

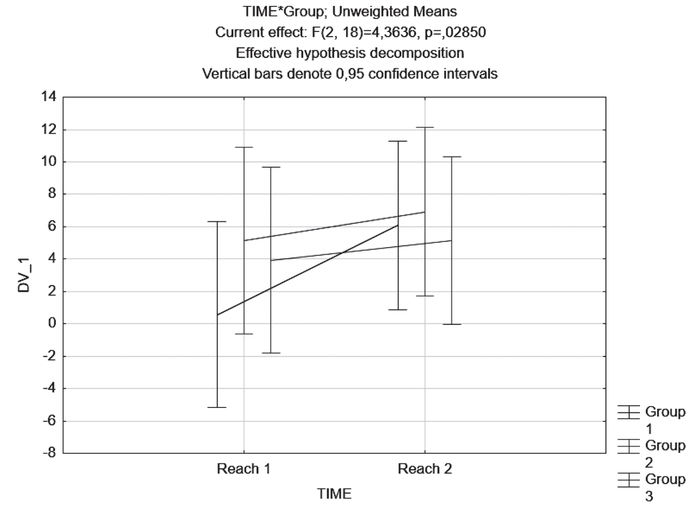
By releasing excess effort, with ease and greater clarity, the ideal position of stability can be reached. (Feldenkrais, 1987). When using this method the choice and precise execution of exercises is crucial. This can also be the reason not much research has been done in this area, and when it was done, results were often conflicting. Hence, it was decided research of the effects on the influence of mobility of kinesthetic training of the Feldenkrais method (1.) compared to the classical stretching method (2.) in a controlled group (3.) would be conducted.

Methods

Research was carried out in May of 2016 at Football club Dinamo Sports Center. The sample comprised of 21 examinees, professional football players of the highest Croatian national rank, age 20.95 ± 4.48 yrs, height 183.00 ± 6.93 cm and of the body mass of 77.93 ± 7.63 kg. All examinees initially partook in the Stand & Reach test (S&R) with a delay of 2 seconds, which was necessary in order to disconnect the influence of the myotatic reflex (stretch reflex) and thus enable the examiner to read the number on the scale (Reach 1) (Hall, 2016; Knudson, 2007). Examinees were then randomly divided into 3 groups with 7 examinees in each group. Group I used the Feldenkrais method (FM) which comprised of 8 variations of the exercise "The Pelvic Walk". Each exercise was performed about 20 times, in a research rather than a repetitive manner, but in search of an easier option of movement. Group II conducted standard stretching exercises (12 in 2 series, holding for 30 seconds). Group III was the control group, meaning the examinees did not partake in any protocol. After 15 minutes of the commencement of a certain protocol, all 3 groups repeated the S&R test and results were measured (Reach 2). The performance of the tests (the initial and final one) were taped with a GoPro 4 Hero camera mounted sideways under an angle of 90 degrees in relation to the examinee, with a sampling frequency of 60 Hz. The video was processed by the Ariel Performance Analysis System (APAS) a program for kinematic analysis. Angles between 4 points of the Modified Dempster model were observed (Dempster, 1955), tip of the toe (TOE), ankle (ANK), knee (KNEE), hip (TROH) and shoulder (ACR). During the implementation of the S&R test examinees were standing on a zebris platform (ZEBRIS) by which the ratio of the pressure between the front and back of the foot was monitored. Parameters were synchronized and processed in the same time unit. The gathered results were registered and processed by software package Statistica 12, licencened by the Faculty of Kinesiology, University of Zagreb. By using the Shapiro-Wilk test normal distribution was checked. On the reach results in the initial testing (Reach 1) statistical method ANOVA was used with the goal to check the non-existence of statistical relevance of differences between 3 groups of examinees before the experiment was carried out. The homogeneity of the distribution of the results for the first and second testing (Reach 1 and Reach 2) was checked by the Levene's test. The existence and importance of differences between the initial and final tests including groups was tested by ANOVA for repeat testing, after which the Post Hoc Tukey HSD was used to analyze within groups where significant differences in the Reach test results between the first and second testing were detected. A significant difference was only found in Group I, the t-test was then used for dependent samples on the kinematic and kinetic variables to determine the space differences in performances.

Results

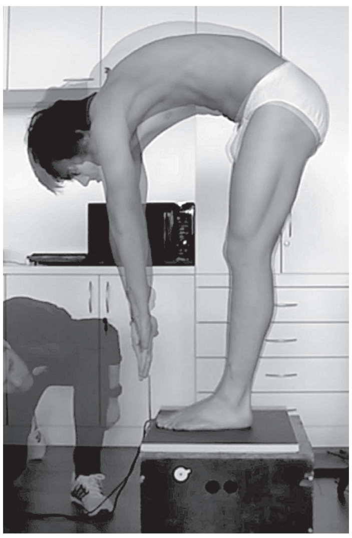
The normality of the distribution of results reached on the initial reach measurement (Reach 1) was checked and verified by the Shapiro-Wilk test value of $W=0.92$, for $p>0.05$. Hence, it was decided the parametric method would be used in the further analysis of results. The use of statistical method ANOVA checked and verified the non-existence of statistical relevance of differences between 3 randomly chosen groups of examinees, value of $F=0.75$ with the possibility of error $p<0.05$. The Levene test determined homogeneity of the distribution of test results Reach 1 and Reach 2, value of F(Reach 1)=6.6, F(Reach 2)=11.2, and everything for $p<0.05$. ANOVA method indicated a significant difference in results for repeat testing of the time point component between the initial and final testing, value of $F=19.4$ for $p<0.05$. In the combination of time and group component, a significant statistical difference between the 2 tests was determined, value of $F=4.4$ for $p<0.05$. Guided by previous results, the Post Hoc Tukey HSD test was used for the time and group component where the existence of a significant difference was detected between the first and second testing but only for Group I, value of $F=0.0014$ for $p<0.05$. Considering the positive changes in Group I, the t-test for dependent samples was used to analyze whether there was a difference in the kinematic and kinetic variable that describes the method of performing the test. Although it was determined the greatest difference of the average value was in the angles of the hip and shoulders, only the angle of the shoulders was statistically significantly higher in the final measurement. The average value of the initial results were 108±15 degrees of the final measurement which was 113±13 degrees, $t=-3.03$ for $p<0.05$. The average value and the trend of the initial and final results for all 3 groups can be seen in Graph 1. Group I had the average initial value of Reach 1=0.57±11.4 cm, and in the final value of Reach 2=6.1±10 cm. Group II had the initial average value of Reach 1=5.1±3.1 cm, while the final value of Reach 2=6.9±3.3 cm. Group III had the average initial value of Reach 1=3.9±4.3 cm, and the final value of Reach 2=5.1±4 cm.



Graph 1: Average values of S&R tests (Reach 1 and Reach 2) in two different time points for each of three groups.

Discussion and conclusions

All 3 groups on an average had better results in the final measurement, however, only the results of Group I (FM) were statistically significant and therefore the most important. The result might be due to the fact that Group I had very low values in the initial measurement, with two very poor results. The positive changes in the results of Group I were shown through a significant increase in the angle of the shoulder joint, although there were differences in the angles of the other joints. The assumption is that the examinees developed different strategies for a better reach in the final testing. Group II (stretching) on an average also made a positive shift but not statistically significant. Group III was also average, but not significantly, it was better in the second measurement, which was coincidently at its lowest. The interpretation can be linked to learning and adjusting to the test. Focus on the test can often be aimed at flexibility of the muscles of the hamstrings and the lower part of the spine. However, it should be pointed out that it is to do with the entire kinetic chain – from the points of support, distribution of weight and mobility of the pelvis against the knee joint up to the adaptation of the spine for arm extensions. In conclusion the Feldenkrais method of exercise enhances function with movement development, enables better biomechanics of movement meaning it gives better support to the skeletal musculature as well as a more efficient synergy of muscle activities (Picture 1). Owing to the biomechanically better executed movement, excess muscle activity disappears, while mobility and motoric control of movement increases (Feldenkrais, 1987). Feldenkrais method offers variability for a greater number of movement options for ankles, hips, spine and shoulders. Further research should explore the effects of prolonged use of this protocol on a larger sample and on more diverse types of examinees. Feldenkrais method doesn't affect everyone equally hence the kinesthetic aspect of performing exercises should be introduced into the training process with the goal of achieving real function of movement which indirectly influences stability and mobility and as a result prevents injuries.



Picture 1: Example of one player, before and after application of Feldenkrais method.

References

1. Andrzejewski, M., Chmura, J., Pluta, B., Strzelczyk, R. and Kasprzak, A. (2013). Analysis of sprinting activities of professional soccer players. Journal of strength and conditioning research, 27(8), 2134-2140.
2. Chinn J, Trujillo D, Kegerreis S, Worrell T. (1994). Effect of a Feldenkrais Intervention on Symptomatic Subjects Performing a Functional Reach. Isokinetics and Exercise Science. 4(4): 131-136.
3. Dempster, WT (1955). Space Requirements of the Seated Operator. WADC Technical Report 55-159, Wright-Patterson Air Force Base, Ohio
4. Dunn, P.A., & Rogers, D.K. (2000). Feldenkrais sensory imagery and forward reach. Perceptual and Motor Skills, 91, 755-757.
5. Feldenkrais, M. (1990). Awareness through Movement. Harper Collins, San Francisco.
6. Hall, J. E. (2016). Guyton and Hall Textbook of Medical Physiology. Elsevier. Philadelphia.
7. Hopper C, Kolt GS, McConville JC. The effects of Feldenkrais Awareness Through Movement on hamstring length, flexibility and perceived exertion. J Bodywork Movement Therapies 3(4): 238-247, 1999.
8. James, M., Kolt, G., McConville, J., Bate, P. (1998). The effects of a Feldenkrais program and relaxation procedures on hamstring length. Aust J Physiother. 1998;44(1):49-54.
9. Knudson, D. (2007). Fundamentals of Biomechanics. Springer Science+Business Media, LLC, 233 Spring Street, New York, USA.
10. Stephens J. Davidson J. Derosa J. Kriz M. Saltzman N. Lengthening the hamstring muscles without stretching using “awareness through movement”. [Journal Article. Randomized Controlled Trial] Physical Therapy. 86(12):1641-50, 2006 Dec.
11. Šoš, K. (2010). Feldenkrais method in training of speed, agility, explosivity and flexibility. Conditioning training for sports 2010; U: Jukić, I., Šalaj, S., Milanović, L., Gregov, C., Trošt-Bobić, T. UKTH and the Faculty of Kinesiology, Zagreb.

Physical Education

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QUALITY PHYSICAL EDUCATION THROUGH MODELS-BASED PRACTICE

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Abstract

In 2017, the United Nations Educational, Scientific and Cultural Organization (UNESCO) outlined the benefits of quality physical education, led by qualified teachers: inclusive, flexible, interactive classes that motivate all children to push their boundaries regardless of their physical capacity, background, religion, or gender. Quality physical education improves children's self-confidence, concentration and communication skills, enabling them to become active, healthy, responsible, well-rounded citizens. Sadly, the UNESCO does not tell us exactly how to become qualified teachers, and our response is: models-based practice. In this article, we review the foundations of this approach, the basics of the main pedagogical models: consolidated (sport education, teaching games for understanding (TGfU), cooperative learning, and teaching for personal and social responsibility) and emerging (adventure education, health-based physical education and physical literacy). Since there is no single model capable of fitting all the physical education contexts, several pedagogical models have been hybridized to reach their fullest potential.

Key words: *pedagogical models; hybridization; student-centred; situated learning*

Introduction

In a recently launched video, the UNESCO outlined the benefits of quality physical education (PE), led by qualified teachers: inclusive, flexible, interactive classes that motivate all children to push their boundaries regardless of their physical capacity, background, religion, or gender. The video highlights that quality PE improves children's self-confidence, concentration and communication skills, enabling them to become active, healthy, responsible, well-rounded citizens. Sadly, it does not tell us how to become qualified teachers that can produce quality PE. However, the response is: models-based practice. The idea of using a model to teach PE reflects a plan to adapt the curriculum to each specific context and to develop appropriate instructional frameworks which can guide instruction. Jewett, Bain and Ennis (1995, p. 15) defined curriculum model as: "a general pattern for creating or shaping program designs that is based on a conceptual framework and incorporates identification of learning goals, selection and structuring of program content". Later, Metzler (2005, p. 13) introduced the concept of *instructional model*: "a view of instruction that included simultaneous consideration of learning theory, long-term learning goals, context, content, classroom management, related teaching strategies, verification of process, and the assessment of student learning". A few years later, Haerens, Kirk, Cardon, and De Bourdeaudhuij (2011, p. 324), coined the term *pedagogical models:* "highlights the interdependence and irreducibility of learning, teaching, subject matter and context". Eight pedagogical models can be considered *consolidated*: direct instruction, sport education, teaching games for understanding (TGfU), personalized system of instruction, peer teaching, inquiry teaching, cooperative learning, and teaching for personal and social responsibility. To be included in this list, "an instructional approach should have deep and strong theoretical foundations, its development and implementation should be carefully researched, and the model should also be tested in many different school settings to assess if it is capable of being used efficiently and effectively for [its] intended purposes" (Metzler, 2005, p. 14). Other pedagogical approaches have raised and evolved, gaining international recognition: adventure education, health-based PE and physical literacy. We have called them *emerging*, because they are being widely implemented and researched to assess their real impact on students. However, many agree that there is no single model capable of addressing the multifaceted challenges that PE teachers have to face in their classes (Casey, 2014). Consequently, different pedagogical models have been hybridized to meet specific demands and enhance the different potentialities that each model has alone. The internationally extended use of pedagogical models and their hybridizations in PE has been called *Models-Based Practice*. Authors such as Casey (2017) believe that there is a need to use a range of pedagogical models to fit the existing demands of today's schools, provide students with the most appropriate educational frameworks and help them achieve the best possible outcomes.

Consolidated models

Cooperative Learning (CL). This pedagogical model is probably the most important one, because cooperation is "at the heart" of many of the other models (Metzler, 2005). Based on the ideas of several authors (Casey, 2012; Johnson & Johnson, 2014; Metzler, 2005), we define CL as a pedagogical model where students learn with, from and for other students in an teaching-learning framework that promotes positive interdependence and interaction, and where teacher and students act as co-learners. The basic goal of a CL structure is to help students learn together in small heterogeneous groups. Its basic features are (Johnson & Johnson, 2014): (1) *Interpersonal and small-group skills:* students must learn to listen to each another, to share space and/or equipment, to support group members, to give and/or receive feedback, to discuss ideas without hurting others....; (2) *Face-to-face interaction*: students should be in direct contact with one another while performing the different activities; (3) *Group processing:* communication among group members is crucial to assess the whole process; students should be forced to discuss ideas that could help them find the solutions; at the end of the activity/class students should go over what has happened to integrate that learning and assess the process; (4) *Positive interdependence:* the basic idea is that individuals succeed only if their group mates do it, too; this sends a clear message: we need each other to achieve a positive a outcome; if one fails or loses, there is no cooperation; (5) *Individual accountability*: in a group each student must feel that he/she is responsible for the group's success, that he/she has a duty. Unfortunately, relations among group members are many times asymmetrical, because individuals are not naturally-born to cooperative and they must learn how to do it. Therefore, CL should be thoughtfully introduced in the schools. The cooperative learning cycle (Fernandez-Rio, 2016) is a framework that helps educators safely introduce this pedagogical model in PE through a three-phase structure: (1) *Building group cohesion*: the goal is to build learning contexts where all students can truly work together; it is divided in four sub-phases: introduce themselves, break the ice, trust one another and get to know yourself; (2) *Cooperative learning as the content*: the goal is to teach students that they can learn to use CL through simple techniques such as collective score and pairs check performance; and (3) *Cooperative learning as the framework*: the goal is to expose students to more difficult techniques such as think-share-perform and Jigsaw.

Sport Education. The basic aim of this model is to provide all students in PE with meaningful sporting experiences to become competent, literate and enthusiastic sportspeople (Siedentop, Hastie & van der Mars, 2011). The six basic features of the Sport Education Model (SEM) are: (1) *Seasons*: learning units are structured like sport seasons; they must last longer than traditional PE units (usually above 10 sessions); (2) *Affiliation*: students are grouped in mixed-ability teams for the whole season (unit) to foster membership; each team must create its own greet, clothing, flag, pet...; (3) *Formal competition*: the complete season must be structured around a series of scheduled competitions (pre, season, post) under different formats (single event, dual meet, progressive season...); (4) *Culminating event*: the season must finish with a festive competition to celebrate the achievements of all teams, and give awards; (5) *Record keeping*: individual and/or group accomplishments are recorded and published during the whole season for feedback, set goals, motivate....; they are more than just the result of a match; points for fair play conduct, enthusiasm, cooperation, improvement... must be awarded too; and (6) *Festivity*: the whole season must encourage a festive atmosphere: excitement, joy, thrill, happiness.... Besides these basic features, another fundamental element of the SEM is the *students' roles*. All pedagogical models have a common trait: they are student-centred. This means that students should play active and leading roles within the PE classes. Referee, coach, captain, journalist, photographer, manager...., all of them are ways to involve all students in the "action". Even the injured ones can play an active role in the class and not "sit away from the action". Each teacher must choose the necessary roles, based on the context (i.e., sport, number of students on each team, resources...), to create students-centred PE classes.

Teaching Games for Understanding (TGfU). The basic idea is that in games / sports teaching, tactics do not have to wait for the development of skills to be taught (Bunker & Thorpe, 1982). The original model evolved into what Oslin and Mitchell (2006) called game-centred approaches: TGfU, play practice, tactical games model, and game sense. The main features of this pedagogical approach are: (1) *Transference between sports*: games/sports can be classified based on the principles of play that they have in common (target, moving target, divided court, fielding and run-scoring, wall, and invasion); therefore, tactical skills can be learned in one sport and transferred into another one of the same category; (2) *Game representation*: adult-size sport should be modified to be developmentally appropriate for the students; teachers can modify any structural element (number of players, playing field, size of implement and/or ball, target, rules....); (3) *Game exaggeration*: teachers must modify games to highlight tactical elements for students to practice and learn; and (4) *Authentic assessment*: students should be assessed during game play, and not in isolated situations. TGfU has a 6-step structure (Bunker & Thorpe, 1982): (1) *Game form*; (2) *Game appreciation*; (3) *Tactical awareness*; (4) *Decision making*; (5) *Skill execution*; and (6) *Performance*. The Tactical Games approach offers a simpler format to follow (Collier, Perlman, & Fisette, 2009): (1) *Game*: an initial modified game is used to make the students experience the problem(s) to solve (game appreciation); (2) *Questions / answers*: through a series of questions the teacher tries to help students find the solutions (tactical and/or technical skills) to the problems faced in the previous game (tactical awareness); (3) *Practice*: it helps students rehearse and refine those solutions (skills) through specifically designed tasks; and (4) *Game*: the same or a modified version (simpler or more complex) of the initial game is use to put into practice the skills (technical / tactical) rehearsed.

Teaching for personal and Social Responsibility (TPSR). The main aim of this model is to help students acquire values through physical activity (Hellison, 2011). They are faced with responsibility levels: (1) *Respect*: self-control, respect the rights and feelings of other people in the class, the right to be included; (2) *Effort and participation*: self-motivation, exploration, effort, to get along with classmates; (3) *Self-direction*: on-task independence, set goals, courage to resist peer pressure; (4) *Helping others and leadership*: caring and compassion, sensitivity and responsiveness, inner strength; and (5) *Transference*: carrying all the previous outside the PE class. The first three relate to personal responsibility, while the other three try to promote social responsibility. The goal for the students is to move from the lower to the higher levels. The daily program format follows a five-part structure (Hellison, 2011): (1) *Relational time*: the teacher must be in direct contact with his/her students to promote relationship and confidence, an provide advice, guide and support; (2) *Awareness talks:* they are used to begin every session and outline the lesson responsibility goals, (3) *Physical activity plan:* it includes activity goals for the session; (4) *Group meetings*: at the end of each session, the students and the teacher discuss about the responsibility levels worked during the session; he/she can ask questions like: did you respect your teammates? (level 1), did you set goals for yourself in the session? (level 3), did you help a classmate? (level 4); and (5) *Self-reflection time*: it is used to evaluate the students' responsibility goals set at the beginning of the class; it can be performed using a quick thumbs-up, thumbs away or thumbs-down response or a brief reflection about the students' behaviour at the selected goal level. Other strategies can be used for specific problems: (a) *The accordion principle*: increase or decrease practice time depending on the behaviour; and (b) *The negotiation and talking bench*: students are sent to a specific area to solve a problem between them.

Emerging Models

Adventure education (AE). This pedagogical model is considered "a form of experiential education that uses adventure to achieve educational and developmental goals, forcing students to use their senses (i.e., sight, hearing, touch, kinaesthetic) for learning" (Fernandez-Rio, 2015, p. 5). In this framework, students participate in adventurous activities to acquire physical, cognitive, and affective skills (Dort et al., 1996). It is rooted in many activities and programs conducted in the outdoors to teach leadership skills, to promote character development and to develop environmental consciousness. Unfortunately, limitations such as location (very far from the schools) or costs (these activities are usually expensive) forced educators to find a way to bring all these programs' ideas and activities into the PE class. The main elements of AE are: (1) *CL*: many adventure activities are performed by the students in isolation, developing intrapersonal skills, but to develop interpersonal connections teachers must modify the tasks' structures to make them cooperative; students should be forced by the tasks to work in groups; (2) *Safe challenge*: "adventure" means risk; however, it can be objective (the real risk an activity holds) and subjective (the risk that a person thinks an activity has); every activity has just one objective (real) risk, but its subjective (perceived) risk varies from one individual to another; in AE, teachers must face students with a challenge that produces uncertainty, but that they can endure; (3) *Problem solving*: AE activities must be designed to provide students with challenges they must solve as a group, effectively using each group member's strengths; consequently, students are forced to develop problem-solving skills; (4) *Enjoyment*: although challenge and risk can be threatening and scary, AE sessions must encourage a joyful environment where excitement, enthusiasm, pleasure, thrill, happiness, ecstasy..... happen constantly; and (5) *Creative use of resources*: schools do not always have the necessary equipment to re-create everything that the outdoors can offer (rocks, trees, rivers, ponds...); many companies offer equipment for adventure activities (indoor climbing walls, firecracker ladders, cargo nets, rope ladders....), but they can be very expensive or they may require too much space; teachers can use and/or modify the equipment they already have in their gymnasiums: wall bars, vault blocks, benches, ropes, big mats...., or bring recycled materials: tyres, wood sticks, plastic containers...

Health-Based PE. The main goal of this model is very simple: help PE teachers promote a physically active live in all their students (Haerens et al., 2011). However, it does not include a specific set of activities, tasks or contents to implement. The idea is that this framework can be used with any content. It is based in the *Self-Determination Theory of motivation* (Deci & Ryan, 2000), one of the most widely used theories to understand motivation in humans. People's motivation occur on a self-determination continuum, from the most self-determined type, intrinsic, to the least: external and amotivation). Intrinsic motivation means doing an activity for its inherent interest, while extrinsic motivation means that an activity is performed because it holds a reward. Finally, amotivation is the lack of motivation to perform an activity. Individuals' motivation is shaped by the fulfilment of *three basic psychological needs* (Vallerand, 2001): (1) *Autonomy*: the aspiration of being the cause of one's own behaviour; (2) *Competence*: the individual perception of being able to show effectiveness; and (3) *Relatedness*: the feeling that one belongs in a specific social setting. The issue that many teachers may be thinking is: how can I foster these three basic needs in my classes, and the answer is: (1) *Choice*: students should be faced with options, with opportunities to develop decision-making skills, which can foster their autonomy; (2) *Successful experiences*: teachers must re-define success in their PE classes to make it learning-oriented and self-referenced (Fernandez-Rio, 2017), so that every student can develop feelings of competence; and (3) *Positive relations*: teachers must create contexts where students can establish positive connections among them, where they can develop positive interpersonal skills and relatedness. Through these actions, teachers can create independent learners who make decisions to organize and conduct physical activities in and out of the PE class (Haerens et al., 2011). Bowler and Sammon (2015a) proposed several actions to achieve these goals: (1) *Promote physical activity in all PE lessons*: teachers must become activators, maximizing opportunities for practice (i.e., eliminating elimination); (2) *Develop knowledgeable movers*: help students learn about physical activity and make appropriate decisions to practice it; (3) *Create a needs-supportive learning environment*: considering students' interests, attending their needs and promoting their interaction; and (4) *Join forces*: school, family and community must work together to promote healthy habits, but teachers must be the leading force opening the doors of the PE class. The goal is to develop habitual, motivated and informed movers (Bowler & Sammon, 2015b).

Physical Literacy. Whitehead (2013, p. 28) defined physical literacy as "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for maintaining purposeful physical pursuits/ activities throughout the life course". Its promotion has been linked to positive outcomes such as health benefits in children and adults (Edwards, Bryant, Keegan, Morgan, & Jones, 2017). Whitehead (2013) believes that physical literacy s not a pedagogical model, but it can be promoted through any pedagogical model. Four core concepts have been identified in this approach (Dudley, 2015): (1) *Movement competencies*: they are linked to the fundamental movement skills (i.e., locomotor, manipulative....), which are related to physical activity, because they allow individuals to engage in meaningful physical activity within their limits; (2) *Rules, tactics and strategies of movement*: they relate to Bunker and Thorpe's tactical approach to teaching games/sports, where students are challenged to find solutions to problems in game contexts ; (3) *Motivational and behavioural skills of movement*: they are linked to Vallerand's basic psychological needs (autonomy, competence and relatedness) and intrinsic motivation, which can be fulfilled through appropriate pedagogical frameworks; and (4) *Personal and social attributes of movement*: they relate to Hellison's teaching for personal and social responsibility model, where these skills can be taught through movement. Based on the ideas of Edwards et al. (2017), Whitehead (2013), and Dudley (2015), the physical literacy model basic features are: (1) Teachers must demonstrate equal *interest* in every student; (2) *Task* should be designed to help every student progress; (3) Motivation and confidence should be promoted at all times; (4) *Content* selection should be carefully reviewed to provide a wide range of activities; (5) The increase of *students' physical competence and self-esteem* should be the focus; (6) *Contextualized, real-world experiences* to foster learning that can be applied outside the PE class; and (7) *Assessment* should be ipsative (self-referenced) and formative.

Hybridizing Models

All pedagogical models described in the previous sections share two ideas: (1) *Student-centred contexts*: students should be placed in the centre stage of the PE class; in the teaching-learning framework, it is time to focus on the learning (students) and not on the teaching (teachers); and *Situated learning*: the physical, social and cultural dimensions the context of learning should be carefully considered (Lave & Wenger, 1991). The main hybridizations conducted in PE settings have been: SE + TGfU, CL + TGfU, CL + AE, CL + TPSR, and SE + TPSR.

Final thoughts

Quality PE improves children's self-confidence, concentration and communication skills, enabling them to become ACTIVE, HEALTHY, RESPONSIBLE, WELL-ROUNDED CITIZENS, but it is hard to achieve. Models-based practice provides teachers with a framework that has been proven to work. It is probably the best structure to achieve the mentioned outcomes.

References

1. Bowler, M., & Sammon, P. (2015a). *Health-based physical education in practice.* Retrieved from https://peandsportvlog.wordpress.com/2015/10/15/vlog-18-health-based-pe-inpractice/#comments
2. Bowler, M., & Sammon, P. (2015b). *Should we have a model for health-based physical education?* Retrieved from https://peandsportvlog.wordpress.com/2015/10/01/vlog-17-shouldwe-have-a-model-for-health-based-pe/
3. Bunker, D., & Thorpe, R. (1982). A model for the teaching of games in secondary schools. *Bulletin of Physical Education, 18*(1), 5-8.
4. Casey, A. (2012). Cooperative Learning through the eyes of a teacher-researcher and his students. En B. Dyson, and A. Casey (eds.) *Cooperative learning in physical education: a research-based approach* (pp. 75-87). London: Routledge.
5. Casey, A. (2014). Models-based practice: Great white hope or white elephant? *Physical Education and Sport Pedagogy, 19*(1), 18-34.
6. Casey, A. (2017). Models-Based Practice. In C.D. Ennis (ed.) *Routledge Handbook of Physical Education Pedagogies* (chapter 5). London: Routledge.
7. Collier, C., Perlman, D., & Fisette, J. (2009). Getting open: games that teach spatial awareness. *Future Focus, 30*(2), 25-28.
8. Deci. E.L., & Ryan, R.M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11,* 227-268. doi: 10.1207/S15327965PLI1104_01.

9. Dort, A., Evaul, T., & Swalm, R. (1996). *Adventure on a shoestring*. Paper presented at the meeting of the Eastern District Association of the American Alliance for Health, Physical Education, Recreation and Dance. Stamford, CT.
10. Dudley, D.A. (2015). A conceptual model of observed physical literacy. *Teacher Education, The Physical Educator*, *72*, 236-260.
11. Dyson, B.P. (1995). Students' voices in two alternative elementary physical education programs. *Journal of Teaching in Physical Education, 14,* 394-407.
12. Edwards, L.C., Bryant, A.S., Keegan, R.J., Morgan, K., & Jones, A.M. (2017). Definitions, foundations and associations of physical literacy: a systematic review. *Sports medicine*, *47*(1), 113-126.
13. Fernandez-Rio, J. (2014). Another Step in Models-based Practice: Hybridizing Cooperative Learning and Teaching for Personal and Social Responsibility. *Journal of Physical Education, Recreation & Dance, 85*(7), 3-5. doi:10.1080/07303084.2014.937158
14. Fernandez-Rio, J. (2015). Models-based Practice Reloaded: Connecting Cooperative Learning and Adventure Education. *Journal of Physical Education, Recreation & Dance, 86*(6), 5-7. doi: 10.1080/07303084.2015.1054197
15. Fernandez-Rio, J. (2016). Implementing Cooperative Learning: A Proposal. *Journal of Physical Education, Recreation & Dance, 87*(5), 5-6. doi: 10.1080/07303084.2016.1156992
16. Fernandez-Rio, J. (2017). Redefining Students' Success (Learning-oriented, Self-referenced) in Today's Physical Education. Journal of Physical Education, Recreation & Dance, 88(3), 3-4. doi: 10.1080/07303084.2016.1271251
17. Haerens, L., Kirk, D., Cardon, G., & De Bourdeaudhuij, I. (2011). Toward the development of a pedagogical model for health-based physical education. *Quest, 63*, 321-338.
18. Hellison, D. (2011). *Teaching personal and social responsibility through physical activity* (3rd ed.). Champaign, IL: Human Kinetics.
19. Jewett, A.E., Bain, L.L., & Ennis, C.D. (1995). *The curriculum process in physical education*. Dubuque, IA: Brown & Benchmark.
20. Johnson. D.W., & Johnson, R.T. (2014). Cooperative Learning in 21st Century. *Annals of Psychology, 30*(3), 841-851. DOI: 10.6018/analesps.30.3.201241
21. Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.
22. Oslin, J., & Mitchell, S. (2006). Game-Centred Approaches to Teaching Physical Education. In D. Kirk, D. MacDonald, and M. O'Sullivan (eds.) *The Handbook of Physical Education* (pp. 627-651). London: Sage.
23. Siedentop, D., Hastie, P.A., & van der Mars, H. (2011). *Complete guide to Sport Education (2th Ed.)*. Champaign, IL: Human Kinetics.
24. Vallerand, R. J. (2001). A hierarchical model of intrinsic and extrinsic motivation in sport and exercise. En G.C. Roberts (Ed.) *Advances in Motivation in Sport Exercise* (pp. 263-320). Champaign, IL: Human Kinetics.
25. Whitehead, M. (2013). Definition of physical literacy and clarification of related. *ICSSPE Bulletin - Journal of Sport Science and Physical Education, 65*, 28-33.

30 YEARS OF SLOFIT: ITS LEGACY AND PERSPECTIVE

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Abstract

Physical fitness is one of the most important determinants of health. Due to the negative effects of growingly sedentary lifestyles, the importance of sustaining sufficient level of physical fitness is increasing. SLOfit is a national surveillance system for physical and motor development of children and youth in Slovenia, which has been enabling annual monitoring of physical and motor status of children in all Slovenian schools from 1987 onwards. On the national level, the SLOfit data serves as scientific backbone for most of the policies, related to improvement of physical activity of children and youth and the policies, related to school physical education. Every April, almost the entire Slovenian population, aged 6 to 19 is measured by 8 motor tests and 3 anthropometric measurements. Annual measurements allow researchers to constantly monitor the population developmental trends, while teachers use the analysed data to identify children with special developmental needs, to follow the development of every individual child and adjust the teaching process to the needs and capabilities of children. Centralised management and evaluation of data with unique feedback system enables children and parents to compare their development with the development of their peers and identify the needs for improvement. To date the SLOfit database includes over 7 million sets of measurements of over 1 million children and is one of the largest cross-sectional and cohort database of physical and motor development in the world. Slovenian educational policy, informed by the SLOfit data, managed to develop one of the most efficient system of physical education and extracurricular sports programs in the world, which results in very favourable level of physical fitness and physical activity of children in Slovenia in comparison to the rest of the world.

Key words: *physical fitness, children, youth, anthropometry, SLOfit*

Introduction

Physical fitness is one of the most important determinants of health (Ortega, Ruiz, Castillo & Sjöström, 2007). Sheltering praxis of parents (restriction of children from access to public spaces, e.g. playing on city playgrounds, from walking alone in their own neighbourhood, from crossing the street by themselves), individualisation (children's incorrect impressions of their role in society), parenteral overprotection and permissive education, are resulting in prevalent sedentary lifestyles among young people (Armstrong, 2007; De la Cruz-Sanchez, & Pino-Ortega, 2010; Ferreira et al., 2007; Jurak, 2006; Strel et al., 2007). Negative effects of such lifestyles are manifested in increased subcutaneous fatness (Olds, Ridley, & Tomkinson, 2007; Strel et al., 2007), growing proportion of the overweight population (Currie et al., 2004; Lobstein & Frelut, 2003; Malina, 2007; Strel et al., 2007; Wedderkopp, Froberg, Hansen, & Andersen, 2004) and deterioration of their cardiorespiratory and motor fitness (Froberg & Andersen, 2010; Strel et al., 2007; Tomkinson & Olds, 2007; Tomkinson, Olds & Borms, 2007). Therefore, the importance of sustaining sufficient level of physical fitness is increasing and many countries strive to establish national physical fitness monitoring systems. Some test batteries are widely used, but rarely on a population level: Eurofit (Committee of Experts on Sports Research, 1993), AAHPER Youth Fitness Project (Plowman et al., 2006), The President's Challenge (President's Council on Physical Fitness and Sports, 2002), Fitnessgram (Mood, Jackson, & Morrow, 2007, Plowman et al., 2006), Japanese MEXT Fitness Test (Nishijama et al., 2001; Shingo & Takeo, 2002) The International Physical Fitness Test (Rosandich, 1999), ALPHA Fitness Test Battery (Ruiz et al., 2011).

Slovenia is a pioneer in this type of accompaniment since national physical fitness surveillance system SLOfit was developed from 1969 to 1989 (Strel et al., 1997). SLOfit monitors and evaluates the annual changes in the physical fitness of schoolchildren and adolescents aged 6 to 19. This year is the 30th anniversary of the introduction of the system in all Slovenian schools. The purpose of this article is to present the legacy of this system and some further perspectives of its development.

What is SLOfit?

SLOfit is a national surveillance system for physical and motor development of children and youth in Slovenia, which was formerly known as Sports Educational Chart. The system was implemented in 1982 on a sample of Slovenian schools and after 5 years of testing, it was introduced to all Slovenian primary and secondary schools. Therefore, SLOfit enables annual monitoring of physical and motor status of children in all Slovenian schools from 1987 onwards. Every April, almost the entire Slovenian population, aged 6 to 19 (220,000 students) is measured by 8 motor tests and 3 anthropometric measurements (see www.slofit.org):

- height (longitudinal dimension of the body)
- weight (voluminosity of the body)
- triceps skinfold (subcutaneous fat)
- 20-second arm plate tapping (neural regulation of movement)
- standing broad jump (explosive power)
- polygon backwards (coordination of whole body movements)
- 60-second sit-ups (isometric strength)
- stand and reach (flexibility of legs and lower back)
- bent arm hang (isotonic strength)
- 60-meter dash (speed)
- 600-meter run (general aerobic endurance)

Based on the results of the 8 motor tests, Physical Fitness Index is calculated as a measure of overall physical efficiency of every child. BMI is also calculated as an additional measure of adiposity.

Enrolment in the SLOfit system requires positive parental informed consent, while in high schools it is the student alone who sign informed consent regardless of their age. The consent enables their data to be processed centrally and included in the SLOfit database. After the school-based measurements are performed, the data are sent from schools to the Faculty of Sport at the University of Ljubljana where they are checked, cleaned, analysed and the feedback reports, which include comparison with the national average, are sent back to schools for every individual child, class and every school.

Annual measurements allow researchers to constantly monitor the population developmental trends, while teachers use the analysed data to identify children with special developmental needs, to follow the development of every individual child and adjust the teaching process to the needs and capabilities of children. Centralised management and evaluation of data with unique feedback system enables children and parents to compare their development with the development of their peers and identify the needs for improvement.

On the national level, the SLOfit data serves as scientific backbone for most of the policies, related to improvement of physical activity of children and youth and the policies, related to school physical education.

To date the SLOfit database includes over 7 million sets of measurements of over 1 million children and is one of the largest cross-sectional and cohort database of physical and motor development in the world. Slovenian educational policy, informed by the SLOfit data, managed to develop one of the most efficient system of physical education and extracurricular sports programs in the world, which results in very favourable level of physical fitness and physical activity of children in Slovenia in comparison to the rest of the world (Sember et al., 2016).

Children grow faster, their body mass is greater and their health-oriented fitness is worsened

Data from SLOfit are often pooled for analyses of global secular trend analysis (NCD Risk Factor Collaboration, 2016a; NCD Risk Factor Collaboration, 2016b). These analyses show that over the past century humans are becoming taller but the gain in adult height is different around the world (NCD Risk Factor Collaboration, 2016b). Among others, being taller is associated with enhanced longevity and lower risk of cardiovascular and respiratory diseases (Özaltin, 2012). Although height is one of the most heritable human traits (Lanktree et al., 2011), cross-population differences are believed to be related to non-genetic, environmental factors. Of these, nutrition is important (Deaton, 2007). However, lack of physical activity and plentifulness of junk food has led us to important gain of body mass. For instance, US citizens were the tallest on the world century ago but they are not nowadays (NCD Risk Factor Collaboration, 2016b). Opposite to this, their gain in body mass in past decades was greater (NCD Risk Factor Collaboration, 2016a). If current trends continue, by 2025, global obesity prevalence will reach 18% in men and surpass 21% in women (NCD Risk Factor Collaboration, 2016a).

Not so much obvious as in other parts of the world, increased body mass and fatness are also markedly present in Slovenian children and youth. In 19-years-olds 2.2% of boys and 1.8% of girls were classified as obese, while on the other side, the share of underweight girls increased to between 5 and 10% (Starc, Strel, & Kovač, 2010). Studies (Starc et al., 2010; Strel et al., 2007) of the physical development of children aged 6 to 10 have revealed that the proportion of overweight and obese children in Slovenia has been increasing particularly in this age group and that the physical fitness of these children is decreasing more than amongst adolescent youth.

The SLOfit data is regularly included also in the Childhood Obesity Surveillance Initiative (COSI) of the World Health Organization (Wijnhoven et al., 2014) and Slovenia has been represented in this initiative from its very beginning in 2006. Through this initiative, Slovenia is able to get direct comparisons of obesity prevalence with other countries from WHO European region and evaluate the efficiency of the national policy and intervention that target childhood obesity. In the four rounds of data gathering in COSI, Slovenia has proved to be one of the countries who achieved the greatest progress in combating obesity and one of rare countries that is on the track of reaching the 2020 goal of lowering childhood obesity.

Tracking overweight and obesity from childhood to young adulthood (Starc & Strel, 2011) shows that height, weight and BMI at 18 years were well predicted from childhood and became more predictable with age, while TSF was not. Obese and overweight children had the greatest risk of becoming obese or overweight young adults. The history of their weight shows that 40.0% of males and 48.6% of females who were obese at 18 years had already been obese at 7 years.

Similar negative changes are also noticed in motor fitness of Slovenian young people: deterioration of their motor potential, mainly endurance and strength (Starc & Strel, 2011; Strel et al., 2007). For instance, if we compare results of 12-yrs boys in 2015 with their peers from 1995, they hang on the bar 5.9 second less than their forerunners. This indicates on 13.9% reduction of their isotonic strengths in upper body.

On the other side, sporting activity of Slovenian primary school children is increasing (Jurak et al., 2003; Strel et al., 2007); primary school children are in most cases physically active more than 60 minutes per day (Jurak et al., 2015). On this basis it can be concluded, that recommended and actual physical activity (60 minutes of moderate to vigorous physical activity per day) is not enough to neutralise all negative effects of contemporary lifestyles of Slovenian youth!

School-based physical activity interventions are effective but their effects decrease after their conclusion

Based on up-to-date and comprehensive insight into physical fitness of our children and youth we can immediately detect problems and propose interventions. With SLOfit, we can also observe effects of school-based physical activity interventions.

According to our findings regarding the decline in physical fitness of children aged 6 to 10, we performed few studies to explore the effects of an intervention, the so-called Enhanced PE curricula. Namely, in the first six years of schooling, Slovenian children have three PE lessons (45 minutes each) per week and legislation prescribes that all the subjects in the this period are taught by elementary class teachers. In the fourth and fifth year, two or three subjects can be taught by a subject specialist (including PE specialists). Notably, current legislation does not allow PE teachers to teach PE independently in the first three years of primary school but have to be accompanied by elementary school class teachers. Such joint teaching comes at a cost because schools are responsible for the additional financial resources through either local municipalities, or parents or their own sources (Jurak et al., 2005). Some primary schools understand the importance of everyday physical activity on children's physical fitness and have been offering an enhanced PE curriculum, containing daily PE lessons and joint teaching of elementary class and PE teachers in the first four years of schooling since 1984 (Jurak et al., 2005). Our findings (Jurak, Strel, Leskošek, & Kovač, 2011; Starc & Strel, 2012) showed that such intervention is effective for physical fitness of children. However, longitudinal study by Jurak et al. (2013) which examined the long-term effects, the effect of such school-based physical activity intervention, showed only limited effects 7 years after the intervention. Nevertheless, the physical activity intervention group achieved better results than the control group in all motor variables, especially in the motor tasks of polygon backwards, 30-seconds sit-ups, and 600 m run. This is particularly important because the muscular endurance and running speed of children of that age have been falling in recent decades (Strel, Starc, & Kovač, 2011). Yet, the differences between the control and the intervention groups decreased with time (Jurak et al., 2013). The results point to the need for increased school-based physical activity interventions during the schooling period.

Healthy Lifestyle intervention in 2010 caused the decline of prevalence of obesity and the growth of physical fitness of children on the national level

Based on our previous findings and good experience with school-based physical activity intervention programme, a national project Healthy Lifestyle was introduced in school year 2010/2011. This was also one of the best examples of the evaluative strength of the SLOfit system. Through SLOfit system the Laboratory detected an accelerated increase of childhood overweight from the mid-1990s onwards that was predicted to exceed 30% of the population in 2020 and we proposed to the Ministry to intervene with the introduction of additional 2 hours of PE per week, administered by newly employed PE teachers. The progress of the included 30,000 children was monitored through the SLOfit system for the next five years and each year an emphasis was put on the poorest component of physical fitness from the preceding school year. Such targeted intervention caused the decline of prevalence of obesity and the growth of physical fitness in all Slovenian schools and the trends from 2010 to 2015 today suggest only 22% prevalence of overweight in 2020, which is at the level of the year 2004.

Parallel to the Healthy Lifestyle intervention, several nation-wide initiatives were also introduced within the educational system based on our findings and suggestions. The efforts focused mainly on providing more opportunity for physical activity within the school curriculum. At the same time foods with little nutritional value were excluded from school meals and healthy dietary choices were accentuated. These initiatives received a lot of media attention, making the fight against childhood obesity an important public concern, which increased the awareness among both the children and their parents.

Research-based evidence about the effects of Healthy lifestyle intervention gave us more public attention. We have taken the advantage of this and started informing the public about the problem of poor physical fitness of students from vocational secondary schools. We determined that in Slovenia young people can be divided in two extreme typical groups according to their lifestyle, which have, in relation to the (un)healthy habits, been named the "coffee and cigarettes" and the "sport" lifestyles (Jurak, 2006). Since unhealthy lifestyle has been a more common practice among students from vocational and professional/technical schools, our analyses showed that physical fitness of adolescents attending these schools is much worse than those from the gymnasium programme (Kovač, Strel, Jurak, & Leskošek, 2012). The differences are smaller amongst boys than girls, but we came to a striking evidence that girls from gymnasiums achieve better absolute results in physical fitness than boys from vocational schools.

We consider the students from vocational schools to be the most critical population since most of them come from deprivileged environments with lower support for physical activity and poorer nutrition. However, these groups of adolescents will soon enter the labor market doing mostly physically demanding jobs which they will not be able to perform effectively due to their poor physical fitness. This is a potential health-care and social hazard which demands immediate action. Therefore, we have suggested to the Government to introduce an intervention called Youth for Youth. In this intervention, young PE teachers will plan and implement special extra-curricular physical activity programs, which will be tailored to the interests and future job demands of vocational-school students. The Government accepted our proposal and the intervention is planned to start in September 2017.

Slovenian children are among the most physically active and the fittest on the world

Slovenian educational policy, informed by the SLOfit data, managed to develop one of the most efficient system of physical education and extracurricular sports programs in the world, which results in very favourable level of physical fitness and physical activity of children in Slovenia in comparison to 38 countries from around the globe (Sember et al., 2016). This behaviour is driven by highly developed school sports infrastructure, a well designed PE curriculum in all Slovenian schools, which is planned on the micro level by taking into account the physical status of every child. This status is objectivelly accessed by annual evaluation of physical and motor development of the entire population and provides the information backbone for implementation of effective measures that try to reverse the overall inactivity levels and decline in physical fttness in children and youth (Strel et al., 2011; Sember et al, 2016).

A comparison with their peers across the world (Tomkinson, Olds, & Borms, 2007; Ortega et al., 2011; Jurak, Milanović, Janić, Sorić, & Kovač, 2015; Tomkinson et al., 2016) indicates that physical fitness of Slovenian children is superior.

Perspectives of SLOfit

Despite its strengths, the SLOfit system has a huge potential for improvement. Currently, SLOfit gives feedback about physical fitness in the schooling period but there is a need for lifelong surveillance of physical fitness. Additionally, the information of physical fitness and somatic development of children from SLOfit is shared directly only with their PE teachers who then share this information with children and their parents. However, in order to improve the identification of higher-health risk children there is a growing demand of school physicians to get access to the SLOfit database to get a better insight into overall development of a child. There is also a growing demand of PE teachers to receive some medical information on the health status of their children in order to minimize any possible health risks, deriving from chronic diseases and conditions of children.

At the moment, there is no sharing of information between PE teachers and school physicians which increases the risks of incorrect diagnoses from the medical side and the risks of contraindicative physical exercising or total excusing from exercise from the educational side. Nor school physicians or PE teachers have any hard evidence on the physical activity of children. PE teachers can only evaluate the habitual physical activity indirectly by physical fitness while school physicians have no possibility of evaluation at all.

At the same time, the parents and children are not informed enough about the consequences of poor physical fitness of a child nor about the adequacy of child's habitual physical activity. In addition, current policies regarding the exchange of data do not allow the linking of personal data between different stakeholders, which means that integration of data from different sources needs to be resolved on the political level.

Current policies for increasing physical activity in schools is effective and produces results but these results could be further enhanced if the health sector could contribute, which is currently impossible because they don't have access to relevant information.

Currently, primary health-care institutions where school physicians work do not use the uniform administrative tools and e-health tools are currently being introduced. Our attention would be put predominantly on the e-medical chart of each individual.

My SLOfit

We have a vision how to implement all mentioned challenges. We are now in the phase of pilot studies. In 2015, we conducted a pilot study on university students to evaluate the possibility of life-long monitoring of physical fitness and new feedback form with health risk zones, calculated from our reach data. In 2016, we launched a new SLOfit web site (Jurak et al., 2016). Its purpose is the dissemination of information to different users of system: children and their parents, university students, PE teachers and physicians. We enable separate access to each of the target group along with the general information, available to wider audience.

In 2016, we finished with cross-sectional project Let's enjoy health. The goal of this project was to evaluate a model of cooperation between schools, primary health care centres and local communities to ensure supporting environment for healthy lifestyle, focused on PA and nutrition. Within this project the health-care prevention teams in local communities have been established. These teams included schoolteachers, led by the PE teachers, school physicians and representatives of local communities. The main actions of this project were:

1. Identification of health-risk students by SLOfit (school) and medical examinations (health-care); according to diagnosis of student‘s fitness, health and social characteristics individual objectives were set and also school doctor set individual recommendations for physical exercise and diet for each students.
2. Special treatment for health-risk students, which included:
    - additional lessons of PE in school; individualization based on the doctor‘s recommendations
    - nutritional workshops for students and their parents in school
    - programmes within health-care system (such as):
        - Adopted physical exercise with kinesiologist for students with motor-control problems
        - Workshop for obese students
        - Workshop with kinesiologist or physiotherapist for students with spine problems

Another part of project were actions for ensuring more PA to all children. The following actions were performed in this regard:

– cooperation of PE teacher and physician regarding the excusing from PE (Jurak & Kovač, 2011a; Jurak & Kovač, 2011b),
– substitutions of phsician's excuse with physician's recommendations for exercising,
– minute for health (in some schools students are engaged in short physical activity breaks in classrooms already for decades),
– physical activity recess (in many schools one longer recess is devoted for variety of physical activities; in some schools PE teachers prepare special individual programmes for obese students for this time),
– designing school environment for more spontaneous PA of students.

One of the important action within this project was also development and testing of a web tool that would promote SLOfit and give more meaning to its results. We prepared a web application My SLOfit (https://moj.slofit.org/Prijava), which allows student and their parents web access to students' SLOfit results. PE teacher could also see a child's SLOfit results via this application as well as a child's physician provided by parents' consent. On My SLOfit annual SLOfit data are available with following augmented feedback:

– progress of student physical fitness in recent year
– comparison of his/her physical and motor development with peers
– fitness and health-risk category of individual SLOfit results

Such report is a good basis for the informed decisions, taken by parents, teacher and physician about school-based and out-of-school physical activities and diet habits of child. The parents have an additional advantage to get the insight into information about physical fitness of all their children on one place. We tested the web application on the sample of 36 schools with around 6,000 users (parents, teachers, physicians) and we got a very positive feedback.

In the period 2017-2020, we will enter the experimental phase. We are participating in H2020 project CrowdHEALTH, which will introduce a new paradigm of Holistic Health Records (HHRs) that include a large number of health determinants. HHRs will be transformed into Social HHRs communities capturing the clinical, social and human context of the population segmentation and as a result the collective knowledge for different factors depending on the communities' formulation criteria (e.g. demographics, diseases, lifestyle choices, nutrition, etc). CrowdHEALTH will deliver a secure integrated ICT platform that seamlessly integrates big data technologies to the health ecosystem stakeholders. CrowdHEALTH will develop policy modeling techniques to facilitate the inclusion of Key Performance Indicators (KPIs) in policies and the correlation of these KPIs both with all health determinants captured in HHRs and with information from other domains towards a "health in all policies" approach. SLOfit is one of the use cases where such solution will be implemented.

Through CrowdHEALTH we would like to improve the SLOfit system by:

1. linking the SLOfit database with the e-health system in Slovenia and the CrowdHEALTH platform in order to enable systematic access to somatic and motor development of every child to school physicians, to enable the sharing of relevant medical information to PE teachers, children and parents, and to provide a combined view of fitness and health information to policy-makers,
2. linking the SLOfit database with the existing systems for tracking physical activity and enabling children to enhance their profile also by adding information on their physical fitness or using automated trackers such as smartphones, smart bracelet trackers and other trackers of physical activity,
3. making all the information available on-line to PE teachers, parents, children and school physicians via web application,
4. providing annual user-friendly SLOfit reports for parents, children, PE teachers, ministry and other decision makers,
5. providing occasional messages for parents and children if the SLOfit data analyzed through the CrowdHEALTH platform suggests that recommendations for physical fitness or activity are not met,
6. developing predictive models, which could visualize health risks and raise the awareness of children, parents, teachers and physicians regarding the health risks due to physical inactivity.

We have also prepared strategic public relations plan. At September 2017, we will start to popularize our findings and activities through SLOfit Facebook profile (www.facebook.com/slofit.org).

Conclusion

The rich legacy of SLOfit challenges us for well-designed further development of system. SLOfit requires big data management therefore all activities should be planned carefully and implemented gradually.

There is a number of things that will be introduced to enable better communication between health institutions and schools based on SLOfit data, and will improve collective knowledge on physical fitness and physical activity of children, and reduce health risks, linked to children's inactivity and obesity:

Introduction of new paradigms of cooperation, new policy proposals and increased collaboration between school and health sectors in local settings (local cooperation between school, primary health-care and municipalities) and on the national level. This would enable the introduction of innovative models of diagnosis and early intervention in the case of childhood obesity or delays in physical and motor development, which could be resolved in cooperation between PE teachers and school physicians. Such a system would enable also the diagnosis of problematic environments concerning physical activities, which would help local authorities to plan and implement adequate solutions to increase walkability and active transport to school.

Improving physical fitness and health data integration of the entire school population, produced at the level of schools and primary health care. Since SLOfit covers the entire population of schoolchildren, this data can be made available to school physicians to give them a holistic view of individual child's longitudinal physical fitness development as well as of child's physical activity patterns. At the same time, PE teachers would get access to individual child's medical record in order to avoid additional risks or help in child's faster rehabilitation, more efficient weight loss or other interventions in cooperation with the school physician.

Real-time Big Data management, which could be used for the monitoring of the interventions and personal progress in reduction of health risks and improvement of physical activity. Any intervention such as increasing physical activity, reducing obesity or general morbidity on the level of class, school, municipality, region or on the national level could be evaluated. At the same time by on-line access to individual data every child, his/her parents school physician and PE teacher would have easily available information about the current status and development of child's physical fitness and physical activity.

Better use of existing information by streaming, alerts, improved visualization and possibilities of personal analysis. The developed application would allow longitudinal somatic and motor development, and physical activity to be related to health risks. In the future, this would enable the integration of predictive models which could visualize health risks and raise the awareness of children, parents, teachers and physicians regarding the health risks due to physical inactivity.

References

1. Armstrong, N. (2007). Physical fitness and physical activity patterns of European youth. In W.D. Brettschneider & R. Naul (Eds.), *Obesity in Europe: young people's physical activity and sedentary lifestyles* (pp. 27–56). Frankfurt am Main: Peter Lang.
2. Brettschneider, W., & Naul, R. (2004). *Study on young people's lifestyle and sedentariness and the role of sport in the context of education and as a means of restoring the balance. Final report*. Paderborn: EC, Directorate-General for Education and Culture, Unit Sport.
3. Committee of Experts on Sports Research. (1993). EUROFIT: Handbook for the EUROFIT tests of physical fitness.
4. Currie, C., Roberts, C., Morgan, A., Smith, R., Settertobulte, W., Samdal, O. et al. (2004). *Young people's health in context. Health behaviour in school-aged children (HBSC) study: international report from the 2001/2002 survey.* Copenhagen: World Health Organization Regional Office for Europe.
5. De la Cruz-Sanchez, E., & Pino-Ortega, J. (2010). An active lifestyle explains sex differences in physical performance in children before puberty. *Coll Antropol, 34*(2), 487-491.
6. Deaton, A. (2007). Height, health, and development. *Proceedings of the National Academy of Sciences*, *104*(33), 13232-13237.
7. Ferreira, I., van der Horst, K., Wendel-Vos, W., Kremers, S., van Lenthe, F. J., & Brug, J. (2007). Environmental correlates of physical activity in youth - a review and update. *Obes Rev, 8*(2), 129-154.
8. Froberg, K., & Andersen, L. B. (2010). The importance of physical activity for childhood health. M. Kovač & G. Jurak (Eds.), *Proceedings of the Fifth International Congress Youth Sport 2010.* Retrieved January 15 from http://www.youthsport2010.si/images/stories/SM2010/proceedings1.pdf
9. Jurak, G. (2006). Sports vs. the "cigarettes & coffee" lifestyle of Slovenian high school students. *Anthropological Notebooks 12*(2), 79-95.
10. Jurak, G., & Kovač, M. (2011a). Frequency and characteristics of excuses given by students attending special sports classes of secondary school to avoid participating in physical education class. *Slovenian Journal of Public Health, 50*(2), 95-105.
11. Jurak, G., & Kovač, M. (2011b). Opravičevanje med poukom športne vzgoje v osnovni šoli. *Didactica Slovenica, 26*(4), 18-31.
12. Jurak, G., Cooper, A., Leskošek, B., Kovač, M. (2013). Long-term effects of 4-year longitudinal school-based physical activity intervention on the physical fitness of children and youth during 7-year follow-up assessment. *Central european journal of public health*, 21(4), 190-195.
13. Jurak, G., Kovač, M., Strel, J., Majerič, M., Starc, G., Filipčič, T., et al. (2003). *Sports activities of Slovenian children and young people during their summer holidays*. Ljubljana: University of Ljubljana, Faculty of Sport.
14. Jurak, G., Kovač, M., Strel, J., Starc, G., Žagar, D., Cecić Erpič, S., et al. (2005). *Športno nadarjeni otroci in mladina v slovenskem šolskem sistemu. [Sports talented children and youth in Slovenian educational system]*. Koper: Annales, Univerza na Primorskem, Znanstveno-raziskovalno središče Koper.
15. Jurak, G., Milanovic, I., Janic, S. R., Soric, M., & Kovac, M. (2015). Some indicators of fatness and motor fitness in slovenian and serbian children. *Int. j. morphol*, *33*(2), 420-427.
16. Jurak, G., Sorić, M., Starc, G., Kovač, M., Mišigoj-Duraković, M., Borer, K., & Strel, J. (2015). School day and weekend patterns of physical activity in urban 11-year-olds: A cross-cultural comparison. *American journal of human biology*, *27*(2), 192-200.
17. Kovač, M., Strel, J., Jurak, G., & Leskosek, B. (2012). Morphological characteristics and motor fitness among girls attending different secondary-school programmes. *International Journal of Morphology*, *30*(2), 411-416.
18. Lanktree, M. B., Guo, Y., Murtaza, M., Glessner, J. T., Bailey, S. D., Onland-Moret, N. C., ... & Shen, H. (2011). Meta-analysis of dense genecentric association studies reveals common and uncommon variants associated with height. *The American Journal of Human Genetics*, *88*(1), 6-18.
19. Lobstein, T., & Frelut, M. L. (2003). Prevalence of overweight among children in Europe. *Obes Rev, 4*(4), 195-200.
20. Malina, R. M. (2007). Physical fitness of children and adolescents in the United States: status and secular change. *Med Sport Sci, 50*, 67-90.
21. Mood, D. P., Jackson, A. W., & Morrow Jr, J. R. (2007). Measurement of physical fitness and physical activity: Fifty years of change. *Measurement in Physical Education and Exercise Science*, *11*(4), 217-227.
22. NCD Risk Factor Collaboration. (2016a). Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19· 2 million participants. *The Lancet*, *387*(10026), 1377-1396.
23. NCD Risk Factor Collaboration. (2016b). Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4· 4 million participants. *The Lancet*, *387*(10027), 1513-1530.
24. Nishijima, T., Kokudo, S., & Suzuki, K. (2001). Secular changes of physical fitness and motor ability during 1964-97 in Japanese youth. *Japanese Journal of School Health*, *42*, 172-173.
25. Olds, T. S., Ridley, K., & Tomkinson, G. R. (2007). Declines in aerobic fitness: are they only due to increasing fatness? *Med Sport Sci, 50*, 226-240.
26. Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International journal of obesity*, *32*(1), 1-11.
27. Özaltin, E. (2012). Commentary: the long and short of why taller people are healthier and live longer. *International journal of epidemiology*, *41*(5), 1434-1435.

28. Plowman, S. A., Sterling, C. L., Corbin, C. B., Meredith, M. D., Welk, G. J., & Morrow Jr, J. R. (2006). The history of FITNESSGRAM®. *Journal of Physical Activity and Health*, *3*(s2), S5-S20.
29. President's Council on Physical Fitness and Sports. (2002). *President's challenge: Physical activity and fitness award program*. Rockville, MD: President's Council on Fitness, Sports & Nutrition.
30. Rosandich, T. P. (1999). International physical fitness test. *The Sport Journal*, *2*(1).
31. Ruiz, J. R., Castro-Piñero, J., España-Romero, V., Artero, E. G., Ortega, F. B., Cuenca, M. M., ... & Gutiérrez, Á. (2010). Field-based fitness assessment in young people: the ALPHA health-related fitness test battery for children and adolescents. *British journal of sports medicine*, bjsports75341.
32. Sember, V., Starc, G., Jurak, G., Golobič, M., Kovač, M., Samardžija, P. P., & Morrison, S. A. (2016). Results from the Republic of Slovenia's 2016 Report Card on Physical Activity for Children and Youth. *Journal of physical activity and health*, *13*(11 Suppl 2), S256-S264
33. Shingo, N., & Takeo, M. (2002). The educational experiments of school health promotion for the youth in Japan: analysis of the 'sport test'over the past 34 years. *Health Promotion International*, *17*(2), 147-160.
34. Starc, G., & Strel, J. (2011). Tracking excess weight and obesity from childhood to young adulthood: a 12-year prospective cohort study in Slovenia. *Public Health Nutr, 14*(1), 49-55.
35. Starc, G., & Strel, J. (2012). Influence of the quality implementation of a physical education curriculum on the physical development and physical fitness of children. *BMC public health*, *12*(1), 61.
36. Starc, G., Strel, J., & Kovač, M. (2010). *Telesni in gibalni razvoj slovenskih otrok in mladine v številkah. Šolsko leto 2009/10. [Physical and motor development of Slovenian children and youth in figures. 2009/10 academic year]* Ljubljana: University of Ljubljana, Faculty of Sport.
37. Strel, J. (1997). *Sports Educational Chart*. Ljubljana: Ministry of Education and Sport.
38. Strel, J., Kovač, M., & Jurak, G. (2007). Physical and motor development, sport activities and lifestyles of Slovenian children and youth – changes in the last few decades In W. D. Brettschneider & R. Naul (Eds.), *Obesity in Europe: young people's physical activity and sedentary lifestyles* (pp. 243-264). Frankfurt am Main: Peter Lang.
39. Strel, J., Starc, G., & Kovač, M. (2011). SLOFIT sistem–analiza telesnega in gibalnega razvoja otrok in mladine slovenskih osnovnih in srednjih šol v šolskem letu 2010/2011. *Univerza v Ljubljani, Fakulteta za šport*.
40. Tomkinson, G. R., & Olds, T. S. (2007). Secular changes in pediatric aerobic fitness test performance: the global picture. *Med Sport Sci, 50*, 46-66.
41. Tomkinson, G. R., Olds, T. S., & Borms, J. (2007). Who are the Eurofittest? *Med Sport Sci, 50*, 104-128.
42. Tomkinson, G. R., Lang, J. J., Tremblay, M. S., Dale, M., LeBlanc, A. G., Belanger, K., ... & Léger, L. (2016). International normative 20 m shuttle run values from 1 142 026 children and youth representing 50 countries. *British journal of sports medicine*, bjsports-2016, 0:1-14.
43. Wedderkopp, N., Froberg, K., Hansen, H. S., & Andersen, L. B. (2004). Secular trends in physical fitness and obesity in Danish 9-year-old girls and boys: Odense School Child Study and Danish substudy of the European Youth Heart Study. *Scand J Med Sci Sports, 14*(3), 150-155.
44. Wijnhoven, T. M., van Raaij, J. M., Spinelli, A., Starc, G., Hassapidou, M., Spiroski, I., ... & Pérez-Farinós, N. (2014). WHO European Childhood Obesity Surveillance Initiative: body mass index and level of overweight among 6–9-year-old children from school year 2007/2008 to school year 2009/2010. *BMC Public Health*, *14*(1), 806.

THE INFLUENCE OF LATERALIZATION ON MOTOR PERFORMANCE OF PRESCHOOL CHILDREN

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Summary

Background: Lateralization is important from the point of view of taking up by a child a number of sequential motor tasks.

Objectives: To establish the level of basic motor performance in preschool children at the age of 6-7 in reference to their lateralization.

Methods: 3178 preschool children at the age of 6-7, including 1627 girls and 1551 boys form Poland were randomly recuited. The EUROFIT test were used to assess motor performance. Additionally, children's motor skills were assessed by means of ball throwing and griping, jumping, kicking. Hand preference was evaluated by means of two trials: a throw and a grip while the leg preference by a kick and one-leg jumping. The eye assessment was based on a trial with the use of a kaleidoscope. The research material was statistically analysed. A series of three-variable Analysis of variance (ANOVA) was performed. The significance level amounted $p \leq 0{,}05$.

Results: Significant differences in the level of marks given for performing motor skills were observed ($p \leq 0{,}05$). Most frequently, dextral children gained the highest level of marks regarding motor skills. Statistically significant effect concerning the level of flexibility, lower limbs explosive strength and running speed was also observed. In most cases regarding motor skills interactions between laterality and the examinees' age were also observed ($p \leq 0{,}05$). However, calculated eta-squared values turned out to be low.

Conclusion: Studies suggest that the overall picture of motor performance does not depend on the type of laterality. The observed lower values of performance components indicate rather incomplete lateralization process. Another problem seems to be the assessment of the quality of performance of motor skills.

Key words: *laterality, preschool children, motor performance*

Introduction

Laterality is considered to be outward manifestation of the cortical integrative activity, manifesting the asymmetric action of the brain hemispheres (Bala, Golubovi & Kati 2010). Its external manifestation is a consistent selection during different motor tasks of the same limb, regardless of the speed and accuracy of the task result. Lateralization also refers to the sense organs such as eyes and ears. Preference in the selection of hand is best recognized phenomenon. While there is much less publicity about the footedness or eyedness. It is believed that about 90% of the population is right-handed. Moreover, it was found that the preference in the selection of the right leg or right eye is also slightly lower. In the case of right footedness the percentage is at a level of about 80%, while the right eyedness frequency is even lower (70%) (Porac & Coren 1981).

Lateralization is important from the point of view of taking up by a child a number of sequential motor tasks ranging from writing and drawing to use of everyday utensils as well as those associated with fun and motor recreation (Van Mier, 2006). The study found an important relationship between lateralization and psychomotor efficiency of preschool children (Tan 1985). According to Keane (2008) bimanual tasks are rather regulated by a general plan of motor movements, than the result of hand dominance. In studies by Bala et al. (2009) there were no significant differences observed in the level of motor performance between children of varying type of handedness. Relation between handedness and motor abilities in preschool children, should be noted by Anette (2009). In addition, foot preference in skilled and unskilled movements was correlated with hand preference and foot / hand-tapping speed. Although in the studies by Mori et al. (2008) there were no significant differences in the performance of activities according to footness. Taking into account the level of lateralization of the body, it was also found that the low degree of lateralization of both lower and upper limbs coexists with low level of motor skills, agility and coordination (Koszczyc 1991).

Aim

The aim of this study is to analyze the relationship between the type of laterality and the level of efficiency and coordination during the execution of motor tasks in children aged 6-7 years.

Methods

The study included 3178 children including 1627 girls and 1551 boys aged 6-7 years. The test trial was representative of the Polish area. In tested were used motor performance tests from EUROFIT batterry test. They included the measurement of total balance, arm speed moment, flexibility, trunk strength, functional strength of arm, explosive leg strength, running speed and agility. Based on the evaluation of the implementation of basic motor tasks such as throws and grips of a bag with right and left hand, jumping on one leg and on both legs on a certain distance, kicking the ball to a target with right and left foot, In addition, every child was tested with kaleidoscope, on the basis of which eye preferences were asssessed. Each test of motor skills was performed 3 times. Based on them children were classified to groups according to their laterality. 4 groups of children were selected with the right and left-hand dominance, crossed and weak sidedness. In each group, statistical analysis was performed. Arithmetic means, standard deviations and standard errors were calculated. A series of three-factor analysis of variance was made (ANOVA) for factors: lateralization, age and gender. In the case of a statistically significant effect a diagram was prepared and planned contrasts were calculated in order to determine which group significantly differs from which one. In addition, indicators of the size of „eta-squared" effect were calculated. They represent the proportion of variance explained from the dependent variable through a given effect. The level of significance was $p \leq 0.05$.

Results

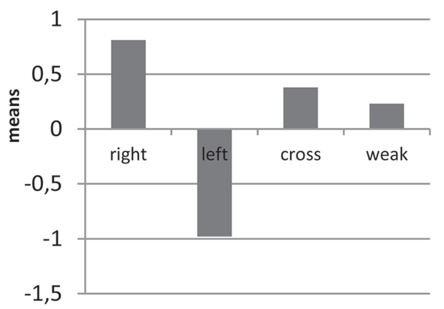
Among the subjects in each age group the largest percentage constitute children with undetermined and right-sided laterality (Table 1). A relatively large group of girls and boys with undetermined lateralization was observed.

Table 1: The number of children according type of laterality

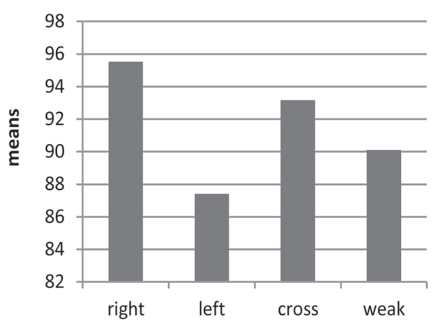
Gender	Age	Right-sided	Left-sided	Cross-dominance	Weak dominance
		N(%)	N(%)	N(%)	N(%)
Girls (n=1627)	6 year (n=789)	302(38,72)	7(0,89)	134(16,98)	346(43,85)
	7 year (n=838)	318(37,94)	7(0,83)	180(21,48)	333(39,74)
Boys (n=1551)	6 year (n=684)	283(41,37)	9(1,31)	123(17,98)	269(39,33)
	7 year (n=867)	338(38,98)	6(0,69)	178(20,53)	345(39,79)

Conducted three-factor analysis of variance indicated a significant relationship between the type of laterality and the majority of the analyzed components of fitness and overall assessment of the performance of motor tasks. (Fig. 1-5). In the case of flexibility, right-sided type of laterality was associated with a significantly better average results ($F= 3.40$, $p \leq 0,05$). The greatest contrasts were obtained for these components between the undetermined and the right-sided type (flexibility $p \leq 0.01$).

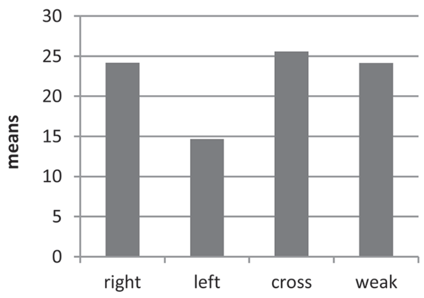
In addition, for flexibility between the crossed and left-sided type ($p \leq 0.05$).



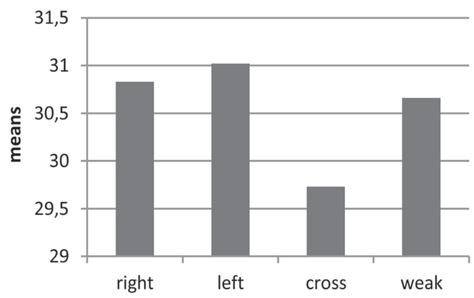
Graph 1: Flexibility according to laterality.



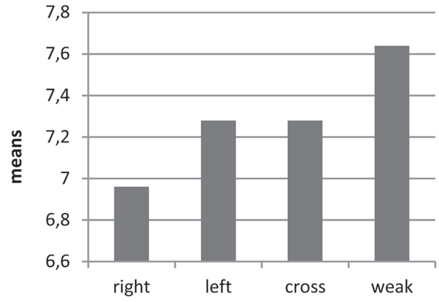
Graph 2: Explosive leg power according to laterality.



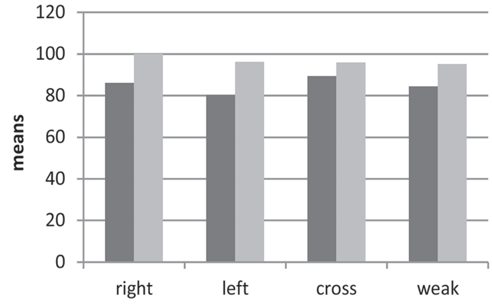
Graph 3: Functional strenght of arm according to laterality.



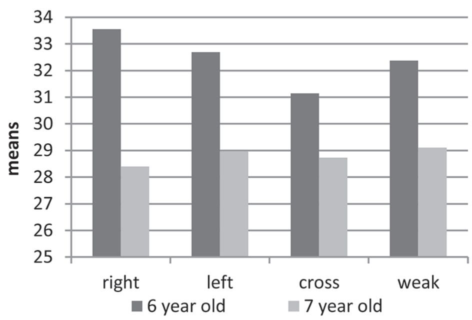
Graph 4: Running speed and agility according to laterality.



Graph 5: Trunk strength according to laterality.



Graph 6: Explosive leg power according to laterality x sex.



Graph 7: Running speed and agility according to laterality x sex.

Right-sided children achieved the highest average results only in the case of explosive strength of the lower limbs ($F= 6.69$, $p \leq 0.001$). Significant differences were shown between children with crossed and undetermined laterality ($p \leq 0.005$) and the right-sided and undetermined ($p \leq 0.001$). Children with crossed lateralization achieved the best results in skills associated with strength and speed (arm strength $F= 6.69$, $p \leq 0.001$, and the running speed $F=3.21$, $p \leq 0.05$). In the arm strength all possible combinations for a left-sided type proved to be significant ($p \leq 0.001$), while for the running speed statistically significant differences were observed between the crossed and right-sided type ($p\leq0.002$) and undetermined ($p\leq0.016$). In the case of abdominal muscle strength, children with undetermined lateralization achieved the highest results and with right-sided one the lowest ($p \leq 0.005$). For the strength of lower limbs and the running speed significant proved to be interaction effect between lateralization and sex (respectively: $F=4.90$, $p \leq 0.01$, $F=7.06$, $p\leq 0.001$), (graphs.6-7). Regardless of the type of laterality 7-year-old children proved to be significantly more advanced in the level of development of explosive strength of lower limbs ($p\leq0.05$) and running speed ($p \leq 0.001$). Planned contrasts in lateralization groups separately in 6 and 7-year-olds showed differentiation. In younger children there were significant differences between the means obtained by the children with crossed and right-sided lateralization ($p\leq0.05$) and undetermined ($p\leq0.001$), whereas in 7-year-olds they concerned right-sided children in relation to their peers with undetermined lateralization ($p\leq0.001$) and crossed ($p\leq0.001$). Taking into account running speed, it was observed between the group of children with undetermined and right-sided laterality ($p\leq0.01$), and crossed ($p\leq0.05$) as well as the crossed and right-sided ($p\leq0.001$). While in the older age group intergroup differences are blurred and apply only to the undetermined and right-sided lateralization ($p\leq0.05$). In most cases, the calculated eta square was low.

Disscusion

The study discusses the problem of laterality and its impact on the level of motor performance It was assumed that the weak and left-sided lateralization may result in a lower level of performance evaluated through the execution of various motor tasks of a child. It is noteworthy that motor skills and the attained level of motor efficiency is one of the manifestations of child's competencies that should be achieved in the course of education in the school. The problem of laterality research is complex, there are many specialized psychological tests for the type and the degree of its severity as well as questionnaires or declarations (Rousson, Gasser, Caflish & Jenni 2009, Leconte & Pagard 2006, Gruber, Meixner, Prosser & Sick 2012). Important from the point of view of the research seem to be findings of Bala et al. (2009). These authors used to assess lateralization gesture and usage tasks demonstrating their high compatibility. The study used motor tasks that a child usually performs in spontaneous plays and movement games. In addition, their simplicity and low requirements for the external environment makes it possible for use in population studies (the presented results are in fact a part of a broader research program evaluating the degree of preparation of younger, six-year-old children for starting school, implemented throughout the country). The studies used the division of children into groups of children with uniform lateralization (right and left-sided) and crossed (defined by non-one-sided position of the dominant organs: eye, hand, and foot) and poor (children while performing tasks use both right and left limb interchangeably) . The percentage of children with right-sided, crossed and undetermined laterality is similar in each group. Not many studies have reported the percentage of each type of lateralization in children. Most frequently they concern the variations in the limb or eye-hand co-operation, or eye-foot (Connolly 1983). On this basis one can point to quite a large percentage of children with crossed lateralization (40% of which 37% relates to the right and 3% to left-handed) . Furthermore, the test by Nachshon et al. (1983) indicate that all three factors have a significant relationship with the dominance of the hemisphere, but the eye of the weakest. For children in preschool age the pattern of uniform, right-sided laterality applies to 57% and is higher than the frequency of children of our studies (Gabbard 1992).

The lateralization process associated with the evolution of specialization of the cerebral hemispheres and their mutual communication is the process of dynamically evolving especially in the age of childhood. Significant is primarily age 5-7 years, when the dominance of hand shapes. It is pointed out that in the case of hand an important factor closely integrated with the process is maturation of the corpus callosum. It maturates from 5 to 10 first years of life (Mori et al. 2008, pp. 792-798). In addition, the functional predominance of one side of the body over the other forms. In this the movement of lower limbs and trunk. Probably the high level of specialization of the dominant side coexists with the appropriate muscle tone (Teixeira & Teixeira 2008, pp. 799-806). In the study there was no significant difference between boys and girls in the frequency of the distinguished types of body lateralization. Probably this fact is justified in the methodology of selection of children for selected types. Since in both types of crossed and poor lateralization there are individuals who choose the right or left limb for the test. The described inter-gender differences concern mainly handedness. For it was found that more often in girls than in boys dominates the right hand. The results are consistent with the results of Nachshon et al. (1983). It was also found that the level of individual components of physical fitness react to the type of laterality in a specific and different way in both sexes. The same it cannot be said which type of laterality is most desirable for physical fitness. However, analyzing the average results of left-sided children of both sexes in relation to the right-sided we can see their significantly reduced level of fitness. In other cases, the results are variable. The most visible proves to be a clear predominance of boys with crossed and undetermined literality in the strength of the abdominal muscles, arms, and flexibility. In children with weak and crossed lateralization, it is highly likely to achieve similar muscle tonus on both sides of the body, hence the possibility of symmetrical and faster execution of certain motor tasks. In Iteya's, Gabbard's and Hart's study (1996) there were no apparent difference between the type of laterality and coordination skills in preschool children as well as in assessing gross motor skills in boys of similar age. In addition, the study of 6-7-year-old children partly confirmed the results of some slightly higher level of overall motility by boys mix hand/left foot slightly better results. In addition to the quantitative evaluation the studies presented the qualitative assessment in relation to the performed motor skills. There was a tendency to achieving higher assessment by right-sided children in comparison with the others. The process of spontaneous and targeted learning of motor tasks in children is primarily by observation and high repetition rate. This leads to produce a situation in which the learner demonstrates proficiency in their execution (Schmidt & Wrisberg 2008). In children with left-sided and the other types of lateralization performance of the tasks of varying complexity can be a bit difficult. The process of learning can be affected by various external factors. One of them seems to be unconscious pressure from the surrounding environment. Above all, peers, siblings or adults. An attempt of visual analysis of motor task shown with the opposite hand to the left and then repeat it in an appropriate manner may take the child a bit more time than his right-sided peer. As a result, this can lead to some disparities in the level and quality of its performance between children. When the left-handed child is trying to master the task correctly, right-handed peer can bring the same movement to perfection.

Conclusion

Studies suggest that the overall picture of motor performance does not depend on the type of laterality. The observed lower values of performance components indicate rather incomplete lateralization process. Another problem seems to be the assessment of the quality of performance of motor skills. Hence the need to pay particular attention to the realization of the proper plays and motor games during which can be shaped primarily motor skills that are the basis for the proper functioning of the child in school.

Biobliography

1. Annett, M. (2009). Patterns of hand preference for pairs of actions and the classification of handedness. *British Journal of Psychology*, *100,* 491-500.
2. Bala, G., Golubovi, P., & Kati, R. (2010). The relation between handedness and motor abilities in preschool children. *Collegium Athropologicum*, *34*, *(Suppl.1),* 69-75.
3. Connolly, B.H. (1983). Lateral dominance with learning disabilities. *Physical Therapy, 63, (2),*183-187.
4. Dellatolas, G., Curt, F., Dargent-Paré, C., & De Agostini, M. (1998). Eye dominance in children: a longitudinal study. *Behavior Genetics, 28,(3),*187-195.
5. Gabbard, C. (1992). Associations between hand and foot preferencje in 3-to5-year-olds. *Cortex, 28,(3),*497-502.
6. Gentry, V., & Gabbard, C. (1995). Foot preference behavior: a developmental perspective. *The Journal of General Psychology, 122, (1),*37-45.
7. Gruber, T., Meixner, B., Prosser, J., & Sick, B. (2012). Handedness test for preschool children: A novel approach based on graphics tablets and support vector machines. *Applied Soft Computing, 12,*1390-1398.
8. Iteya, M., Gabbard, C., & Hart, S. (1995). Patterns of limb laterality and gross -motor agility in children. *Perceptual and Motor Skills, 81,(2),*623-626.
9. Keane, A. M. (2008). What aspect of handedness is general motor programming related to? *International Journal of Neuroscience*, 118(4), 519-530.
10. Koszczyc, T. (1991). *Asymetria morfologiczna i dynamiczna oraz możliwości jej kształtowania u dzieci w młodszym wieku szkolnym. Wrocław: AWF,* pp.184.
11. Leconte, P., & Pagard, J. (2006). Which factors affect hand selection in children's grasping in hemispace? Combined effect o task dem and and motor dominancie. *Brain and Cogniton, 60,*88-93.
12. Mori, S., Iteya, M.,& Gabbard C. (2007). Hand preference consistency and simple rhythmic bimanual coordination in preschool children. *Perceptual Motor Skills, 104 (1),* 792-798.
13. Nachshon, I., Denno, D., & Aurand S. (1983) Lateral preferences of hand, eye and foot: relation to celebral dominance. *International Journal of Neuroscience, 18, (1-2),* 1-9.
14. Porac, C. & Coren, S.(1981). *Lateral Preferences and Human Behavior*. New York: Springer.
15. Rousson, V., Gasser, T., Caflish, J., & Jenni, O.G. (2009). Neuromotor performance of normalny developing left-handed children and adolescents. *Human Movement Science, 28,*809-817.
16. Schmidt, R.A., & Wrisberg, C.A. (2008). *Motor learning and performance. A situation - based approach* (4th ed). Illinois, Human Kinetics.
17. Tan, L.E. (1985). Laterality and motor skills in four-year-olds. *Child Development, 56,* 119-124.
18. Van Mier, H. (2006). Developmental differences in drawing performance of the dominant and non dominat hand in right-handed boys and girls. *Human Movement Science, 25,* 657-677.
19. Whintinghton, J.E., & Richards, P.N. (1987). The stability of children's laterality prevalence and their relationship to measures of performance. *British Journal of Educational Psychology, 57,(1),* 45-55.
20. Teixeira, M.C., &Teixeira, L.A. (2008). Leg preference and interlateral performance asymmetry in soccer player children. *Developmental Psychobilogy,50,(8),* 799-806.

INLINE SKATING AS AN AIDING TOOL FOR BETTER LEARNING BASICS OF ALPINE SKIING IN ADULT SKI BEGINNERS

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Abstract

This research aimed to investigate the possible correlation between the knowledge of inline skating with learning of alpine skiing. We included 134 participants, randomized to two equal-sized groups based on their previous knowledge on recreational level inline skating. They were enrolled in 10-days alpine ski school under similar conditions. The acquired knowledge of alpine skiing was graded based on performance of six previously chosen elements of alpine ski technique. The overall level of new alpine ski knowledge was tested by Factor analysis. The calculated Eigen value of first principal component (λ=5,741) was significant and represented the acquired alpine ski knowledge which was further used in data analysis. The group of participants with the recreational level knowledge of inline skating was more efficient while learning alpine skiing compared to participants lacking knowledge of inline skating (4.1 vs. 3.4; p=0.00). Moreover, results have shown high and statistically significant correlation between the level of acquired alpine ski knowledge and estimated knowledge of inline skating (r=0.78). We conclude that inline skating can be used as an efficient tool for better learning alpine skiing.

Key words: *learning alpine skiing, recreational skiers, alternative sport*

Introduction

Condition training for alpine skiing uses many alternative sports such as: mountain bike, uphill and downhill running, inline skating, football, judo or sports gymnastics. Frequency and amount of their use depends upon the skier's age and period of training (Maffiuletti et al., 2003). As alpine skiing is a winter sport, training during summer months often relies on alternative sports, which use similar elements as skiing, and help in conditioning trainings for upcoming competitions. For competitive alpine skiers inline skating can to some extent replace skiing training. On skates one can make similar turns in narrow corridor as on skies. The example of such discipline is slalom (Kroll et al., 2005). On the other hand, research also showed differences between turns made on skies and skates. Mainly differences are evident in ground surface and equipment used, which in turn affect speed. This also changes distribution and intensity of forces influencing skier during a turn (Takahashi & Yoneyama, 2001). However, there are far more similarities than differences between skier's movements during turns while skiing and inline skating (Ropret, 2010). When skier's movements during ski and inline skating turn are compared in sagittal and frontal planes there seem to be no great differences. Almost identical movements in ankles, knees and hips as well as in leg muscles and back extensors must be performed in order to make continuous turns in an ideal balance position during both ski and inline skating turns (Kroll et al., 2005). From the aspect of motor abilities, one has to accentuate explosive strength, balance and agility as being the most important for success in alpine skiing (Neumayr et al., 2003). Investigation also suggests that inline skating and skiing influence development of similar motor abilities (Muehlbauer et al., 2013). According to the theory of similarity, there is a dependence of identical elements among the tasks which can be transferred when there are similarities between the two motor activities. This could explain the relationship between balance and rotation which are important for inline skating but can also aid teaching alpine skiing (Roman et al., 2009). In contrast to studies on elite skiers, there is still paucity of scientific literature concerning the recreational alpine skiing and influence of inline skating on better and faster learning basics of alpine skiing. The single study to the best of our knowledge investigation relationship of inline skating and learning basics of alpine skiing was published in 2009 by Roman and coworkers on children aged 7 to 13. This study pointed to positive effects of inline skating on efficiency of alpine ski learning. Positive correlation between movements performed during skiing and inline skating leads to an assumption that knowledge of inline skating might influence process of learning alpine skiing at a recreational level. Due to correlation between turns on skates and skies, this investigation aimed at determining correlation between the levels of acquired knowledge of alpine skiing with previous knowledge of inline skating in adult alpine ski beginners.

Methods

Participants – 139 volunteers entered the study. They were recruited from University of Zagreb. The participant's sample was separated into two groups according to the knowledge of inline skating-one group consisted of 67 participants with prior knowledge of inline skating at a recreational level and other of 72 participants with no knowledge of inline skating.

Variables – Acquired ski knowledge of all study participants was measured on six representative elements of ski technique: traversing, uphill turn, basic turn, snowplough, parallel turn and short turn. Each participant demonstrated all the mentioned elements, and traversing and uphill turn were performed in the left and right side so overall four marks were given for these specific elements. Based on the grades, the knowledge of skiing was rated. Final grade was calculated by factorial analysis.

Study protocol – At the beginning of investigation participants' with prior knowledge of inline skating self-evaluated their inline skating according to the three proposed levels; no knowledge of inline skating whatsoever, basic knowledge of inline skating, and advanced knowledge of inline skating. Mentioned use of self-evaluation was previously seen in other investigations (Sporis et al., 2011), and is especially reliable among young people. Moreover, participants involved in this investigation were from the population of kinesiology students, who among other, are educated to evaluate/self-evaluate abilities and knowledge. All participants were taught alpine skiing during 10 days alpine ski school. During the period they had identical conditions concerning the number of participants pro group (10), number of learning hours per day (4), number of hours for practice daily (2), quality and adequacy of skiing equipment, quality of ski instructors, and adequacy of ski terrains. Upon finishing structured program of alpine ski school each participant demonstrated the acquired knowledge of alpine skiing on six elements, graded by independent judges. According to the grades obtained, each participant's knowledge of alpine skiing was ranked. Grading process followed the five point scale, where one represented worst and five best knowledge of skiing. Data acquisition followed the standardized procedure of rating ski knowledge (Cigrovski et al., 2008).

Statistical methods – Obtained data was analyzed by statistical package "SPSS for Windows 14.0". Obtained distributions were tested by Kolmogorov-Smirnov test (K-S). Basic descriptive parameters were calculated for six tests used to value acquired alpine ski knowledge. Significance of difference between ski knowledge of two participant groups was determined by ANOVA. Fisher's test was then used to analyze the determined difference. Factor analysis was used to determine the participants' overall skiing knowledge. Catell scree criterion or GK criterion were used to determine the number of factors. Afterwards, Pearsons correlation coefficients (r) were used to determine the level of correlation between knowledge of alpine skiing and knowledge of rolling.

Results were significant with $p<0.05$.

Results

Results of central and dispersive parameters for mean knowledge of alpine skiing and inline skating are given in Table 1.

Table 1: Descriptive statistical parameters of graded knowledge of alpine skiing; alpine skiing of participants with prior knowledge of inline skating; alpine skiing of participants with no prior knowledge of inline skating and graded knowledge of inline skating

Motor knowledge	N	Min	Max	M	SD
Alpine skiing	139	2.25	5.00	3.7	0.70
Alpine skiing in participant with prior knowledge of inline skating	67	3.00	5.00	4.1	0.54
Alpine skiing in participants with no prior knowledge of inline skating	72	2.25	5.00	3.4	0.65
Inline skating	67	2.00	5.00	3.91	0.82

Of 139 participants who were included in the investigation, 67 had previous knowledge of inline skating. Average grades of acquired alpine skiing were significantly higher for participants who had previous knowledge of inline skating. Significance of difference between the participants of the two groups (4.1 *vs.* 3.4) was tested by ANOVA.

Table 2: Results of difference between the two groups of participants based on graded level of alpine skiing

Variable	Alpine skiing in participants with prior knowledge of inline skating		Alpine skiing in participants with no prior knowledge of inline skating		ANOVA	
	M	**SD**	**M**	**SD**	**F**	**P**
Knowledge of alpine skiing	4.1	0.54	3.4	0.65	52.29	0.00

F=Fisher's test

Statistically significant difference in the level of acquired alpine ski knowledge was determined between the two groups of participants (p=0.00; Table 2). One group used inline skating before the school of alpine skiing and the other didn't. Results suggest how inline skating prior to structured program of alpine ski school can aid better learning of alpine skiing.

Factor analysis determined the main components based on eight grades given to each participant for the demonstration of chosen elements of alpine ski technique (Table 3).

Table 3: Results of factor analysis

Components (factors)	λ	%	Cumulative %
1	**5.741**	**71.765**	**71.765**
2	0.589	7.362	79.127
3	0.442	5.526	84.653
4	0.389	4.858	89.511
5	0.311	3.891	93.403
6	0.198	2.474	95.876
7	0.178	2.228	98.104
8	0.152	1.896	100

λ = Eigen value; %= percentage of explained variance

Table 3 shows the results of main components, and first main component with the only statistical significance (λ=5.741). Based on calculated results, one can extract the first main component explaining almost 72% of overall variance and presenting the factor of skiing knowledge.

By correlation we analyzed the first main component, correlating the defined factor of ski knowledge with grade of each participant on elements of alpine ski technique.

Table 4: Results of correlation analysis between average grades for elements of alpine ski technique and first main component defined as ski knowledge

Elements of alpine ski technique	Correlation with first main component
traversing left	0.84*
traversing right	0.859*
uphill turn to the left	0.854*
uphill turn to the right	0.879*
basic turn	0.797*
snow plough turn	0.821*
parallel turn	0.874*
short turn	0.85*

* p<.05; ** p<.01

Based on calculated correlation shown in Table 4, it is evident how grades of all eight elements of alpine ski technique correlate significantly with first main component. Calculated correlations are high and significant and allow the use of first main component as a factor of acquired knowledge of alpine skiing.

Table 5 shows results of correlation analysis between the level of alpine ski knowledge and estimated knowledge of inline skating.

Table 5: Correlation coefficients between the level of alpine ski knowledge and knowledge of inline skating

	knowledge of alpine skiing	knowledge of inline skating
knowledge of alpine skiing	1	0.78**
knowledge of inline skating		1

* p<.05; ** p<.01

Correlation analysis shows significant correlation between level of acquired knowledge of alpine skiing and knowledge of inline skating. Alpine skiing and inline skating share many similarities so calculated correlation is not surprising (Kroll et al., 2005; Ropret, 2010). Results suggest positive correlation between knowledge of inline skating and learning of alpine skiing.

Discussion and conclusion

The purpose of our investigation was to test whether recreational level inline skating can aid safer and more successful learning alpine skiing in adult ski beginners. The statistically significant correlation between knowledge of inline skating and level of acquired alpine skiing in our investigation suggests that this is an advantage when starting a basic alpine ski school program for adults. Same results were also seen for children alpine ski beginners by Roman and coworkers (2009), where children with previous knowledge of inline skating learned basics of alpine skiing better than children with no experience in inline skating. In the mentioned research, experimental group of children were training inline skating sixteen days before attending basic alpine ski school and achieved better results compared to control group. Mentioned can be explained by the theory of similarity, which emphasizes how the alikeness of tasks can be transferred into better learning (Rienhoff et al, 2013), suggesting knowledge of one sport can make learning of other similar sport much easier. In the example of alpine skiing and inline skating sharing balance and rotation, one can expect knowledge of skating to aid acquisition or improvement of alpine skiing. Following this principal, ski beginners could benefit from knowledge of inline skating which could facilitate successful and safe motor learning of an activity such as alpine skiing (Roman et al., 2009). Previous investigation showed no significant difference between alpine ski competitor's movements during slalom turn and similar radius turn made on inline skates (Takahashi and Yoneyama, 2001). From the aspect of controlling both skies and skates, the main correlation is in the way of achieving speed and change of direction. The mentioned in turn led to the wider use of inline skating during condition training of alpine ski competitors (Kroll et al., 2005). As alpine skiing is a risky and technical sport, many of research investigates the safe ways of learning alpine skiing under controlled and structured programs of alpine ski school (Žvan et al., 2015). Inline skating is a popular sport on a recreational level, but also for the beginners it is often associated with a high potential for falls and injuries (Muehlbauer et al., 2013). According to one model of learning, ski beginners would advance in alpine skiing by changing the length of skies every few days during alpine ski program. During mentioned approach, in the first ski day ski beginners use very short skies, 90 cm in length. Afterwards they are advanced to skies of 125 cm and only at the end of the program to the skies of standard length, customized for each individual ski beginner (Murovec, 2006). Such program favors inline skating in the pre-alpine ski school program not only because of the similar length of skates and starting skies but also because of the similar motor patterns during inline skating and alpine skiing. Short skies just like skates require constant maintenance of central position during turns, which in turn help in keeping perfect balance. One could for the mentioned reason expect the adjustment to the short skies to be faster if participants are experienced in inline skating. Our own results suggest more successful and consistent learning of alpine skiing for adult participants of alpine ski school with previous knowledge of inline skating. For the above mentioned reasons, participants of the alpine ski school with knowledge of inline skating would in the same time period of structured alpine ski school program achieve basics of alpine skiing much faster. Based on our results we would suggest ski beginners to use inline skating as a preparation for basic alpine ski school. Inline skating is a practical tool while its basics can be learned on almost all hard and flat surfaces available in different town or village settings and easily matched with every-day life responsibilities. To conclude, inline skating is an ideal activity to prepare adult ski beginners for learning basics of alpine skiing.

References

1. Aerenhouts, D., De Raedemaeker, L., Clarys, P., Zinzen, E. (2015). Energy expenditure in novice skiers and snowboarders. In: Science and skiing. In E. Műller, J. Kroll, S. Lindinger, J. Pfusterschmied and T. Stoggl (Eds.), Proceedings from: The six international Congress on Skiing and Science (pp. 89-94). Oxford, UK: Mayer & Mayer Sport.
2. Cigrovski, V., Matković, B., Matković, R.B. (2008). Evaluation of objectivity and homogeneity of skiing knowledge grading process. In: D. Milanović, F. Prot (Eds.), 5th International Scientific Conference on Kinesiology (pp. 513-517). Zagreb: Faculty of Kinesiology.
3. Kroll, J., Schiefermuller, C., Birklbauer, J., & Muller, E. (2005). In-line skating as dry land modality for slalom racers-electromyographic and dynamic similarities and differences. In: E. Muller, D. Bacharch, R. Klika, S. Lindinger, & H. Schwameder (Eds.), Proceedings from: The thirth international Congress on Skiing and Science (pp. 76-86). Oxford, UK: Mayer & Mayer Sport.
4. Maffiuletti, K., Jordan, K., Spring, H., Impellizzeri, F.M., Bizzini, M. (2009). Physiological profile of Swiss elite alpine skiers-a 10-year longitudinal comparison. In: Muller, E., Lindinger, S. and Stoggl, T. (Eds.), The fourth international Congress on Skiing and Science (pp. 365-373). Oxford, UK: Mayer & Mayer Sport.
5. Muehlbauer, T., Kuehnen, M., Granacher, U. (2013). Inline skating for balance and strength promotion in children during physical education. Perceptual and Motor Skills, (3), 665-681.
6. Murovec, S. (2006). Na kanto! : UPS – učenje s podaljševanjem smuči. Kranj: Format Kranj.
7. Neumayr, G., Hoertnagl, H., Pfister, R., Koller, A., Eibl, G., & Raas, E. (2003). Physical and Physiological Factors Associated with Success in Professional Alpine Skiing. International Journal of Sports Medicine, 24(8), 571-575.
8. Rienhoff, R., Hopwood, M.J., Fischer, l., Strauss, B., Baker, J., Schorer, J. (2013). Transfer of motor and perceptual skills from basketball to darts. Frontiers in Psychology, 4, 593. doi: 10.3389/fpsyg.2013.0059.
9. Roman, B., Miranda, M.T., Martinez M. and Jesus, V. (2009), Transfer from in-line skating to alpine skiing instruction in physical education. In: Muller, E., Lindinger, S. and Stoggl, T. (Eds.), The fourth international Congress on Skiing and Science (pp. 430-439). Oxford, UK: Mayer & Mayer Sport.
10. Ropret, R. (2010). The application of rollerblades in alpine skiers training. Physical culture, 64(1), 72-78.
11. Sporis, G., Siljeg, K., Mrgan, J., Kevic, G. (2011), Self evaluation of motor and functional abilities among pupils, Croatian Journal of Education, 13, 66-81.
12. Takahashi, M., & Yoneyama, T. (2001). Basic ski theory and acceleration during ski turn. In: Science and skiing. In E. Műller, H. Schwameder, C. Raschner, S. Lindinger, and E. Kornexl (Eds.), The second international Congress on Science and Skiing (pp. 307–321). Hamburg, Germany: Verlag Dr. Kovač.
13. Žvan, M., Lešnik, B., Supej, M. (2015). Progressive increase in velocity, ground reaction forces, and energy dissipation in Alpine ski school elements. In: Science and skiing. In E. Műller, J. Kroll, S. Lindinger, J. Pfusterschmied and T. Stoggl (Eds.), Proceedings from: The six international Congress on Skiing and Science (pp. 354-358). Oxford, UK: Mayer & Mayer Sport.

THE IMPLEMENTATION OF THE PEER ASSISTED LEARNING STRATEGIES IN PHYSICAL EDUCATION IN HONG KONG

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Purpose: Peer assisted learning (PAL) strategies have been widely adopted in physical education (PE). They facilitate peer education and involved peer-based interaction and learning (Ward & Lee, 2005). These strategies are innovative, and effective in helping students in different learning domains. The reciprocal style of teaching (Mosston & Ashworth, 2002) and cooperative learning (CL) (Dyson & Casey, 2012) are common PAL strategies in PE. They aim to tackle problems associated with large classes, limited equipment, and insufficient feedback to students and learners diversity. However, these strategies are rarely practiced and studied in Hong Kong. The purpose of the study was to investigate students' perceptions of, and experiences in reciprocal teaching and cooperative learning in PE in Hong Kong schools. Factors that influence students' learning with these strategies were also examined.

Methods: Eight experienced local primary and secondary PE teachers from different regions of Hong Kong and their classes were purposely selected to take part in the study. Four teachers were briefed on the principles and implementation of the reciprocal style, while another four teachers were reminded the principles and implementation of CL, and taught a 10-lesson unit with the same strategies in their schools. A combination of techniques was used to collect qualitative data: lesson observations, formal interviews of students and teachers, student reflective journals and teachers' self-review. Constant comparison and inductive analysis were used to organize code and categorize the data.

Results: Findings indicated that the students' learning benefited from the PAL. Learning experiences influenced the students' learning attitudes in PE lessons. Teachers' experience, support, tasks designed and tutors' abilities were found to be major factors influencing students' learning in PAL strategies. In particular, teachers' intervention and preparation availed students in the learning process. Students and teachers require time to learn and adapt to PAL strategies; they also held positive views and recognized the values of the approaches.

Conclusions: Findings of the study contain implications that will help pre-service and in-service PE teachers adopt PAL strategies in schools.

Reference

1. Dyson, B., & Casey, A. (2012). *Cooperative learning in physical education: A research-based approach*. London: Routledge.
2. Mosston, M., & Ashworth, S. (2002). *Teaching physical education* (5th ed.). San Francisco: Benjamin Cummings.
3. Ward, P., & Lee, M-A. (2005). Peer-assisted learning in physical education: A review of theory and research. *Journal of Teaching in Physical Education, 24*(3), 205-225.

THE EFFECT OF AN INSTRUCTIONAL PROGRAM USING THE EDUCATIONAL PLAYING STRATEGY ON THE SKILLS PERFORMANCE LEVEL OF TRACK AND FIELD COMPETITIONS OF THE SIXTH GRADE STUDENTS

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Abstract

Purpose: The research aims to design an instructional program using the educational playing strategy and its effect on the skills performance level of track and field competitions of the sixth grade students.

Methods: The researcher used the experimental method for two groups, one of them is experimental and the other is control, and the program implementation took (8) weeks with four learning units for the research' skills, two lessons weekly and the lesson time is (45) minutes according to the school curriculum's content.

Results: The study concluded that the educational program of educational games has a positive effect in improving the skill performance of the experimental group in track and field competitions of the research' sample.

Discussion: After the application, the post measurements were carried out and data collection, which have been statistically, analyzed using t-test for the significance of differences of pre and post measurements، This improvement is also due to the achievements of the use of a program of educational games provide the feedback for students in the experimental group in all steps of education, which is reflected on the level of the learner in a positive, where control through the main educational games and display them attractive and interesting and easy manner through the use of images and so it takes into account the level of capabilities and the needs of pupils educated individual and their differences, leading to attract their attention and increase their enthusiasm to do more, thereby increasing motivation and achieving high performance rates towards learning methodology skills in athletics, "under discussion". That you can not teach the skills of sports activities, including through rote because it desperately needs to be to take advantage of all the means of technological and scientific progress of the methods and techniques in order to make it easier for the teacher and the learner to reach the desired goals (Mahmoud Abdel-Halim, 2006).

References

1. Mahmoud Abdel Halim Abdel Karim: dynamic teaching of Physical Education, the book center, Cairo, 2006.

METRIC CHARACTERISTICS OF BALANCE TESTS FOR PRESCHOOL CHILDREN, AGE 5-6

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Abstract

The aim of this study was to determine the metric characteristics of five motor tests for assessing balance. Sample included preschool children at the age 5-6. The study included 53 children, 34 boys and 19 girls from Zagreb, Croatia. Measuring instrument consisted of five different motor tests: *Standing with one foot on the balance cube* (MRJK), S*tanding on one leg longitudinally on the balance bench with open eyes* (MRUO), *Standing on one leg longitudinally on the balance bench with eyes closed* (MRUZ), *Standing on two legs across the balance bench with open eyes* (MRPO) and *Standing with two legs across the balance bench with eyes closed* (MRPZ). Data of the tests were checked with descriptive statistics and metric characteristics of each test was proven: objectivity, sensitivity, reliability, homogeneity and validity. Results showed only one test *Standing with one foot on the balance cube* (MRJK) has satisfactory metric characteristic, and it is recommended for preschool teacher to use it when testing balance motor skill.

Key words: *balance; child; measurements, preschool teacher*

Introduction

The balance as a motor characteristic is a complex feature, since psychological, physiological and biomechanical components are integrated together. The ability to maintain balance in static or dynamic conditions is very important for successful implementation of a numerously human activities in daily life as well as the specific ones in programmed activities. (Tkalčić, 1987).

The problem of monitoring motor skills in preschool population lies in inadequate measuring instruments for preschool children with unsatisfactory metric characteristics of the same since most of those have been designed for adults or school population. The applied tests for assessment of the balance can be divided into two: tests for static and dynamic balance: like balancing on one or both feet on the balance bench (eyes can be open or closed), balancing on only one foot on the ground, walking along the line between the feet, walking on a line, on a gymnastics beam or on an elevated bench, etc. Using a large sample of 7-years-old Babin (1993) determined metric characteristic of the test for assessing the balance *Standing on the balance bench across with both legs with the open eyes*, and in results has obtained weak average value of the correlation between the particles. Then, in a sample of preschool children Horvat et al. (2008) have also tried to determine metric characteristic of three tests for assessing a balance. Two tests: *Standing with both feet transversely to the direction of the bench* and *Standing with one foot transversely to the direction of the bench* shown satisfactory metric characteristics while the third one *standing with one foot along the bench* shown something worse results. Same authors believe it would be justified to make certain changes in the construction of the tests, like so, to increase the standing surface of the instrument balance board. They assumed this change would probably improve metric characteristics of designed test. Hraski et al. (2015) used a sample of 4-year-olds and found that the test for assessing the balance *Walking on the narrowed field* has satisfactory metric characteristics and can be used for this age group when assessing the balance. Still, another test *Standing on one leg* showed a poor metric characteristics and they don't recommend it for assessing balance. Popeska et al. (2015) on a sample of 7-year-old used the test *Walking on upturned Swedish bench* and conclude, test can be recommended for future use for estimation of dynamic balance, while the test *Standing on a bench in width* has the best metric characteristics and could be recommended for future use when evaluating static balance in 7-year-old children.

The earliest childhood is the best time to start with different exercises when we talk about development of gross motor characteristic of balance. For adopting balance there are numerous games and exercises tailored and appropriate for preschool children. There are games of imitation and animals like movements, all exercises crossing along the benches, climbing and descending the slope, field games, different dances and dance structures, all kind of elements of rhythmic and sport gymnastics on the ground, ballet, etc. (Kosinac, 2011). The child's environment influence largely on one's motivation and the willingness to play and exercise what is necessary for the proper development of balance motor skill.

The aim of this study was to check the metric characteristics of five balance tests for children aged 5-6 years old and to produce recommendation for preschool teachers' when they perform testing in preschool institutions.

Methods

The research sample consisted of 53 preschool children (34 boys and 19 girls) from three different kindergarten groups in Zagreb, Croatia. Children were 5 - 6 years of age. For each child, it was obtained parents written consent according to Code of Ethics for Research with Children (Dulčić, 2003), which allow child's participation in research. At the time of data collection, no child had health problems or disease, and all were tested in the same conditions. Five different tests were used for purpose of this study. The first test was *Standing with one foot on the balance cube* (MRJK), second, *Standing on one leg longitudinally on the balance bench with open eyes* (MRUO), third, *Standing on one leg longitudinally on the balance bench with eyes closed* (MRUZ), fourth *Standing on two legs across the balance bench with open eyes* (MRPO) and the last *Standing with two legs across the balance bench with eyes closed* (MRPZ).

Results and Discussion

The basic descriptive statistics are shown in Table 1. Result values presented a significant dispersion of the results in all tests except the first one: MRJK - *Standing with one foot on the balance cube*. The coefficient of asymmetry (Skew) exposed a positive asymmetric distribution in all particles of tests which means the majority of respondents classify in areas of lower results with few extremely high values. Normality of distribution was tested with Kolmogrov-Smirnov (K-S) test. According to the K-S test, distribution of the results in seven variables do not deviate from the "normal" (p> .20) while in eight does. Only one variable MRJK - *Standing with one foot on the balance cube* in all three measurements had normal distribution of results and only for the one satisfactory sensitivity of the test can be determined (Table 1).

Table 1: The basic descriptive statistics of tests

	M	SD	Min	Max	Skew	Kurt	K-S	p
MRJK1	12.33	12.19	1.28	60.00	1.61	3.29	0.18	p< .10
MRJK2	13.13	13.45	1.82	60.00	1.74	2.90	0.21	p< .05
MRJK3	13.96	12.42	1.11	60.00	1.53	2.62	0.16	p< .15
MRUO1	2.96	1.19	1.24	7.03	1.16	1.90	0.11	p> .20
MRUO2	2.74	1.33	1.05	9.05	2.56	9.32	0.16	p< .15
MRUO3	3.10	2.02	1.13	13.26	3.11	12.46	0.25	p< .01
MRUZ1	2.13	0.93	0.84	5.91	1.73	4.15	0.19	p< .05
MRUZ2	2.24	0.78	0.94	4.04	0.64	-0.38	0.13	p> .20
MRUZ3	2.09	0.65	0.79	3.70	0.64	0.24	0.14	p> .20
MRPO1	2.24	0.84	0.52	4.67	0.33	0.46	0.05	p> .20
MRPO2	2.44	0.94	0.80	4.70	0.68	0.17	0.10	p> .20
MRPO3	2.19	0.86	0.98	6.37	2.34	9.82	0.14	p< .05
MRPZ1	1.89	0.75	0.75	5.30	1.91	7.05	0.13	p> .20
MRPZ2	1.90	0.57	0.95	3.83	1.30	2.92	0.12	p> .20
MRPZ3	1.95	0.66	0.73	3.98	0.93	0.75	0.14	p> .20

MRJK - 1st, 2nd, and 3rd measurement - Standing with one foot on the balance cube; MRUO - 1st, 2nd, and 3rd measurement - Standing on one leg longitudinally on the balance bench with open eyes; MRUZ - 1st, 2nd, and 3rd measurement - Standing on one leg longitudinally on the balance bench with eyes closed; MRPO - 1st, 2nd, and 3rd measurement - Standing on two legs across the balance bench with open eyes; MRPZ - 1st, 2nd, and 3rd measurement - Standing with two legs across the balance bench with eyes closed; The arithmetic mean (M), Standard deviation (SD), The minimum value (Min.), The maximum value (Max.), Coefficient of asymmetry (Skew), Coefficient of curvature (Kurt), Value of Kolmogrov-Smirnov test (KS), The value of significance (p)

Homogeneity is a property of the composite tests, explaining does the results of the respondents in all the particles depend on the same object of measurement or identical combinations of different items of measurement (Dizdar, 2006). The homogeneity of tests was calculated with correlation between the particles. High enough correlation between the particles from 0.61 to 0.71 was found only in the test MRJK - *Standing with one foot on the balance cube*, like shown in Table 2., while the other four conducted tests do not meet this metric characteristic.

Table 2: Correlation of the particles for the test MRJK - Standing with one foot on the balance cube

Variable	Correlation		
	MRJK1	MRJK2	MRJK3
MRJK1	1.000	0.611	0.713
MRJK2	0.611	1.000	0.704
MRJK3	0.713	0.704	1.000

Reliability of internal consistency is expressed through Crombach alpha. Only one test MRJK - *Standing with one foot on the balance cube* shown good metric characteristic with Crombach α 0.86, while Crombach α of remaining four tests range in the interval from 0.32 to 0.62 and do not meet the reliability of these tests (Table 3).

Table 3: Reliability of internal consistency expressed through Crombach alpha for all five test

variable	Cronbach alpha	Standardized alpha	Average inter-item corr
MRJK	**.860**	**.862**	**.678**
MRUO	.622	.628	.368
MRUZ	.528	.536	.279
MRPO	.466	.460	.225
MRPZ	.320	.319	.135

The validity of all five tests was determined by factor analysis. Rotation of the principal components in varimax position gave the two-factor structure of the analysed area (Table 4). The first factor has eigenvalue of 4.69 and explains 31.28% of the total variance of the analysed variables (Table 5). It is evident, the test MRJK - *Standing with one foot on the balance cube* described the strongest area of the first factor, thus confirming the validity of this test for use in pre-school, with children of 5 - 6 years of age.

Table 4: The principal components obtained by factor analysis – varimax position

variable	Factor 1	Factor 2
MRJK1	**0.772**	0.100
MRJK2	**0.850**	-0.018
MRJK3	**0.726**	0.093
MRUO1	0.510	0.433
MRUO2	0.710	-0.149
MRUO3	0.570	0.342
MRUZ1	0.694	0.129
MRUZ2	0.131	0.569
MRUZ3	0.386	0.342
MRPO1	0.363	0.345
MRPO2	0.235	0.467
MRPO3	-0.131	0.680
MRPZ1	0.596	0.089
MRPZ2	-0.031	0.693
MRPZ3	0.292	0.452
Explain variance	4.233	2.302
Total proportion	0.282	0.153

Table 5: Eigenvalues and percentage of total variance explained

	Eigenvalues	% total Variance	Cumulative Eigenvalues	Cumulative %
1	4.693	31.288	4.693	31.288
2	1.843	12.287	6.536	43.575

Results received of the proportion between mean and standard deviation acknowledge bad sensitivity of all used tests. Average values of tests are highest in the test MRJK - *Standing with one foot on the balance cube* which could be explained throughout wider foothold where children could hold out longer period of balance position in relation to other tests whose surface was narrower. The scatter of skewness values showed that all the tests are difficult to perform on the sample's age. Analysing the results for validity, reliability and representativeness of the tests, again only MRJK test - *Standing with one foot on the balance cube has good* metric characteristics. Similar result with low discrimination got

Popeska (2015) on a research sample of 7-years-old in the test *Walking on upturned Swedish bench* and *Standing on bench in width and in length* with also high validity and representativeness. In research sample of 6-years-old using the same tests Popeska (2014) communicate bad sensitivity but high reliability and validity of applied tests. In another research Ikeda and Aoyagi (2007) on a sample of preschool children explained how the test for assessing the balance (standing on a one foot and squat balance) are difficult for them, because it is hard for young children to find motivation while they perform what is related with their determination. Satisfactory discriminability is not found for the test *Standing on one leg* on research sample of 4-year-olds (Sindik, Horvat i Hraski, 2016) while different test *Walking on the plank* had good metric characteristics. Same, can be found in other researches (Perić, 1991; Popeska & Jovanova-Mitkovska, 2014; Hraski, Horvat & Bokor, 2016) where this test they recommend as consider appropriate for use with preschool children.

The concern of metric characteristics of different tests for assessing the balance in preschool population can be explained by research Foudriat et al. (1993) where it is explained how the same somatosensory-dominant postural control as in adults can be achieved in age of six, what leads to conclusion, development of standing balance can almost be finished in early school years. Morioka (2001) has reported that the ability to maintain the one-leg standing position with eyes open will dramatically improve in children within the period from late preschool age to early school age, and the improvement will slow down during late school age. Similar results described Figura et al. (1991) where suggests that around 8-years-of-age some static balance abilities have already been acquired, such as two-feet postures, but somewhat more difficult postures, such as standing on one foot only, are still in their major developmental phases.

Conclusion

Based on the results of the sensitivity analysis, and on the values of the asymmetry and curvature of distribution (skewness and kurtosis), it is possible to conclude that measuring instrument MRJK - *Standing with one foot on the balance cube* in all three measurement has a normal distribution, and the results can be concluded that only this test from five initially suggested is satisfactory sensitive. The condition of homogeneity in terms of the correlative relationship between the particles is also satisfied in the test MRJK - *Standing with one foot on the balance cube* while the Cronbach α of the same test was 0.86. From the above it can be also settled that the test MRJK - *Standing with one foot on the balance cube* showed factorial validity, and can be applied to estimate the static balance of preschool children in practice. As mentioned before, other four tests for assessing balance used in this research didn't showed satisfactory metric characteristics.

Limitation of the research refers to small research sample and limited geographical area, which in future research no doubt need to be expanded in both directions but staying strictly in the same age group.

The results for defining the metric characteristics of selected test for assessing balance will contribute to better programming of kinetic activities in preschool programs, monitoring motor development of children and can increase the quality of work of preschool teachers.

References

1. Babin, J., (1993). Pouzdanost nekih motoričkih testova kod polaznika prvog razreda osnovne škole. In: V. Findak (Ed.), *Conference Proceedings: 2. ljetna* škole *pedagoga fizičke kulture Republike Hrvatske: Motorička znanja u funkciji razvoja* čovjeka, (pp.58-60). Rovinj: Hrvatski savez pedagoga fizičke kulture.
2. Dizdar, D. (2006). *Kvantitativne metode*. Zagreb: Faculty of Kinesiology, University of Zagreb
3. Dulčić, A. (Ed) (2003). *Etički kodeks istraživanja s djecom*. Zagreb: Vijeće za djecu Vlade Republike Hrvatske, državni zavod za zaštitu obitelji, materinstva i mladeži.
4. Figura, F., Cama, G., Capranica, L., Guidetti, L., & Pulejo, C. (1991). Assessment of static balance in children. *The Journal of Sports Medicine and Physical Fitness*, 31(2): 235-242.
5. Foudriat, B. A., Di Fabio, R. P., & Anderson, J. H. (1993). Sensory organization of balance responses in children 3-6 years of age: a normative study with diagnostic implications. *International Journal of Pediatric Otorhinolaryngology*, 27(3): 255-271.
6. Horvat, V., Jenko Miholić, S., & Blažević, K. (2009). Metric characteristics of tests for assessing balance in preschool children. In I. Prskalo, V. Findak, & J. Strel (Eds.), *Conference Proceedings: 3rd Special Focus Symposium: Kinesiological education – heading towards the future* (pp. 75-82). Zadar: Faculty of Teacher Education, University of Zagreb.
7. Hraski, M., Horvat, V., & Bokor, I. (2016). Metric Characteristics of Tests for Assessing Coordination, Speed and Balance in Four-Year-Old Children. *Croatian Journal of Education*, 18(SE1): 61-70.
8. Ikeda, T., & Aoyagi, O. (2008). Relationship between test characteristics and movement patterns, physical fitness, and measurement characteristics: suggestions for developing new items for 2-to 6-year-old children. *Human Performance Meauserement*, 5: 9-22.
9. Kosinac, Z. (2011). *Morfološko-motorički i funkcionalni razvoj djece uzrasne dobi od 5. – 11. godine*. Split: Savez školskih športskih društava grada Splita.
10. Morioka, S. (2001). Changes in the ability to stand on one leg in children from babyhood to school age. *Rigakuryohogaku*, 28: 325-328.
11. Perić, D. (1991). Comparative analysis of the methodological system of explication biomotoric status of preschool children. (Unpublished doctoral dissertation, University of Beograd) Beograd: Fakultet za fizičko vaspitanje.

12. Popeska, B., & Jovanova-Mitkovska, S. (2014). Draft battery of tests for evaluation of motor abilities in 6 years old children. *Research in Kinesiology*, 4(1): 15-21.
13. Popeska, B., Jovanova - Mitkovska, S., & Barbareev, K. (2015). Manifestation, Measurement and Assesment of Balance in 7 Year Old Children. *Research in Kinesiology*, 43(1): 115-121.
14. Sindik, J., Horvat, V., & Hraski, M. (2016). Towards the Construction of Test for Assessing Motor Abilities in Four-aged Preschool Children. *Antropologist*, 24(1): 186-192.
15. Tkalčić, S. (1987). *Struktura ravnoteže*. (Doctoral dissertation). Zagreb: Faculty of physical education, University of Zagreb.

PHYSICAL ACTIVITY AS A METHOD OF COPING WITH STRESS, AND OTHER STRESS MANAGEMENT METHODS AMONG TEACHER EDUCATION STUDENTS, AND THEIR RELATION WITH PHYSICAL ACTIVITY MEASURED BY IPAQ

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Abstract

The aim of this study was to reveal stress coping methods, including exercising, among students belonging teacher education study programs, and to determine their relation with physical activity, measured by IPAQ. A total 432 first year full-time students from 20 teachers' training study programs participated in this study. The most frequently reported stress coping methods included *listening to music* (78.7%), *sharing concerns with friends/family* (53.9%), *exercising* (48.4%), *engaging in favourite activities* (47.5%), and *walking outdoor* (44.2%). In the study population14.8% *smoke,* 9.8% *take alcohol*, 4.4% *take sedatives* to cope with stress. *Exercising* and *walking outdoor* as the stress coping methods were used more often by representatives of high PA level compared to those whom PA level is moderate and low.

Key words: *teacher education students, physical activity, stress coping methods*

Introduction

Significant levels of psychological distress have been reported in higher education students globally (Deasy et al., 2014; Stallman et al., 2010). The ways in which these students cope with distress has potential consequences for their health and academic performance. Schools are reported to be a potentially stressful environment. Work-related stress among teachers has the highest mean score and is the main stressor, followed by time management, discipline, and motivation (Austin et al., 2005). Among secondary teachers the level of psychological distress was found to be twice that expected in the general population with higher prevalence among female teachers (Stallman et al., 2010).

Consistent engagement in vigorous physical activity may help to protect the mental health of individuals in the college years and beyond (Downs et al., 2011). Physical activity has positive protective impact of on coping with stress. Bland el al. (2016) concluded that vigorous exercise, stretching, and resistance training were significantly associated with high stress tolerance among college students.

Coping strategies are known to influence an individuals' experience of stress (Kumar et al., 2013). For most students, managing stress during college can be extremely challenging. However, learning how to manage stress may help students cope with every day social and academic pressures, and thus have a better college experience. Being able to manage responsibilities, problems, or difficulties in a calm and thoughtful manner is one way of coping. Rieg et al. (2016) in the pre-service teachers study asked several open-ended questions to identify whether or not the cope with stress strategies were effective. Only one of ten persons used physical activity and a walk to relieve stress.

Physical exercise is a useful coping strategy for student teachers and that they must develop the time management skills to ensure that physical exercise is part of their lifestyle (Rieg et al., 2016; Montgomery et al., 2012). Montgomery et al. (2012) quoting Colangelo (2004) suggests that teachers who exercised moderately experienced less stress than did teachers who did not exercise. The author observed that there is a relationship between teacher's physical well-being and coping. Rieg et al. (2016) suggest teacher preparation programs should prepare students to recognize stress factors and to employ effective coping mechanisms. Summarizing previous studies the authors state that twenty-five to fifty percent of beginning teachers resign during their first three years of teaching, and having the ability to deal with stressors is vital in teacher retention. They also emphasize that pre-service and novice teachers should identify stress factors and cope with these issues.

The aim of this study was to reveal stress coping methods, including exercising, among students belonging teacher education study programs, and to determine their relation with physical activity, measured by IPAQ.

Methods

A total 432 first year full-time students (32.6% (141) males 67.4% (291) females) aged 18-23 (mean age 19.35±1.02) from Lithuanian University of Educational Sciences from 20 teachers' training study programs participated in the study. Standardized Physical Activity Questionnaire – Short Form (IPAQ-SF) was used (*Guidelines..., 2005).* Three levels of physical activity (PA) were used to classify the study population: low, moderate and high. Original questionnaire of eleven statements was developed to assess students' stress coping methods. To establish content validity the survey was pilot tested on university aged students who did not participated in the study, and found reliable.

To determine the differences between teacher education students' who study in different study programs, all study population was divided into two groups according to whether the study program includes classes with physical exercise into the curriculum. The first group (Gr.1) was composed of the programs, as Physical Education, Physical Education and Natural Sciences, Dance Pedagogy, and Ethics and Health Education. Other study programs which do not have obligatory physical education (Art Pedagogy, Primary Education, Music Pedagogy, Psychology, Theatre Pedagogy, English Philology, Polish Philology, Russian Philology and intercultural Communication, Biology, Geography, Pedagogy of Technologies, General Technologies, Pedagogy of Mathematics and Informatics, History, Lithuanian Philology, Social Pedagogy and Ethics, Philosophy) were attributed to the second group (Gr.2).

Results

It the study population 16.2% of the students had low, 29.9% - moderate, and 53.9% - high level of PA, measured by IPAQ. Females were significantly less active than males: the ratio between males/females in low PA group was 9.9%/19.2%, moderate PA group - 20.6%/34.4%, and in high PA group 69.5%/46.4% (χ^2=20.54, p=0.0001). There were significant differences of PA among study programs Gr.1 and Gr.2. The ratio between Gr.1/Gr.2 in low PA group was 7.7%/19.9%, moderate PA group - 13.5%/35.1%, and in high PA group 78.8%/46%, (χ^2=34.22, p= 0.0001).

Most frequently coping with stress methods reported by students included *listening to music* (78.7%), *sharing concerns with friends/family* (53.9%), *exercising* (48.4%), *engaging in favourite activities* (47.5%), *walking outdoor* (44.2%). In the study population 17.8% of the respondents said they *take herbal tea* to manage with stress, 14.8% *smoke,* 9.8% *take alcohol*, 4.4% *take sedatives*. Part of the students said they use relaxation techniques, *like breathing, meditation, yoga* (7.4%). Women *listening to music* as coping with stress method used more often compared to men (χ^2=6.24, p=0.012). They also reported *sharing concerns with friends/family* (χ^2=26.58, p=0.0001), *taking herbal* tea (χ^2=5.99, p=0.014), and taking *sedatives* (χ^2=6.77, p=0.009) more often than men. Men pointed out using *exercising* as stress release method more often compared to women (χ^2=20.00, p=0.0001); they also reported *smoking* more often than women (χ^2=6.92, p=0.008). There were no statistically significant differences by other stress coping methods.

Some stress coping methods were reported significantly more often by the representative of the study programs that contain some physical education (Gr.1): the ratio between those who said they *exercise* to cope with stress in Gr.1/Gr.2 was 81.7%/37.8 χ^2=61.00, p=0.0001. On the contrary, significantly more often Gr.2 reported such stress coping methods as *sharing concerns with friends/family* (the ratio between Gr.2/Gr.1 was 58.2%/40.4 χ^2=10.12, p=0.001); *walking outdoor* (the ratios between Gr.2/Gr.1 was 47.3%/34.6 χ^2=5.11, p=0.024); *taking alcohol* (the ratios between Gr.2/Gr.1 is 11.6%/3.8 χ^2=5.38, p=0.02); *taking herbal tea* (the ratio between Gr.2/Gr.1 was 20.4%/9.6 χ^2=6.30, p=0.012). There is a tendency showing that representatives of the study programs that doesn't contain physical education (Gr.2) tend to use *smoking* (the ratio between Gr.2/Gr.1 was 16.5%/9.6 χ^2=2.93, p=0.087), and *taking sedatives* (the ratio between Gr.2/Gr.1 was 5.5%/1.0 χ^2=3.84, p=0.05) as cope with stress method more often compared to ho the study programs that contain some physical education (Gr. 1).

Exercising and *walking outdoor* were mentioned significantly more often by the representatives of high PA level compared to those who were attributed to moderate and low PA level (table 1).

Table 1: Distribution of different stress cope methods by the level of PA among teacher education students

Stress cope methods		Level of PA			
		Low n=70	Moderate n=129	High n=233	χ^2, p
I exercise (play games, go in for sports, dance)*					
Yes		40.0	35.7	57.9	χ^2=18.85, p=0.0001
No		60.0	64.3	42.1	
I go for a walk outdoor / to the nature*					
Yes		28.6	46.5	47.6	χ^2=8.33, p=0.016
No		71.4	53.5	52.4	
I listen to music					
Yes		78.6	82.2	76.8	χ^2=1.42, p=0.5
No		21.4	17.8	23.2	

I share my concerns with friends /family					
Yes		52.9	56.6	52.8	χ^2=0.52, p=0.7
No		47.1	43.4	47.2	
I engage in my favourite activities (reading, surfing the internet, etc.)					
Yes		44.3	44.2	50.2	χ^2=1.54, p=0.5
No		55.7	55.8	49.8	
I meditate, do breathing exercises, yoga					
Yes		10.0	5.4	7.7	χ^2=1.45, p=0.5
No		90.0	94.6	92.3	
I smoke					
Yes		8.6	14.7	16.7	χ^2=2.84, p=0.2
No		91.4	85.3	83.3	
I take alcohol					
Yes		8.6	8.5	10.7	χ^2=0.58, p=0.7
No		91.4	91.5	89.3	
I take sedatives					
Yes		4.3	3.9	4.7	χ^2=0.14, p=0.9
No		95.7	96.1	95.3	
I take herbal tea					
Yes		17.1	15.5	19.3	χ^2=0.84, p=0.6
No		82.9	84.5	80.7	

*Significant differences

Discussion

This paper studies stress coping methods, including *exercising*, among teacher education students and how these methods are related with students physical activity level. The most frequently reported stress coping method was *listening to music; t*wo-thirds of respondents mentioned it. About half of the study population said they *share concerns with friends/ family*, *exercise*, *engage in favourite activities*, and *walk outdoor* to relieve stress. About one fifth part of the students noticed they take *herbal tea*. Men pointed out using *exercising* as stress relieve method more often compared to women. The cope with stress methods, named *listening to music, sharing concerns with friends/family* and *taking herbal* were more prevalent among women. Bland et al. (2014) found that the most frequently reported coping mechanisms reported by college students (listening to music, sleeping, relaxing, feelings of being supported by friends/family/instructors, and surfing the Internet) were considered to be risk factors for low stress tolerance. While the students may be implementing several different strategies for coping, they are still placing themselves at risk for low stress tolerance by engaging in coping strategies that are maladaptive. Our study showed that 15 percent of teacher education students *smoke* (more often men), 10 percent *take alcohol,* 4 percent - *take sedatives* (more often women) to cope with stress. Previous studies (Deasy et al., 2016) found positive relationship between elevated psychological distress and escape avoidance behaviours including substance use (alcohol, tobacco and cannabis) is of particular concern among undergraduate nursing/midwifery and teacher education students.

In our study *exercising* and *walking outdoor* as the stress coping methods were used more often by representatives of high PA level compared to those whom PA level is moderate and low. *Exercising* as stress coping methods was reported significantly more often by the representative of the study programs that contain some physical education classes, whereas other stress coping methods as *sharing concerns with friends/family, walking outdoor, taking alcohol, taking herbal tea, smoking* were more prevalent among representatives of the study programs that do not include them (there is also the tendency, that *taking alcohol* and *taking sedatives* are also more prevalent among them). Kumar et al. (2013) in the study aimed to assess the stress level of Physical Education and Engineering students concluded that Physical Education students had better coping strategy than engineering students. Coping strategy was higher in boys than girls of their respective profession, but Physical Education girls had higher coping strategy than boys and girls of Engineering. Authors explain, a healthy lifestyle is an essential companion to any stress-reduction program. Stress occurs when pressure exceeds beyond its perceived ability to cope. Stress is the body's reaction to a change that requires a physical, mental or emotional adjustment or response. The study, designed to assess the level of anxiety, depressiveness and physical activity among medical students showed that the highest rates of anxiety were among non-sporting participants (Deksnytė et al., 2014). The findings from teachers' study implied that 'escape avoidance', 'accepting responsibility' and 'uncontrolled aggression' were used as negative coping strategies and only one strategy, 'exercise', was indicated to be an effective way of coping (Austin et al., 2005).

Considering practical implication of the study results it is obvious need of Physical education course in teacher training curriculum, as the university may provide opportunities to take up new activities and learn skills that will students to be lifelong adheres. Despite the fact that no physical tests are performed entering the Lithuanian University of Educational Sciences, likely, students from study programs that contain some physical education classes, have already developed healthier lifestyle during their childhood and adolescence compared to the peers from more "academic" specialities. As Rieg et al. (2016) state, teacher education programs have addressed students' cognitive domains; however, the research also supports the concept of developing students' affective domain so that pre-service teachers and novice teachers can deal effectively with the daily stressors of the elementary classroom.

Conclusions

1. Half of the teacher education students studied reported *exercising* as stress release method. The most frequently reported stress coping methods it the study population included *listening to music* (78.7%), *sharing concerns with friends/ family* (53.9%), *engaging in favourite activities* (47.5%), and *walking outdoor* (44.2%). In the study population14.8% *smoke,* 9.8% *take alcohol*, 4.4% *take sedatives* to cope with stress.
2. *Exercising* and *walking outdoor* as the stress coping methods were used more often by representatives of high PA level compared to those whom PA level is moderate and low. Students from the study programs that have no classes with physical exercise in their study curriculum *take alcohol* to relieve stress significantly more often *compared* with peers who have these activities. They also tend to use *smoking* and *taking sedatives* as stress coping methods more often.

References

1. Austin, V., Shah, S., & Muncer, S. (2005).Teacher stress and coping strategies used to reduce stress. *Occupational Therapy International*, 12 (2), 63-80.
2. Bland, H., Melton, B., Bigham, L., & Welle, P.(2014). Quantifying the impact of physical activity on stress tolerance in college students. *College Student Journal*, 48 (4), 559-568.
3. Deksnytė, A., Danilevičiūtė, V., Aranauskas, R., Budrikaitė, J., & Palinauskaitė, K. (2014). Vilniaus universiteto Medicinos fakulteto studentų fizinio aktyvumo įtaka nerimastingumui ir depresiškumui. *Neurologijos Seminarai*, 18 (1), 42-48.
4. Deasy, C., Coughlan, B., Pironom, J., Jourdan, D., & Mannix-McNamara, P. (2014). Psychological Distress and Coping amongst Higher Education Students: A Mixed Method Enquiry. *Plos ONE*, 9 (12), 1-23.
5. Downs, A., & Ashton, J. (2011). Vigorous Physical Activity, Sports Participation, and Athletic Identity: Implications for Mental and Physical Health in College Students. *Journal Of Sport Behavior*, 34 (3), 228-249.
6. Guidelines for Data Processing and Analysis of the International Physical Activity questionnaire (IPAQ) – Short and Long Forms *(*2005). *Available from: https://sites.google.com/site/theipaq/scoring-protocol* .
7. Kumar, S., & Bhukar, J. P. (2013). Stress level and coping strategies of college students. *Journal of Physical Education and Sport Management,* 4 (1), 5-11.
8. Montgomery, C., MacFarlane, L., & Trumpower D. (2012). Student teacher ess and physical exercise. *ASBBS Proceedings*,19 (1), 974.
9. Rieg, S., Paquette, K., & Chen, Y. (2007). Coping with stress: an investigation of novice teachers' stressors in the elementary classroom. *Education,* 128(2), 211-226.
10. Stallman, H. (2010). Psychological distress in university students: A comparison with general population data. *Australian Psychologist*, 45(4), 249-257.

INDIVIDUAL ATHLETIC PROFILES IN RELATION TO THE EFFECT OF SPECIFIC EXERCISE STIMULI

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Purpose: The purpose of the study was to determine time stability of individual athletic profiles in relation to the effect of specific exercise stimuli.

Methods: The sample consisted of 6- and 7-year-old children who attended 1st grade of elementary school. Children, who participated in baseline testing in June 2016 and re-testing in February 2017, performed 10 motor fitness tests. Baseline testing and re-testing scores of both child athletes and nonathletes were used to determine time stability of their individual athletic profiles. To evaluate differences between samples of paired data, we used the statistical methods of Pearson's correlation coefficient, partial correlation, and canonical correlation.

Results: The results showed time stability of individual athletic profiles, which do not depend on the type and volume of exercise performed at this age period.

Conclusions: We may conclude that the specific exercise stimuli have no effect on individual athletic profiles of both child athletes and nonathletes.

PHYSICAL ACTIVITY LEVEL OF PUPILS FROM 1ST TO 4TH GRADE

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Abstract

In the past few decades, a substantial reduction in the level of physical activity (PA) of children was registered, so the goal of this study was to determine the level of physical activity of pupils from 1st to 4th grade. The study involved 107 participants from two primary schools in Zagreb. The level of physical activity was examined by Fels questionnaire for children aged 7-19. Analysis of the physical activity levels trend was tested by polynomial regression analysis. The results showed that there was a significant effect of time on the indexes of each component of physical activity, but overall physical activity over the years has stagnated. Given the results of this longitudinal study, we can conclude that children need to increase their level of physical activity as soon as possible because studies show that the level of physical activity reduces even more by entering adolescence.

Key words: *sport index, free time index, index of household chores, primary education*

Introduction

The importance of child' s regular PA on health has been proven in many studies (Myers, 2003; Sothern, Loftin, Suskind, Udall, Blecker,1999). From the health point of view, leisure time PA is the most important, but in order to get total image, all categories of PA must be taken into account because studies have shown that there is a correlation between the level of leisure time physical activities with the level of PA in the other categories (Schneider and Becker, 2005).

While there have been studies on the impact of PA on the adult, the same research in the younger population are rare. However, scientists have proven at least moderately positive effects of PA on aerobic fitness, blood lipids, blood pressure, body composition, metabolism, bone and psychological health of children (Janssen and LeBlanc, 2010) and an important role in weight control (Rippe and Hess, 1998).

Nowadays children spend up to 7,5 hours a day sitting (National Heart Foundation of Australia, 2011), and it is proven that children who watch television for more than 4 hours a day have twice as many chances to develop obesity (da Costa Ribeiro, Taddei and Colugnatti, 2003).

The World Health Organization believes (2007) that increasing physical activity in children and adults can significantly reduce the current epidemic of obesity and other diseases related to inactivity. Ladabaum, Mannalithara, Myer and Singh (2014) in its 22 years long study have found out that calorie intake of Americans remained the same but physical activity has decreased.

However, many children are less physically active than recommended, and in addition, physical activity decreases as children get older (Basterfield et al, 2011). So, the purpose of this longitudinal study is to determine the level of PA of one generation of children (from 1st to 4th grade) to see if PA level decreases, increases or stagnates when they enter adolescence.

Methods

The study was conducted on 107 participants (59 girls and 48 boys) in two primary schools in Zagreb. One generation of pupils was monitored from 7 to 10 years, ie from 1st to 4th grade.

The level of physical activity was assessed by Fels questionnaire (Treuth, Hou, Young, & Maynard, 2005), intended for children and adolescents from 7 to 19 years. The questionnaire assesses the PA in three categories: sports, leisure time and housework. The sum of all categories gives an insight into the overall level of PA.

Analysis of the trend levels of physical activity was tested by polynomial regression analysis, and the quantity of adequately and sufficiently physically active children is shown in percent.

Results

Table 1 shows the distribution of participants with the lack (values 2 and 3) and sufficient (values 4 and 5) level of PA. In both genders in all the years of measurement, more than half of the participants fulfills a sufficient level of PA (value 4), while only a small percentage of participants meet the highest level of PA (value 5).

Table 1: The values of the overall physical activity level of pupils from first to fourth grade

		Physical activity level			
Grade		2	3	4	5
1	**M**	0,00%	47,92%	50,00%	2,08%
	F	5,08%	42,37%	52,54%	0,00%
2	**M**	0,00%	43,75%	56,25%	0,00%
	F	0,00%	49,15%	50,85%	0,00%
3	**M**	2,08%	33,33%	62,50%	2,08%
	F	0,00%	50,85%	47,46%	1,69%
4	**M**	0,00%	35,42%	62,50%	2,08%
	F	1,69%	45,76%	52,54%	0,00%

Legend: 2 and 3- insufficient levels of PA, 4 and 5- recommended level of PA (Treuth at al., 2005b), M-male, F-female

Table 2: Polynomial regression analysis for sport index for boys and girls

The significance of the regression model	**M**		F-value **(1,190) = 5,708679**			
	F		F-value **(1,234) = 1,988334**			
Variables	**Standardized Beta regression coefficient**		**t-value**		**p-level of significance**	
	M	**F**	**M**	**F**	**M**	**F**
Grade	0,17	0,09	7,7627	9,6214	**0,01***	0,15

Table 3: Polynomial regression analysis for free time index for boys and girls

The significance of the regression model	**M**		F-value **(1,190) = 9,955691**			
	F		F-value **(1,234) = 10,15504**			
Variables	**Standardized Beta regression coefficient**		**t-value**		**p-level of significance**	
	M	**F**	M	F	M	F
Grade	0,22	0,20	7,0398	8,1867	**0,00***	0,00*

Table 4: Polynomial regression analysis for house chore index for boys and girls

The significance of the regression model	**M**		F-value **(1,190) = 16, 28625**			
	F		F-value **(1,234) = 15,03658**			
Variables	**Standardized Beta regression coefficient**		**t-value**		**p-level of significance**	
	M	**F**	**M**	**F**	**M**	**F**
Grade	0,28	0,24	6,5250	7,6663	**0,00***	0,00*

Table 5: Polynomial regression analysis for total physical activity for boys and girls

The significance of the regression model	M		F-value **(1,190) = 2,791843**			
	F		F-value **(1,234) = 0,7442698**			
Variables	**Standardized Beta regression coefficient**		**t-value**		**p-level of significance**	
	M	**F**	**M**	**F**	**M**	**F**
Grade	0,12	0,05	25,095	27,577	0,09	0,38

In the field of sports (Table 2), although low, there is a positive correlation that is significant for boys (r = 0.17; p = 0.01) and not significant for girls (r = 0.09; p = 0.15). In both boys and girls, the level of physical activity in the area of free time showed a slight increase over time (r = 0.22; p = 0.00 / r = 0.20; p = 0.00) as well as in the field of performing household choirs (r = 0.28; p = 0.00 / r = 0.24; p = 0.00). Although in all indexes (except for the girls in the field of sports) a significant positive correlation over time was recorded, the total physical activity did not show significant correlation in boys (r = 0.12; p = 0.09) nor in girls (r = 0.05; p = 0.38). Despite significant positive correlation of all 3 indexes (sport, leisure time and house chores), total physical activity was not significant and it can be concluded that total level of physical activity for both boys and girls in this research stagnates over time.

Discussion

Some studies have given similar results to these, while some got quite different (recorded a decrease or increase in physical activity over time). Research conducted on children aged 9-13 years, showed that the level of physical activity of children from 2002 to 2006 is stable or slightly improving over the years (Huhman at al., 2012). Dearth-Wesley, Gordon-Larsen, Adair, Zhang and Popkin (2012) on a sample of 353 Chinese children, 6-9 years of age, have recorded an increase in the level of PA over the years, but the time spent in sedentary activities was high all the time. Results of study by Sigmund, Sigmund, Hamřík and Kalman (2014) show that it is evident that the level of physical activity of 11-year-old boys and girls decreases, or at best, stagnates over the years. In a longitudinal study, Wall, Carlson, Stein, Lee and Fulton (2011) showed the results in which it was recorded decrease in leisure activities in both genders aged 9-17 years. Dos Santos et al. (2014) surveyed the level of physical activity of children in Mozambique and came to the conclusion that the level of PA in house chores reduced over the years, while the level of PA in house chores children in this study showed a slight increase. The activity level of these children in Mozambique is also reduced and in the field of sports (girls from Mozambique recorded a slight increase, while in this study, the boys recorded a slight increase) and the conclusion is that the overall level of physical activity of children decreases over the years. Delva, O'Malley and Johnston (2006) conducted a longitudinal study in the United States to 62,156 children from 8th grade, 64,899 children from 10th grade in the period from 1993 to 2003 and 35,107 children from 12th grade in the period in 1986. to 2003. They proved that over the years' time spent in high intensity activities decreases in boys while in girls is stable. Swaminathan et al. (2011) on a sample of 203 Indian children (8-15 years) in just one year recorded a decrease of moderate and high intensity activities, in both genders, that is largely influenced by the decrease in the school PA. In cases where physical activity level was stable over time, research showed that children with physical activity level lower than their peers have increased chance of becoming less active adults with increased risk of death from chronic diseases (Livingstone, Robson, Wallace and McKinley, 2003).

Also, the level of PA in children is reduced because of the environment they live in. Today, walking or cycling to school is unusual behavior that is replaced by driving a car, outdoor leisure is a rarity for the safety of children, especially in cities, and most of the free time children spend sitting in front of computers (Boreham and Riddoch, 2001). However, many studies have shown reduction in levels of physical activity in both genders when entering the adolescence (Sherar, Esslinger, Adam Baxter-Jones and Tremblay, 2007), while many longitudinal studies have shown that increased levels of PA and reduction of time in sedentary activities has a protective role in preventing the accumulation of excess body fat (Must and Tybor, 2005).

Conclusion

Although, through all the measurements, more than half of students meet the recommended level of PA, number of children inactive for four years is worrying. The fact that the PA level of these children has stagnated over the years is another alarming finding because research has proven that such children are most likely to be inactive adults which entails many health, and social problems. The age of primary education is an ideal time to acquire healthy habits, so the results of this research aim to raise awareness of the importance of regular physical exercise from an early age and maintaining your health by maintaining desirable body weight throughout life.

References

1. Basterfield, L., Adamson, A. J., Frary, K. J., Parkinson, N. K, Pearce, M. S., & Reilly, J. J. (2011). Longitudinal Study of Physical Activity and Sedentary Behavior in Children. *Pediatr, 127*(1), e24-e30. doi: 10.1542/peds.2010-1935
2. Boreham, C., & Riddoch, C. (2001). The physical activity, fitness and health of children. *J Sports Sci, 19*, 915-929
3. da Costa Ribeiro, I., Taddei, J.A, & Colugnatti, F. (2003). Obesity among children attending elementary public schools in São Paulo, Brazil: a case–control study. *Public Health Nutrition, 6*(7), 659-663. doi: https://doi.org/10.1079/PHN2003473
4. Dearth-Wesley, T., Gordon-Larsen, P., Adair, L. S., Zhang, B., & Popkin, B. M. (2012). Longitudinal, cross-cohort comparison of physical activity patterns in Chinese mothers and children. *Int J Behav Nutr Phys Act, 9*, 39. doi: 10.1186/1479-5868-9-39
5. Delva, J., O'Malley, P. M., & Johnston, L. D. (2006). Racial/ethnic and socioeconomic status differences in overweight and health-related behaviors among American students: national trends 1986–2003. *J Adolesc Health, 39*(4),536–545
6. Dos Santos, F. K., Maia, J. A., Gomes, T. N., Daca, T., Madeira, A., Damasceno, A., Katzmarzyk, P. T., & Prista, A. (2014). Secular trends in habitual physical activities of Mozambican children and adolescents from Maputo City. *Int J Environ Res Public Health*, *11*(10), 10940-50. doi: 10.3390/ijerph111010940.
7. Huhman, M., Lowry, R., Lee, S.M., Fulton, J. E., Carlson, S. A., & Patnode, C. D. (2012). Physical activity and screen time: trends in U.S. children aged 9-13 years, 2002-2006. *J Phys Act Health*, *9* (4), 508-515
8. Janssen, I., & LeBlanc, A. G. (2010). Review Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act, 7*, 40: http://www.ijbnpa.org/content/7/1/40
9. Ladabaum, U., Mannalithara, A., Myer, P.A., & Singh, G. (2014). Obesity, Abdominal Obesity, Physical Activity, and Caloric Intake in US Adults: 1988 to 2010. *The American Journal of Medicine, 127*(8), 717-727.e12. DOI: http://dx.doi.org/10.1016/j.amjmed.2014.02.026
10. Livingstone, M. B., Robson, P. J., Wallace, J. M., & McKinley, M. C. (2003). How active are we? Levels of routine physical activity in children and adults. *Proc Nutr Soc, 62* (3), 681-701.
11. Must, A., & Tybor, D. J. (2005). Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. *Inter J Obes, 29*, s84-s96. doi:10.1038/sj.ijo.0803064
12. Myers,J. (2003). Exercise and Cardiovascular Health. Circulation, 107: e2-e5. https://doi.org/10.1161/01.CIR.0000048890.59383.8D
13. National Heart Foundation of Australia (2011). *Sitting less for children*. Skinuto s mreže 21.4.2015. sa stranice http://www.heartfoundation.org.au/SiteCollectionDocuments/HW-PA-SittingLess-Child.pdf
14. Rippe, J. M., & Hess, S. (1998). The role of physical activity in the prevention and management of obesity. *J Am Diet Assoc*, *98* (10 Saplament 2), S31-S38
15. Schneider, S., & Becker, S. (2005). Prevalence of physical activity among the working population and correlation with work-related factors: results from the first German National Health Survey. *J Occup Health, 47* (5), 414- 423
16. Sherar, L. B., Eslinger, D. W., Baxter-Jones, A. D. G., & Tremblay, M. S. (2007). Age and Gender Differences in Youth Physical Activity: Does Physical Maturity Matter? *Med Sci Sports Exerc*, *39* (5), 830-835
17. Sigmundova, D., Sigmund, E., Hamrik, Z., & Kalman, M. (2014). Trends of overweight and obesity, physical activity and sedentary behaviour in Czech schoolchildren:HBSC study. *Eur J Pub Health*, *24* (2), 210-215
18. Sothern, M.S., Loftin, M., Suskind, R.M.,Udall, J.N., Blecker, U. (1999). The health benefits of physical activity in children and adolescents: implications for chronic disease prevention. Eur J Pediatr, 158, 271-274
19. Swaminathan, S., Selvam, S., Thomas, T., Kurpad, A.V., & Vaz, M. (2011). Longitudinal trends in physical activity patterns in selected urban south Indian school children. *Indian J Med Res, 134,* 174-180
20. Treuth, M. S., Hou, N., Young, D. R., & Maynard, L. M. (2005b). Validity and Reliability of the Fels Physical Activity Questionnaire for Children. *Med Sci Sports Exerc*, *37* (8), 488-495
21. Wall, M. I., Carlson, S. A., Stein, A. D., Lee, S. M., & Fulton, J. E. (2011). Trends by age in youth physical activity: Youth Media Campaign Longitudinal Survey. *Med Sci Sports Exerc*, *43* (11), 2140-2147. doi: 10.1249/MSS.0b013e31821f561a
22. WHO (2007). *Global Strategy on Diet, Physical Activity and Health*. Geneva: WHO

CANONICAL RELATIONS BETWEEN THE VARIABLES OF MOTOR SKILLS AND SUBCUTANEOUS ADIPOSE TISSUE IN GIRLS OF PRESCHOOL AGE

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Abstract

A system of fifteen variables, twelve variables of motor skills (serving as predictor variables) and three variables of morphological variables of subcutaneous fat (serving as criteria variables), was applied on a sample of 59 girls of preschool age with the aim of determining the statistical significance of the correlation between the two systems. The data were analyzed using canonical correlation analysis and the results showed that only the first pair of canonical factors display a satisfactory statistical significance of their interaction at the level of p = 0.030. In the mobility area, it can be defined as the integral canonical factor of motor skills since it is determined by all the applied variables except for P15 - lifting the torso in 15 seconds - and PSR - wide-legged seated forward fold. In the morphological area, it can be defined as the canonical factor of subcutaneous fat because it is determined by all three applied morphological variables. The results showed that on the basis of the first pair of canonical factors girls achieve satisfactory values in the variables of the integral canonical factor of motor skills, which are in a statistically significant interaction with the results of morphological variables subcutaneous fat.

Key words: *girls, preschool age, motor skills, subcutaneous fat, relations*

Introduction

In kinesiology anthropology and applicative methodology and technology legality accomplishments of their development is often neglected, which clearly point to the established scientific facts that anthropological abilities and characteristics can be most successfully developed during periods when it is objectively possible, and this is the period of childhood and adolescence. It follows the rule that the development of some anthropological abilities and characteristics, in particular motor, should start even more earlier, if the variability coefficient was smaller and in which the genetic components of variability were greater (Malacko and Pejčić, 2009).

When it comes to motor skills in girls of preschool age, which are the subject of this study, one must consider the fact that they are more or less genetically determined, which means that the effects of actions directed depend to a large extent on the coefficient inherent to each of them. Another significant limiting factor is the fact that the development of human characteristics, abilities and characteristics, and therefore the ontogenetic development in general (Pejčić and Malacko, 2005), is not flowing evenly nor simultaneously, which is commonly referred to as "heterochrony" of different sides of individual development. Basically, "heterochrony" is expressed, on the one hand, in the formation of asynchrony and different tempo of maturation of individual fragments of the same functional system, and in time mismatch of the formation and maturation of various organic structures that shall be necessary for organism in different periods of postnatal development" (Aršavskij, 1975).

With the advent and application of multivariate mathematical-statistical methods of data processing, the problem of relations between the segments of the anthropological status began to resolve by the canonical process. Although the relation researches had been conducted over all analyzed segments of anthropological status, in most cases the research of motor skills with other segments of the human body in kinesiology anthropology was conducted. Relations research between motor skills and morphological characteristics showed that in both sexes subcutaneous fat has a very pronounced negative impact on indicators of energy output, especially in the parts of the body where there is a more dramatic accumulation of body fat (Kurelić, Momirović, Mraković and Sturm, 1979).

So, a problem that occurs in this connection consists in finding statistically significant relations between the individual latent dimensions of corresponding morphological characteristics and some components of motor skills, which are relevant to individual activities, in order to, on the one hand, maintain and check the desired anthropological harmony with children of this age, and on the other hand, to implement the required educational and/or training technology and implementation of programs.

The aim of this study consisted in determining statistically significant relations between the system of morphological variables of body fat and some basic variables of motor abilities in girls of preschool age, in order to ensure, on the one hand, the possible factors of disturbance of body fat in manifestation of motor skills, and on the other hand, what is the compliance of their development, so that one could determine valid and meaningful projections of their future development.

Methods

System of 15 variables was applied in a sample of 59 preschool age girls, of which 12 variables of motor abilities (as predictor variables) and 3 variables of morphological characteristics of subcutaneous fat (as criterion variables).

Test	Measured capacity	Measuring unit
Motor variables:		
MOD - moving the dice	*agility*	sec
BHS - walking backwards and with hand support	*coordination*	“
SLJ - standing long jump	*explosive strength of the legs*	cm
EWH - endurance while hanging	*static strength of arms and shoulders*	sec
L15 - lifting the abdomen for 15 seconds	*repetitive strength of the abdomen*	fr
BWS - bent while sitting	*flexibility of hamstrings*	cm
SLL - spreading the legs on the wall while lying - left	*flexibility of the hips*	“
SLR - spreading the legs on the wall while lying - right	“	“
SAW - spreading the arms while lying	*flexibility while lying*	“
PBA - pulse before the activities	*endurance*	fr
PAA - pulse after activities	“	“
3MP - 3 - minute polygon	“	“
Morphological variables:		
SUA - skin crease of the upper arm	*panniculus adiposus*	mm
SCB - skin crease of the back	“	“
SUL - skin crease of the upper leg	“	“

Metric characteristics of the tests have been reviewed in the study Trajkovski Višić, Plavec and Antonić (2007). Morphological characteristics were measured by the International Biological Program (IBP).

For each variable applied the following statistical central and dispersion parameters were calculated: arithmetic mean (M), the minimum value (min), the maximum value (max) and standard deviation (S). Normality of variables distribution was tested using skewness (Sk) and kurtosis (Ku). The correlation between the applied variables was performed using the variables correlation matrix.

Canonical correlation analysis was applied to calculate the relation between the system of criterion morphological variables and predictor system of motor variables. Testing the statistical significance of the hypothesis of global connection between two different variables system was carried out using: λ - statistically significant characteristic roots, Rc - coefficient of canonical correlation of statistically significant pairs of canonical factors, χ^2 - Bartlett's chi-square test and p - test of the statistical significance on level 0.05 to 0.00 (p = 0.05-0.00).

Results

An examination of Table 1, which shows statistically central and dispersion parameters of variables, as well as their discrimination by skewness and kurtosis, clearly shows that in the applied system of basic motor variables, most has a satisfying discrimination (marked by asterisk *), because the value of skewness hover around 1.00 of standard deviation, i.e. that the data within the allowed limits are normally distributed and precisely measured, which is very important in the further interpretation of the results. Only with motor variables moving the dice (MOD), walking backwards and with hand support (BHS) and endurance while hanging - (EWH) distribution deviates from the normal, and the results are moving toward lower values, which may be due to the complexity and difficulty of performing tests. With morphological variables skin crease of the upper arm (SUA), skin crease of the back (SCB) (SUL) - skin crease of the upper leg (SUL) distribution also deviates from the normal, and the results are moving towards an initial increased (unwanted) values, which is the beginning of an increased amount of fat.

Table 1: The basic statistical parameters and testing the normality of their distribution

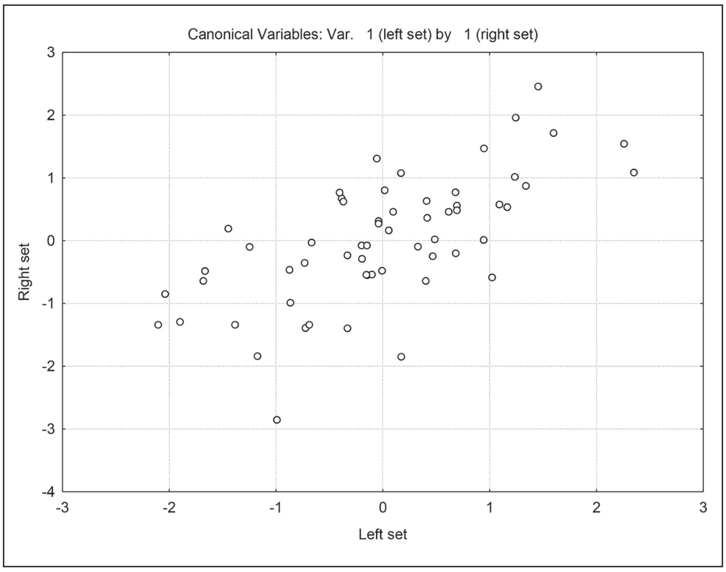
Variable	M	min	max	S	Sk	Ku
MOD	16.39	13.20	23.50	2.10	1.30	1.57
BHS	10.12	24.83	24.83	3.63	1.79	4.59
SLJ	97.32	147.00	147.00	21.19	**0.03***	-0.75
EWH	4.71	35.09	35.09	6.61	2.34	7.35
L15	5.66	10.00	10.00	2.85	**-0.45***	-0.45
BWS	4.35	19.00	19.00	6.58	**-0.12***	0.32
SLL	67.23	85.00	85.00	7.91	**0.32***	-0.57
SLR	63.86	85.00	85.00	9.37	**0.33***	-0.44
SAW	21.61	33.00	33.00	5.65	**0.16***	-0.70
PBA	106.40	129.00	129.00	12.39	**-0.78***	1.94
PAA	117.88	142.00	142.00	12.06	**-0.40***	0.01
3MP	368.81	480.00	480.00	57.86	**-0.43**	-0.00
SUA	7,62	3,00	18,00	3,33	1,02	0,72
SCB	5,86	2,00	15,00	2,75	1,22	1,45
SUL	8,62	3,00	20,00	2,80	1,36	3,84

Legend: M – arithmetic mean, min, max – minimal and maximum score, S – standard deviation, Sk – skewness, Ku – kurtosis

Table 2: Crosscorelation between variables of morphological characteristics and variables of motor abilities

Variable	KNN	KNL	KNP
MOD	-0,15	0,06	0,14
BHS	-0,18	0,12	0,23
SLJ	0,18	-0,09	-0,05
EWH	0,10	-0,24	-0,22
L15	0,12	0,19	0,18
BWS	-0,18	-0,05	-0,07
SLL	-0,18	0,19	0,12
SLR	-0,28*	-0,01	-0,07
SAW	0,06	-0,05	-0,10
PBA	0,10	0,11	-0,06
PAA	0,16	0,04	-0,05
3MP	-0,01	0,01	-0,15
λ	**Rc**	**χ^2**	**p**
0,34	0,67	53,42	0,03*
0,62	0,49	23,45	0,37
0,82	0,42	9,70	0,46

Legend: λ – Wilk's Lambda, Rc – canonical correlation, χ^2 – Bartlett's Chi-square test, p – level of significance



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The analysis of cross correlations matrix between basic motor and morphological variables of subcutaneous fat (Table 2) showed no statistically significant correlations between the variables, except variables - spreading the legs on the wall while lying - right (SLR) at the level of p = 0.05.

By solving characteristic equations of cross-correlation matrix, using Bartlett's chi-square test (χ^2=53.42, χ^2=23.45, χ^2=9.70) the statistical significance of their canonical correlation coefficients was tested (Rc=0.67, Rc=0.49, Rc=0.42). This identified an independent and statistically significant structure of the first canonical factor in both area which is statistically significant at the level of p = 0.03. This shows that both canonical factors within their area exhausted all relevant properties, which can be seen from their mutual correlation (Rc=0.67), and only as a whole within their area show their values, considering that at that age there were still no significant differentiation.

Table 3: Structure of canonical factors (Fc) of˝morphological characteristics and motor abilities

Variables	Fc - 1
Motor variables	
MOD	**-0,479****
BHS	**-0,661****
SLJ	**0,337****
EWH	**0,478****
L15	-0,089
BWS	-0,148
SLL	**-0,440****
SLR	**-0,277***
SAW	**0,278***
PBA	**0,331****
PAA	**0,368****
3MP	**0,275***
Morphological variables	
SUA	**0,414****
SCB	**-0,363****
SUL	**-0,546****

**$p_{.01 = 0,325}$; *$p_{.05 = 0,250}$

This is confirmed by the received results in Table 3 from which it can be seen that the structure of motor canonical factor (Fc-1) is consisted of the following of variables: MOD - moving the dice, BHS - walking backwards and with hand support, SLJ - standing long jump, EWH - endurance while hanging, SLL - spreading the legs on the wall while lying - left, SLR - spreading the legs on the wall while lying - right, SAW - spreading the arms while lying, PBA - pulse before the activities, PAA - pulse after activities and 3MP - 3-minute polygon. Morphological structure of the canonical factor (Fc-1) is consisted of the following variables: SUA - skin crease of the upper arm, SCB - skin crease of the back and SUL - skin crease of the upper leg.

Discussion and conclusions

Since the structure of the first motor canonical factor consists of variables agility, coordination, explosive strength of the legs, static strength of arms and shoulders, flexibility of the hips, flexibility while lying and endurance, it can be interpreted as an integral factor of motor skills, while the first canonical factor of morphological characteristics can be defined as a canonical factor of subcutaneous fat, because it is defined by all three applied morphological variables. Their mutual relations (Rc=0.67) show that girls of preschool age achieve good results in all the applied motor skills variables, as they have decreased values in all variables of subcutaneous fat SCB - skin crease of the back and SUL - skin crease of the upper leg, and vice versa, they achieve weaker results in motor variables if they have increased values in these variables, where the subcutaneous fat appears as a disturbing factor.

In the interpretation of canonical correlation analysis, this rule is applied in a way that a linear increase in the value of the resulting vector of variables of canonical factor from the first anthropological area suits proportional linear increase in value of resulting vector variables of canonical factor from the second anthropological area, and vice versa, provided that between the two studied system of variables in different areas there is a statistically significant correlation. Concretely in this study it means that on the basis of established pair (FC-1) of canonical factors, based on established relations with the morphological characteristics of subcutaneous fat, girls achieve good results in motor variables agility, coordination, explosive strength of the legs, static strength of arms and shoulders, flexibility of the hips, flexibility while lying and endurance.

Research results can be satisfactorily applied in specific educational and training practice, especially when it comes to the formation of rational procedures for sports orientation and selection, planning and programming of educational/ training content, development of relevant sporting abilities, as well as their control, primarily in sports dominated by the speed of movement.

References

1. Kurelic, N., Momirovic, K., Mrakovic, M. Sturm, J. *(*1979). Struktura motoričkih sposobnosti i njihove relacije sa ostalim dimenzijama ličnosti. *Kineziologija*, 1-2. (The structure of motor abilities and their relations with other dimensions of personality. *Kinesiology*, 1-2)
2. Malacko, J. Pejčić, A. (2009). Changes in biomotor dimensions of school boys afed 11: experimental programme of sports games VS standard PE programme. Sport Science, 2 (1):52-61.
3. Trajkovski Višić, B., Berlot, S. Kinkela, D. (2007). Metrijske karakteristike testova namijenjenih za procjenu snage, koordinacije i fleksibilnosti kod četverogodišnjaka. Poreč: 16. Ljetna škola kineziologa Republike Hrvatske, *Zbornik radova* (257-262). (Metric characteristics of tests designed to assess the strength, coordination and flexibility with four year old. Poreč: 16th Summer School of the Croatian kinesiologists, *Proceedings* (257-262))
4. Trajkovski Višić, B., Plavec, D. Antonić, D. (2007). Osobitosti testiranja kardiovaskularnih funkcionalnih sposobnosti djece predškolske dobi. II. međunarodni simpozijum "Nove tehnologije u sportu", *Zbornik naučnih i stručnih radova* (311-313). Sarajevo: Fakultet sporta i tjelesnog odgoja. (Peculiarities of testing the cardiovascular functional abilities of children of preschool age. II. International Symposium "New technologies in sport", *Proceedings of scientific papers* (311-313). Sarajevo: Faculty of Sport and Physical Education)
5. Pejčić, A. Malacko, J. (2005). The ontogenetic development of morphological characteristics and motor abilities of boys and girls in early elementary school. Kinesiologia slovenica, 2 (2):42-55

THE KNOWLEDGE AND OPINION OF THE FACULTY OF KINESIOLOGY STUDENTS ON ARTISTIC GYMNASTICS

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Abstract

The purpose of this research was to find out level of theoretical knowledge and motor skills in artistic gymnastics of the Faculty of Kinesiology, University of Zagreb students at the beginning of 2nd year of study. Research was conducted, in total on 175 male and female students. Students have filed a questionnaire about the opinion of their theoretical knowledge and motor skill in artistic gymnastics. Statistica 12 software was used for data analysis. With frequency of questions and claims from 1 to 5, it was determined that the level of theoretical knowledge was very high, more than 85%, and that the level of motor knowledge was low, because the grade for basic gymnastics elements was 2. Students agree that artistic gymnastic has an important role in curriculum in primary and high schools in Croatia.

Key words: *gymnastics elements, motor skills, knowledge, questionnaire, curriculum*

Introduction

From the standpoint of the science of kinesiology, artistic gymnastics can be briefly defined as a sport branch in which aesthetically designed acyclic movement structure are evaluated according to previously prescribed convention of movement defined by rules for evaluation proposed by the International Gymnastics Organization (Živčić, 2000). Gymnastics is divided into professional and recreational sport. Faculty of Kinesiology curriculum contains artistic gymnastics as a compulsory subject on the 2nd year of study. Aim of the subject is to educate students about artistic gymnastics for work in primary and high schools as a physical education teacher. As a basic sport, gymnastics has an important place in the curriculum of primary and high school. Gymnastics content appears in the curriculum in each year of education in primary and high schools (Vican & Milanović, Litre, 2006).The aim of the application of general gymnastic content is versatile development, adoption of motion habits and improving health status; or to overcome basic motor skills and abilities which are useful in everyday life (Živčić Marković & Krističević, 2016). Knowledge of gymnastics can also be included in a variety of recreational programs in extracurricular and free time activities. Although a basic and one of most important supports for healthy growth and maturation, because of problems such as inadequate facilities and lack of reconciliation in schools, it is also one that is most difficult to implement. For this reason it happens that children during attendance of primary and high schools do not acquire curriculum prescribed theoretical and practical knowledge about gymnastics. This situation is not specific only for Croatia, but the same problem also occurs in Slovenian schools. Some authors (Novak et al., 2008.) have found that teachers carried out only about 40 percent of gymnastics curriculum content, with least in high school and more in the third cycle of primary school (Bučar et al., 2010). The aim of this research is to find out the level of theoretical knowledge and motor skills in artistic gymnastics of the Faculty of Kinesiology, University of Zagreb, students at the beginning of the 2nd year of study.

Methods

Research was conducted on a sample of 176 students of second year of the Faculty of Kinesiology, University of Zagreb. 29,30% were female and 70,7% male students, before the start of college (Artistic Gymnastics I.). Answers on opinion questions ranged from 0 to 5, considering the importance of the question. Number 0 means that students do not have an opinion. Number 1 means that students do not agree with the claim. Number 2 means that students partially agree with the claim. Number 3 means that students neither agree nor disagree with the claim. Number 4 means that students agree with the claim. Number 5 means that students completely agree with the claim. Variables of opinion questions were: artistic gymnastics in curriculum for primary school has an important role. (2.2.1.), artistic gymnastics in curriculum for high school has an important role. (2.2.2.), theoretical knowledge of artistic gymnastic has an impact on successful performance of elements. (2.2.3.), gymnastics has scared me. (2.2.4.), I am afraid of height (2.2.5.), I am afraid of speed (2.2.6.), I am afraid of handstand (2.2.7.), learning of gymnastic elements develops a sense of mutual assistance (2.2.8.), Artistic gymnastics develops coordination (2.2.9.), artistic gymnastics has a positive influence on psychomotor development of children and youth (2.2.10.), artistic gymnastics develops perseverance (2.2.11.), artistic gymnastics develops diligence (2.2.12.), artistic gymnastics develops determination (2.2.13.), artistic gymnastics develops creativity (2.2.14.), artistic gymnastics develops independence (2.2.15.), artistic gymnastics develops aggressiveness (2.2.16.), artistic gymnastics develops precision (2.2.17.), artistic gymnastics develops self-confidence (2.2.18.), artistic gymnastics has an influence on correct posture (2.2.19.), how do you grade the importance of artistic gymnastics on motor development (2.2.20.), how do you grade the importance of athletics on motor development (2.2.21.), how do you grade the importance of sports games on motor development (2.2.22.). Variables of motor abilities were basic acrobatic elements: KOLNAP (forward roll), KOLNTR (backward roll), KNTPN (backward roll with extended legs), SVJ (candlestick), ZVD (cartwheel right), ZVL (cartwheel left), STOJ (handstand), TOTAL (total motor knowledge).

Statistica 12 was used for analysis of data. Basic descriptive parameters, and frequencies were calculated for all variables.

Results

Table 1 displays frequencies of opinion questions where students agree with importance of artistic gymnastics in the curriculum of primary and high school.

Table 1: Frequency table of opinion questions

Number of question	0	1	2	3	4	5
2.2.1.	0,64%	5,10%	6,37%	26,11%	19,75%	**42,04%**
2.2.2.	0,64%	7,01%	5,10%	27,39%	26,75%	**33,12%**
2.2.3.	1,91%	3,82%	10,19%	28,66%	**31,85%**	23,57%
2.2.4.	0,64%	**27,39%**	25,48%	21,02%	14,65%	10,83%
2.2.5.	0,00%	**45,22%**	15,92%	16,56%	11,46%	10,83%
2.2.6.	0,00%	**56,69%**	21,66%	11,46%	5,10%	5,10%
2.2.7.	0,64%	**60,51%**	12,74%	13,38%	6,37%	6,37%
2.2.8.	0,64%	9,55%	10,83%	**33,76%**	29,30%	15,92%
2.2.9.	0,00%	2,55%	4,46%	12,74%	30,57%	**49,68%**
2.2.10.	0,00%	1,27%	3,82%	8,28%	31,85%	**54,78%**
2.2.11.	0,00%	1,27%	1,27%	12,74%	31,21%	**53,50%**
2.2.12.	0,00%	1,27%	1,91%	12,10%	31,85%	**52,87%**
2.2.13.	0,00%	2,55%	0,64%	10,19%	28,63%	**57,96%**
2.2.14.	0,00%	3,82%	3,18%	14,65%	29,94%	**48,41%**
2.2.15.	0,00%	3,18%	3,18%	21,02%	34,39%	**38,22%**
2.2.16.	0,00%	**40,76%**	28,03%	16,56%	7,01%	7,64%
2.2.17.	0,00%	7,01%	9,55%	19,75%	25,48%	**38,22%**
2.2.18.	1,27%	2,55%	2,55%	10,83%	32,48%	**50,32%**
2.2.19.	0,64%	1,91%	3,18%	12,10%	22,29%	**59,87%**
2.2.20.	1,91%	1,27%	1,27%	4,46%	35,03%	**56,05%**
2.2.21.	0,00%	1,91%	1,27%	12,10%	**42,68%**	42,04%
2.2.22.	0,00%	3,18%	1,91%	20,38%	**37,58%**	36,94%

Table 2 displays basic descriptive parameters of acrobatic elements. Total grade of KOLNAP, KOLNTR, KNTPN, SVJ, ZVD, ZVL, STOJ was 2.

Table 2: Descriptive statistics of acrobatic elements

Variable	Descriptive Statistics: Acrobatic elements				
	Valid N	Mean	Minimum	Maximum	Std.Dev.
KOLNAP	157	2,28	1	5	1,04
KOLNTR	157	2,22	1	4,66	1,01
KNTPN	157	1,90	1	5	1,04
SVJ	157	1,83	1	4,66	0,89
ZVD	157	2,04	1	5	1,09
ZVL	157	2,07	1	5	1,07
STOJ	157	2,19	1	4,66	1,02
TOTAL	157	2,07	1	4,66	0,71

Discussion

Before college enrollment, 94,90% of students were active in some sport activities, 56,68% of them were involved in professional sports and 21,64% in recreational. 80,89% of students do not agree with appropriateness of entrance examination of the college. 55,41% of students did not acquire theoretical knowledge about artistic gymnastics in primary schools, and 50,95% in high school. More than 85% of students know how to execute several acrobatic elements on vault, uneven and parallel bars, horizontal bar, still rings and balance beam.

42,04% of students completely agree that gymnastics has an important role in primary schools, and 33,12% completely agree that gymnastics has an important role in the curriculum for high schools.

Descriptive parameters of measured variables about student motor knowledge have shown that the total grade of basic gymnastic elements was 2. 80% of students have declared that they know how to execute several elements on apparatus, but it has been established that their score of execution of basic elements was very low. Based on this information, we can conclude that students do not have knowledge about proper execution of individual elements. Difference between theoretical and practical knowledge of students lies in the fact that a proper execution is based on understanding of theoretical execution of the technique.

In answers to questions related to fear of gymnastics, height, speed and handstand, highest percentages were recorded in the claim "I disagree", which indicates that students do not feel fear in regard to gymnastics. Reason for that is that 56,68% of students were involved in professional sports. Students completely agree that gymnastics develops positive personality characteristics, and they completely disagree that gymnastics develops aggressiveness. 56,05% of students completely agree with the claim that gymnastics is important for motor development. It is known that gymnastics completely develops coordination of motion, strength, flexibility and balance, which are neglected in the daily life (Zajec, 1992).

Conclusion

From acquired data, it can be concluded that students of second year of Faculty of Kinesiology have weak motor knowledge, which is not the case with theoretical understanding of execution of gymnastic elements on apparatus. Based on that information, it can be concluded that students do not have an understanding of proper execution of individual elements. Difference between theoretical and practical knowledge of a student lies in the fact that proper execution of elements is based on understanding of theoretical execution of the technique. Likewise, students have emphasized the importance of implementation of elements of artistic gymnastics in primary and high schools. In regard to cognitive personality characteristics, students claim that gymnastics does not develop aggressiveness, but encourages mutual cooperation.

References

1. Bučar Pajek, M., Čuk, I., Kovač, M., Jakše, B. (2010). Implementation of the gymnastics curriculum in the third cycle of basic school in Slovenija. *Science of gymnastics journal,* 2(3*),* 15–27.
2. FIG (2017). Code of points Woman artistic gymnastics. Moutier: Federation International de Gymnasstique.
3. Lipovnik, S. (2011). Znanja in mnenja študentov fakultete za šport o gimnastiki. [Knowledge and opinions of students of the Faculty of Sport of Gymnastics. In Slovenian.] (Unpublished Diploma thesis, University of Ljubljana) Ljubljana: Faculty of Sport, University of Ljubljana.
4. Novak, D., Kovač, M., Čuk, I. (2008). *Gimnastična abeceda*. [Gymnastic alphabet. In Slovenian.] Ljubljana: Univerza v Ljubljani, Fakulteta za šport, Inštitut za šport.
5. Vican, D., & Milanović Litre, I. (2006). Nastavni plan i program za osnovnu školu. *Zagreb: Ministarstvo znanosti, obrazovanja i športa*, 19-22.
6. Zajc, B. (1992). *Motorične sposobnosti slovenskih tekmovalk v športni gimnastiki v primerjavi s povprečno šolsko populacijo*. [Motor skills Slovenian contestants in gymnastics compared to the average school population. In Slovenian.] (Unpublished Diploma thesis, University of Ljubljana) Ljubljana: Faculty of Sport, University of Ljubljana.
7. Živčić Marković, K. and Krističević, T. (2016).*Osnove sportske gimnastike*. [Basics of artistic gmnastics. In Croatian.] Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
8. Živčić, K. (2000*). Biomehaničko vrednovanje vježbi za izvedbu premeta naprijed.* [Biomechanical evaluation exercises to perform a forward handspring. In Croatian.] (Unpublished doctoral dissertation, University of Zagreb) Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.

PARENTS' ATTITUDES TOWARDS PHYSICAL ACTIVITY OF PRESCHOOL CHILDREN

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Abstract

A part of responsibly for widespread physical inactivity and obesity epidemics lies on parents and their lifestyle choices that are observed and followed by their children. The aim of this study is to investigate what are parents' attitudes towards physical activity and what are some of the reasons parents are struggling to meet their children minimal physical activity requirements. Altogether 1271 preschool children's parents were asked to fill in on-line questionnaire at their convenience examining their attitude toward physical activity of their children. The questionnaire comprised 19 items asking participants to state their agreement with proposed claims. Descriptive statistics was used to present the results in each item, exploratory factor analysis (EFA) was conducted using a principal components method to uncover the underlying structure and univariate analysis of variance with Bonferroni post-hoc test was used to determine differences in a questionnaire items between parents of different age. Statistical significance level was set to $p<0.05$. Results of present study showed that parents have positive attitude towards physical activity of their children. They find physical activity worthwhile and not less important than computer literacy. They encourage their children to be physically active and often visit playgrounds and parks. Parents often spend free time with their children in the outdoors but they generally not pay attention on their own diet and they exercise less than 3 times per week. Children look up to their parents and role model their behaviors based on actions of their parents. Even when parents are providing the opportunities to eat healthy and be physically active, if they are not personally doing it children might still acquire unhealthy habits. Present study's results indicate that younger parents note financial constraints as obstacle for their children participation in sport programs in higher degree that older parents ($F=6.293$, $p=0.002$) but they spend more free time with their children in outdoors ($F=10.802$, $p=0.000$) and have more time for physical activity with their children due to business obligation ($F=8.294$, $p=0.00$). Older parents seem to acknowledge the risks of physical inactivity in higher degree than younger parents ($F=6.640$, $p=0.001$).

Introduction

To meet minimal needs for physical activity children should accumulate at least 60 minutes of moderate-to-vigorous intensity physical activity daily (WHO, 2010). Failing to accumulate minimum physical activity requirements, ideally by performing multiple bouts during the day, increases the risk of many health problems and deviations. It is estimated that more than 42 million preschool children were overweight in 2015 (WHO, 2017).

Preschool children should be given the opportunity to be physically active throughout the day and included in the activates that are both organized and led by professionals but also supervised free play. Attitudes and habits children acquire thought childhood are likely to influence their decisions in adulthood. It is documented that overweight and obese children are likely to stay obese and more likely to develop noncommunicable diseases (WHO 2017). Reversing the increasing trend of overweight and obese children is possible and related health-problems are preventable if whole community, city authorities, public health organizations, schools, teachers and most importantly their parents work together.

Parents are role models to their children and their actions either motivate or discourage their children to engage in physical activity. A part of responsibly for widespread physical inactivity and obesity epidemics lies on parents and their lifestyle choices that are observed and followed by their children. Therefore, the aim of this study is to investigate what are parents' attitudes towards physical activity and what are some of the reasons parents are struggling to meet their children's' minimal physical activity requirements.

Methods

Altogether 1271 preschool children's parents (M-2,8%, F-97,2%) participated in this study. Most of the parents where between 26-35 (62.8%) followed by 21.7% and 10.5% <20 and >35 years old, respectively. They were asked to fill in on-line questionnaire at their convenience examining their attitude toward physical activity of their children. A total of 1201 parents (94%) completed the questionnaire and their results were used for further analysis.

The questionnaire comprised 19 items asking participants to state their agreement with proposed claims on the 5-point Likert scale (1 - strongly disagree; 5 - strongly agree). The items addressed children activities in free time (e.g. “I often spend free time with my children in outdoors”, “My child spends more than 2 hours a day watching TV or playing video games”), participation in organized physical activity (e.g. “My child is participating in sport program after school because it enhances his/her socialization”, “I find it important for my child to participate in sport programs because I am aware of physical inactivity risks”) and interest towards physical activity (“Participating in physical activities is a waste of time”, “My child is participating in other activities like drama, music, acting and there is no time for sport activities”).

Descriptive statistics was used to present the results in each item, exploratory factor analysis (EFA) was conducted using a principal components method to uncover the underlying structure and univariate analysis of variance with Bonferroni post-hoc test was used to determine differences in a questionnaire items between parents of different age. Statistical significance level was set to $p<0.05$.

Results

Ninety-three percent of parents strongly disagree that participating in physical activities is a waste of time (1.09±0.45; Table 1). Parents also strongly disagree (82,5%) that their child is not enrolled in sport program because they fear he/she might get hurt (1.30±0.82) and that playing in kindergarten is the only physical activity their child participates in (74.3%; 1.43±0.92). Most of the parents strongly agreed (70.3%) that they encourage their child to be physically active in free time (4.61±0.75) and that their child is physically active more than 60min per day (65.4%; 4.50±0.87). They generally disagree (58.1%) that their child is not interested in available sports programs (2.31±1.45) and strongly disagree (65.8%) that their child doesn’t show interest in physical activity in free time (1.62±1.00). Most of the parents (77.7%) agree that their child participates in sport programs because they are aware of physical inactivity risks (4.26±1.08).

Univariate analysis of variance reveled significant differences in parents’ attitudes towards physical activity of their children based on parents’ age in some items. In the item “My child is not participating in sport programs because I can’t afford it” significant difference between parents of different age was found ($F=6.293$, $p=0.002$). Younger parents (<25yrs) reporter somewhat higher agreement (2.44±1.48) with proposed statement than parents aged 26-35yrs (2.09±1.38) and older that 35yrs (1.94±1.34). Differences were found in the item “I find it important for my child to participate in sport programs because I am aware of physical inactivity risks” ($F=6.640$, $p=0.001$). Younger parents (<25yrs) reported less agreement (3.95±1-2) with proposed claim compared to parents aged 26-35yrs (4.28±1.06) and older that 35yrs (4.33±1.07). Significant differences between parents of different age was found also for item “I often spend free time with my children in outdoors” ($F=10.802$, $p=0.000$). Younger parents (<20yrs) reported higher agreement (4.45±0.8) that parents aged 26-35yrs (4.2±0.91) and older that 35yrs (4.01±1.04). Significant differences were also found in the item “I don’t have enough time for physical activity with my child due to my business obligations” ($F=8.294$, $p=0.00$). Parents aged 26-35yrs (2.67±1.42) and older that 35yrs (2.79±1.42) reported higher agreement with proposed claim compared to younger parents (2.21±1.36).

Table 1: Frequency and descriptive statistic of parents’ attitudes towards physical activity of preschool children

Items	Total	Strongly disagree	Disagree	Don’t know	Agree	Strongly agree	Missing	Chi-square test
	MEAN±SD	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	p
I pay attention to my diet and I exercise at least three times per week	2.63±1.29	341 (26.2)	282 (21.7)	259 (19.9)	293 (22.5)	90 (6.9)	35 (2.7)	<0.001
My child is not participating in sport programs because I can’t afford it	2.09±1.38	690 (53.1)	144 (11.1)	148 (11.4)	191 (14.7)	96 (7.4)	31 (2.4)	<0.001
I encourage my child to be physically active in free time	4.61±0.75	12 (0.9)	22 (1.7)	75 (5.8)	242 (18.6)	914 (70.3)	35 (2.7)	<0.001
My child is not enrolled in sport program because I fear he/she might get hurt	1.30±0.82	1073 (82.5)	88 (6.8)	43 (3.3)	46 (3.5)	19 (1.5)	31 (2.4)	<0.001
I often visit playgrounds/parks with my child	4.49±0.83	19 (1.7)	34 (2.6)	72 (5.5)	329 (25.3)	815 (62.7)	31 (2.4)	<0.001
My child is not interested in available sport programs	2.31±1.45	580 (44.6)	176 (13.5)	204 (15.7)	153 (11.8)	154 (11.8)	33 (2.5)	<0.001
Playing in kindergarten is the only physical activity my child participates in	1.43±0.92	966 (74.3)	160 (12.3)	53 (4.1)	63 (4.8)	26 (2.0)	32 (2.5)	<0.001
Participating in physical activities is a waste of time	1.09±0.45	1201 (92.4)	43 (3.3)	9 (0.7)	5 (0.4)	8 (0.6)	34 (2.6)	<0.001

I find it important for my child to participate in sport programs because I am aware of physical inactivity risks	4.26±1.08	50 (3.8)	58 (4.5)	148 (11.4)	269 (20.7)	741 (57.0)	34 (2.6)	<0.001
I find computer literacy more important than physical activity	1.96±1.07	566 (43.5)	323 (24.8)	247 (19.0)	106 (8.1)	24 (1.8)	34 (2.6)	<0.001
My child is physically active in free time more than 60minutes a day	4.50±0.87	28 (2.1)	26 (2.0)	90 (6.9)	272 (20.9)	850 (65.4)	34 (2.6)	<0.001
My child is participating in other activities like drama, music, acting and there is no time for sport activities	1.66±1.09	810 (62.3)	228 (17.5)	119 (9.1)	51 (3.9)	57 (4.4)	35 (2.7)	<0.001
My child is participating in sport program after school because it enhances his/her socialization	3.98±1.28	121 (9.3)	58 (4.5)	175 (13.5)	298 (22.9)	614 (47.2)	34 (2.6)	<0.001
My child spends more than 2 hours a day watching TV or playing video games	2.75±1.39	332 (25.5)	266 (20.5)	213 (16.4)	302 (23.2)	154 (11.8)	33 (2.5)	<0.001
My child expressed interest to participate in sport programs and I enrolled him	3.60±1.42	202 (15.5)	76 (5.8)	228 (17.5)	292 (22.5)	464 (35.7)	38 (2.9)	<0.001
My child doesn't show interest in physical activity in free time	1.62±1.06	856 (65.8)	175 (13.5)	116 (8.9	78 (6.0)	39 (3.0)	36 (2.8)	<0.001
I often spend free time with my children in outdoors.	4.19±0.94	22 (1.7)	51 (3.9)	178 (13.7)	432 (33.2)	583 (44.8)	34 (2.6)	<0.001
I don't have enough time for physical activity with my child due to my business obligations	2.64±1.41	412 (31.7)	200 (15.4)	203 (15.6)	312 (24.0)	135 (10.4)	38 (10.4)	<0.001
I don't attach too much importance to physical activity	1.62±1.00	818 (62.9)	211 (16.2)	138 (10.6)	78 (6.0)	22 (1.7)	33 (2.5)	<0.001

To uncover the underlying structure of the questionnaire exploratory factor analysis (EFA) was conducted using a principal components method (Table 2 and 3). Three meaningful factors were retained with eigenvalues from 3.49 to 1.38. The three factors combined explained 33.49% of the variance.

Table 2: Factor structure from exploratory factor analysis

Items	***Factors***		
	1	**2**	**3**
Children activities in free time			
I often spend free time with my children in outdoors.	0.733		
I don't have enough time for physical activity with my child due to my business obligations	-0.589		
I often visit playgrounds/parks with my child	0.586		
My child spends more than 2 hours a day watching TV or playing video games	-0.472		
My child is physically active in free time more than 60minutes a day	0.457		
Playing in kindergarten is the only physical activity my child participates in	-0.424		
I don't attach too much importance to physical activity	-0.408		
Children participation in organized sport programs			
My child is participating in sport program after school because it enhances his/her socialization		0.757	
My child expressed interest to participate in sport programs and I enrolled him		0.718	
I find it important for my child to participate in sport programs because I am aware of physical inactivity risks		0.606	
I encourage my child to be physically active in free time		0.445	
I pay attention to my diet and I exercise at least three times per week		0.382	
Interest and attitudes towards physical activity			
Participating in physical activities is a waste of time			0.558
I find computer literacy more important than physical activity			0.521
My child is not enrolled in sport program because I fear he/she might get hurt			0.517

My child is participating in other activities like drama, music, acting and there is no time for sport activities			0.468
My child is not participating in sport programs because I can't afford it			0.433
My child is not interested in available sport programs			0.428
My child doesn't show interest in physical activity in free time			0.388
Eigenvalues	**3.49**	**1.49**	**1.38**
Percentage of explained variance	**18.34**	**7.87**	**7.27**
Percentage of total explained variance	**18.34**	**26.21**	**33.49**

Table 3: Pearson correlation coefficients between variables

Factors	*1*	*2*	*3*
1. Children activities in free time	1.00		
2. Children participation in organized sport programs	-0.227	1.00	
3. Interest and attitudes towards physical activity	0.257	-0.160	1.00

The three scales represent *children activities in free time* (e.g. “I often spend free time with my children in outdoors”, “My child spends more than 2 hours a day watching TV or playing video games”), *participation in organized physical activity* (e.g. “My child is participating in sport program after school because it enhances his/her socialization”, “I find it important for my child to participate in sport programs because I am aware of physical inactivity risks”) *and interest towards physical activity* (“Participating in physical activities is a waste of time”, “My child is participating in other activities like drama, music, acting and there is no time for sport activities”).

Discussion and conclusion

This study aimed to explore the attitudes and potential obstacles of preschool children’s parents towards physical activity. Today, when industrialization and new technologies replace the need of human movement, new generations of children are raised in the world where physical activity is less needed in everyday life. Therefore, they need to be educated about importance of physical activity on wide range of health indicators to gain healthy habits and reduce the risk of cardio-respiratory diseases, diabetes and obesity. Parents have the most important role in preschool children’s development. The importance of parental influence on establishing healthy habits of their children have been documented in previous studies (Golley et al. 2011; Niemeier et al., 2012; Natale et al. 2014). Golley et al. (2011) reviewed studies researching interventions aiming at parents to improve children’s health indicators such as their weight status or eating habits. They found that interventions they considered effective were among others, ones where parents were responsible for participation and implementation of intervention and ones where greater parental involvement was found. Similarly, Niemeier et al. (2012) investigated differences in intervention effectiveness with different levels of parental participation. They found that combination of parental participation and duration of intervention predicts overall effectiveness of intervention. Interventions that require parental participation more effectively reduces body mass index of children and adolescents (Niemeier et al., 2012).

Results of present study showed that parents have positive attitude towards physical activity of their children. They find physical activity worthwhile and not less important than computer literacy. They encourage their children to be physically active and often visit playgrounds and parks. Parents often spend free time with their children in the outdoors but they generally not pay attention on their own diet and they exercise less than 3 times per week. Children look up to their parents and role model their behaviors based on actions of their parents. Even when parents are providing the opportunities to eat healthy and be physically active, if they are not personally doing it children might still acquire unhealthy habits. Natale et al. (2014) found that “parental nutrition and physical activity patterns influence their preschool-age children’s consumption of fruits/vegetables, junk food, and level of sedentary behavior”.

Present study’s results indicate that younger parents note financial constraints as obstacle for their children participation in sport programs in higher degree that older parents but they spend more free time with their children in outdoors and have more time for physical activity with their children due to business obligation. Older parents seem to acknowledge the risks of physical inactivity in higher degree than younger parents.

References

1. Golley. R.K., Hendrie, G.A., Slater, A., Corsini, N. (2011). Interventions that involve parents to improve children's weight-related nutrition intake and activity patterns - what nutrition and activity targets and behaviour change techniques are associated with intervention effectiveness? Obesity Reviews, 12(2), 114–30. doi: 10.1111/j.1467-789X.2010.00745.x. [PubMed: 20406416]
2. Natale, R.A., Messiah, S.E., Asfour, L., Uhlhorn, S.B., Delamater, A., Arheart, K.L. (Role modeling as an early childhood obesity prevention strategy: effect of parents and teachers on preschool children's healthy lifestyle habits. Journal of Developmental & Behavioral Pediatrics, (6), 378–87. doi: 10.1097/DBP.0000000000000074. [PubMed: 25007060]
3. Niemeier, B.S., Hektner, J.M., Enger, K.B. (2012). Parent participation in weight-related health interventions for children and adolescents: a systematic review and meta-analysis. Preventive Medicine, 55(1), 3–13. doi: 10.1016/j.ypmed.2012.04.021. [PubMed: 22575353]
4. World Healtf Organization (2017). Global Strategy on Diet, Physical Activity and Health. Retrieved on February 27th from: http://www.who.int/dietphysicalactivity/childhood/en/
5. World Health Organization (2010). Global recommendations on physical activity for health. WHO Library Catalougiung-in-Publication Data, Geneva, Switzerland

FACTORS RELATED TO THE FUNDAMENTAL MOTOR SKILLS IN PRESCHOOL CHILDREN

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Abstract

Fundamental motor skills affect children's physical, social, and cognitive development. The aim of this research was to determine the influence of body mass index, motor abilities, physical activity and sedentary behavior of parents on fundamental motor skills of preschool children. Participants were 103 parent-child dyads from one child care center in Čakovec. Parents completed a questionnaire which is measuring parental physical activity and sedentary behaviour. Children were tested by four motor tests and fundamental motor skills test. Preschool teachers evaluated the physical activity of children. The connection was calculated by the regression analysis. The highest partial impact (BETA=.363; p=.00) on the criterion variable has a variable activity of children, while is lower in the variable age (BETA=.246; p=.01). Other variables did not have a significant effect on the criterion variable fundamental motor skills. In accordance with research, it can be concluded that the investment and the creation of optimal conditions for the development of motor skills in preschool age is invaluable.

Key words*: test of gross motor development 2, motor abilities, parental habitual physical activity*

Introduction

Biotic motor skills are an essential factor in a human being's formation during the phylogeny and ontogeny, and they enable effective mastering of space, obstacles, resistance, and perform manipulation of various sizes and shapes. The development of fundamental movement skills is a key factor in promoting long-term physical activity. Research demonstrated the salience of personal, familial and environmental factors that influence on physical activity, fundamental movement skills and sedentary behaviour in children. Parental model has a role in developing a healthy behavior and preserving health of children through engagement in sports and recreational activities. Research of Moore et al. (1991) indicated that when both parents are physically active, children show up to 6 times higher probability to be physically active than children of inactive parents. Cools et al. (2011) showed the positive correlation between physical activity of fathers and motor skills of preschool children. Also, low competency in fundamental motor skills was associated with a range of sociodemographic characteristics, including gender, socioeconomic status, cultural background (Hardy et al., 2012).

Livonen & Saakslahti (2013) indicated that age, gender, physical activity and preschool based programmes are positive determinants of fundamental motor skills in preschool-aged children.

The aim of this research was to determine the predictive value of demographic parameters, body mass index and motor abilities and physical activity and sedentary behavior of parents on success in motor skills.

Methods

The sample of subjects consisted of a total of 103 preschool children aged 4-6 years, from kindergarten in Čakovec. Data were collected between January and June 2016. With the prior consent of children's parents and after the measuring of body height and body weight, their body mass index (BMI) was calculated. Also, all the subjects were measured by 4 motor tests to estimate the balance (standing on one leg), flexibility (bend and reach), coordination (polygon backwards) and frequency of movement (hand tapping).

Demographic variables included informations about the qualification of parents and the number of siblings. Physical activity and free time sedentary habits of parents were estimated by using a questionnaire. Parents reported the amount of time in a typical weekdays and weekends "walked continuously for at least 10 minutes without stopping"; "did moderate physical activities" and "did vigorous activity which made a breathe harder or puff and pant". Physical activities of different intensity were calculated as the total time spent in physical activity on weekdays (PAPAMF) and weekends (PAPASS). Free time sedentary habits in a typical weekdays (SEDPAMF) and weekends (SEDPASS) included the assessment of time spent watching TV, DVD, video, playing electronic games and using the computer.

Subscale of the activity assessment was taken from the questionnaire about the child's temperament [EAS Temperament Survey for Children (Buss & Plomin, 1986)]. Although the questionnaire was originally intended for the assessment of children's temperament by parents, reviewing the items it was concluded that they are suitable for the assessment by educators as well. Subscale Activity (ACTIVITY) consists of 5 items which reflect the motor activity and forcefulness (item example: As he wakes up, already running). Assertions are estimating on a scale of 1 - completely not typical for a child, 2 - not typical for a child, 3 - neither is, neither is not typical for a child, 4 - typical for a child and 5 - completely typical for a child. All of these variables consisted the predictor set of variables.

Criterion variable consisted of a total sum (SUMSKILLS) of motor skills which were estimated by Test of Gross Motor Development TGMD-2 (Ulrich, 2000) for age 3-10 years, which includes 6 locomotor skills (run, hop, gallop, leap, horizontal jump, and slide) and 6 object control skills (ball skills such as striking a stationary ball, stationary dribble, catch, kick, overhand throw, and underhand roll). The TGMD-2 is a process-oriented measure, assessing the components of each skill rather than the outcome or product of the skill execution. The performance of children was video-recorded and afterwards evaluated by one observer.

Basic descriptive statistic parameters were calculated: mean, standard deviation, minimum and maximum result, skewness, kurtosis, normality analysis (KS-test). The connection between the predictor variables and total result in motor skills was calculated by the regression analysis.

Results and Discussion

Table 1 shows that the majority of variables do not have a normal distribution, which is a requirement for the use of regression analysis. Such variables were recoded according to the median in a dichotomous (1 lower, and 2 more than the median). From a total of 103 parents, the physical and sedentary activities questionnaire filled out 83 mothers (80.6%), 19 fathers (18.4%) and 1 grandparent (1%). By gender sample consisted of 54 (52.4%) males and 49 (47.6%) females. By age, 33 (32%) were 4-5 years old, 33 (32.1%) 5-6 years old and 37 (35.9%) were 6-7 years old. By the qualification of parents, 2 (1.9%) have finished primary education, 57 (55.3%) high school, 18 (17.5%) higher and 26 (25.2%) have the university degree. A variable number of siblings indicated that 29 of children (28.2%) do not have siblings, 64 (62.1%) have one, and 10 (9.7%) have two or more siblings.

Table 1: Descriptive statistics of the study sample

	Mean	Min	Max	SD	Skewness	Kurtosis	K-S test
BMI	16.56	13.30	23.13	1.93	1.31	2.08	0.02
STANDING ONE LEG (s)	15.97	2.30	60.40	11.65	1.56	2.97	0.09
POLYGON (s)	19.31	9.00	38.65	6.14	0.98	1.24	0.42
BEND AND REACH (cm)	35.16	20.00	49.00	6.67	-0.12	-0.61	0.64
HAND TAPPING (nr.)	13.07	4.00	21.00	3.12	-0.15	0.42	0.02
PAPAMF (min)	247.03	10.00	1800.00	254.70	2.73	12.72	0.00
PAPASS (min)	128.34	10.00	900.00	158.02	2.46	7.36	0.00
SEDPAMF(min)	381.00	20.00	2100.00	337.66	2.12	6.73	0.01
SEDPASS (min)	237.00	15.00	1020.00	187.33	1.42	2.50	0.00
ACTIVITY	16.84	6.00	24.00	4.02	-0.57	-0.45	0.01
SUMSKILLS	52.70	16.00	88.00	16.82	-0.16	-0.70	0.94

Table 2: Regression analysis for fundamental motor skills (SUMSKILLS)

$R=0.75$; $R^2=0.56$; Adj.R=0,49 $F(16.86)=7.00$; $p=0.00$; SEE=12.07	B	SE	Beta	t	p
AGE	4.670	1.860	.246	2.510	.014
GENDER	3.290	2.607	.099	1.262	.210
KINSHIP	.971	3.211	.025	.303	.763
EDUCKINSHIP	1.268	1.478	.067	.858	.393
NRSIBLINGS	1.176	2.203	.042	.534	.595
BMI	-1.611	2.547	-.049	-.632	.529
BALANCE	.127	.126	.088	1.006	.317
COORDINAT	-.285	.249	-.105	-1.144	.256
FLEXIBILITY	.149	.212	.059	.703	.484

TAPING	.512	.770	.096	.665	.508
PAPAMF	-1.867	3.565	-.056	-.524	.602
PAPASS	-.877	3.431	-.026	-.256	.799
SEDPAMF	-.664	3.337	-.017	-.199	.843
SEDPASS	1.153	2.861	.034	.403	.688
ACTIVITY	12.047	2.755	.363	4.373	.000

LEGEND: R – multiple correlation, R^2 -coefficient of determination, Adj. R^2 – adjusted coefficient of determination, F – value of F-test, p– value of significance threshold of F-test, SEE– standard error of estimation, BETA– partial standard coefficient of regression, SE. BETA – standard error of partial coefficient of regression, t – degree of freedom, p – significance level

According to the value of the coefficient of multiple correlation (R=0.75), with a significance level of p=.00 it can be established that there is a statistically significant correlation between the predictor and criterion variable motor skills (Table 2). The value of the coefficient of determination shows that the set of predictors explained 56% of variance of the criterion variable, i.e. mostly according to corrected coefficient of determination, 49% of the criterion variance. Of all the variables, it is evident that only two are in statistically significant relations with the criterion. Highest partial impact (BETA=.363; p=.00) on the criterion variable has a variable activity of children (ACTIVITY), while is lower in the variable age (AGE) (BETA=.246; p=.01). The positive correlation of age is expected and in accordance with the results of previous research (Krombholz, 2006), because children develop and improve motor skills naturally through growth and maturational processes (Malina et al., 2004).

The activity of children was evaluated by preschool teachers with indirect method, and obtained values showed whether the child is „always in motion“, „prefers to have more active games“ etc., so it is assumed that more active children, tested by objective measurement methods of physical activity such as pedometer and accelerometer, would have a higher overall level of physical activity. The obtained predictive value of physical activity significantly contributes to the explanation of fundamental motor skills (FMS), i.e. higher level of physical activity will provide a higher level of motor skills. Therefore, it is assumed, in accordance with previous research, Robinson et al. (2012) reported on mean steps per minute being associated with amount of variance in locomotor score and positive correlation between daily steps or walking time and five different motor skills across the three fundamental movement skills (Kambas et al., 2012). However, in many cross sectional studies positive relationship was found between fundamental movement skills and physical activity of children, and this relationship has not yet been sufficiently clarified. Causal relation remains unclear: are preschoolers more active because of better motor skills or do they have better motor skills beacuse they are more active? Study of Burgi et al. (2011) showed that the relationship between children’s physical activity and motor skills was dominated by the impact of physical activity on motor skills. The postulated reciprocal relationship has been examined only in two longitudinal studies (Barnett et al., 2011; Jaakkola & Washington, 2013), as demanded in the review of Lubans et al. (2010). These studies do not allow a final statement about a cause and effect relationship, because both studies report results which are predictive in both directions. Demographic variables kinship, qualifications of parents, number of siblings did not show predictive value in motor skills. Insignificant impact of body mass index (BMI) on motor skills can be explained by the results (Kim & Lee, 2016) in which were not obtained significant correlations between overall score FMS and BMI, but they are in significant inverse association with some locomotor (running, sliding) and object control skills (kicking). According to the same author, obese and overweight children develop FMS at the same rate as children with healthy weights. Furthermore, we assume that insignificant impact of BMI and motor abilities on FMS is perhaps because of the assessment of movement skills (run, throw, skip, etc.), which require performance instead of product over a short time and they are probably independent of weight, height and physical fitness. Kim & Lee (2016) claim that test TGMD-II requires the cognitive-understanding regarding the FMS by the children. For instance, in skill catching, as the FMS test, one of the criteria is the preparatory phase, specifically position of hands. In other words, if children show well-developed catching skills without awareness of preparation phase, the catching score is low. The differences in FMS performance in children, therefore, are more likely related to their cognitive abilities and physiological responses than their motor abilities, such as physical fitness and that possibility should be examined in future studies. In relation to family context, parental physical activity and sedentary behaviour had no significant effect on result in motor skills of children. The research of Cools et al. (2011) shows that physical activity of fathers, but not mothers, have positive associations with FMS, and negatively associated father-child interaction in TV-viewing and reading books. Since this research included informations on physical activity of one parent, in this case (80.6%) physical activity of mothers, for further understanding of the FMS in relation to family context, both parents should be included.

Conclusion

In further research is necessary to increase the number of predictor variables which would provide more informations on factors related to the level of motor skills, such as the level of physical activity of children in leisure time measured by direct methods (e.g. accelerometers), sedentary behavior patterns of children at home and preschool, involvement in organized physical activity, time spent in physical education lessons in kindergarten, time spent outdoors and access to safe parks and play areas. Also, this research suggests to observe separately locomotor skills and object control skills, because the sample of pre-school population is not subjected to organized physical exercise as children in primary education. In accordance with research, it can be concluded that the investment and the creation of optimal conditions for the development of motor skills in preschool age is invaluable.

References

1. Barnett, L.M., Morgan, P.J., van Beurden, E., Ball, K., & Lubans, D.R. (2011). A reverse pathway? Actual and perceived skill proficiency and physical activity. *Medicine and Science in Sports and Exercise,* 43(5), 898-904.
2. Burgi, F., Meyer, U., Granacher, U., Schindler, C., Marques-Vidal, P., Kriemler, S., & Puder, J.J. (2011). Relationship of physical activity with motor skills, aerobic fitness and body fat in preschool children: A cross sectional and longitudinal study. *International Journal of Obesity*, 35(7), 937-944.
3. Buss, A.H. & Plomin, R. (1986). *The EAS Approach to Temperament*. In R. Plomin i J. Dunn (Eds.) The Study of Temperament: Changes, continuities and challenges. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.
4. Cools, W., Martelaer, K.D., Samaey, C., & Andries, C. (2011). Fundamental movement skill performance of preschool children in relation to family context. *Journal of Sport Sciences*, 29, 649-660.
5. Fisher, A., Reilly, J.J., Kelly, L.A., Montgomery, C., Williamson, A., Paton, J.Y., & Grabt, S. (2005). Fundamental movement skills and habitual physical activity in young children. *Medicine and Science in Sports and Exercise*, 37(4), 684-688.
6. Hardy, L.L., Reinten-Reynolds, T., Espinel, P., Zask, A., & Okely, A.D. (2012). Prevalence and correlates of low fundamental movement skill competency in children. *Pediatrics*, 130(2), 390-397.
7. Jaakkola, T., & Washington, T. (2013). The relationship between fundamental movement skills and self-reported physical activity during Finnish junior high school. *Physical Education and Sport Pedagogy*, 18(5), 492-505.
8. Kambas, A., Michalopoulou, M., Fatouros, I.G., Christoforidis, C., Manthou, E., Giannakidou, D…Zimmer, R. (2012). The relationship between motor proficiency and pedometer-determined physical activity in young children. *Pediatric Exercise Science*, 24(1), 34-44.
9. Kim, C., & Lee, K.Y. (2016). The relationship between fundamental movement skills and body mass index in Korean preschool children. *European Early Childhood Education Research Journal*, 24(6), 928-935.
10. Livonen, S., Saakslahti, A.K. (2013). Preschool childrens fundamental motor skills: a review of significant determinants. *Early Child Development and Care*, DOI:10.1080/03004430.2013.837897.
11. Lubans, D.R., Morgan, P.J., Cliff, D.P., Barnett, L.M., & Okely, A.D. (2010). Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Medicine*, 40(12), 1019-1035.
12. Malina, R.M., Bouchard, C., & Bar-Or, O. (2004). *Growth, Maturation and Physical Activity* (2nd ed.) Champaign, IL: Human Kinetics.
13. Moore, L.L., Lombardi, D.A., White, M.J., Campbell, J.L., Oliveria, S.A., & Ellison, R.C. (1991). Influence of parent's physical activity levels on activity levels of young children. *Journal of Pediatrics*, 118(2), 215-219.
14. Robinson, L.E., Webster, E., Logan, S., Lucas, W., & Barber, L.T. (2012). Teaching practices that promote motor skills in early childhood settings. *Early Childhood Education Journal*, 40(2), 79-86.
15. Ulrich, D.A. (2000). *Test of Gross Motor Development (TGMD-2)* (2nd ed.). Austin, TX: PRO ED, Inc. Preuzeto 15. siječnja s http://www2.pef.uni-lj.si/ srp_gradiva/tgm.pdf

FUTURE PHYSICAL EDUCATION TEACHERS EXPERIENCING FAILURE DURING THEIR TEACHING PRACTICE

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Abstract

Teaching practice is regarded as one of the essential periods of professional development which could have an impact on professional identity, therefore, the purpose of the study was to analyse the experiences of the students of physical education by revealing emotional encounters of the students and their behaviour after experiencing failure during their teaching practice. After autonomous teaching practice, the method of semi-structured interviews was used to interview 29 students of physical education in their fourth year of studies. The study revealed that, during their failure, the students experience different negative emotions and, in the presence of emotional stress, choose various modes, which are oriented towards self, towards pupils, towards other teachers, to resolve a problematic situation. While improving the process of the studies, more strategies and methods, which are aimed at classroom management during a lesson of physical education, should be included, a student should also be given the possibility to make mistakes and correct them while making a decision on his own.

Key words: *students of physical education, failure, teaching practice, emotion, behaviour.*

Introduction

Teaching practice is regarded as an essential period of professional development (Hormenu et al., 2014). This phase is extremely tense, requiring much effort and is associated with increased fatigue and vulnerability (Evelein et al., 2008; Klassen, Chiu, 2011; Caires et al., 2010, 2012; Midford, Buchworth, 2015). It is an intensive period of searches, knowledge and exploration of self and others (Caires et al.,2012). Teaching practice provides students with an opportunity to get the feel of a school environment and allows them to adapt, to change their expectations before starting their teacher career (Ferber, Nillas, 2010). Although teaching practice enables a student to act in educational reality, but limited professional experience, the application of theory in practical work, which requires pedagogical decisions in ever-changing situations, force a student to rethink his choice to become a teacher one more time. Caires et al. (2010) describe this situation, which is complicated for a student, as a „reality shock“, because students experience a lot of stress and challenges due to the gap between theory and practice, in which they are intended to function, i.e. to teach. In view of arising difficulties, Kirbulut, Bektas (2011) consider the period of practice as a critical period of professional development. When different difficulties, which are related to professional, personal and environment aspects, arise students choose their own strategies to overcome them. The work of the teacher of physical education is specific and differs from that of other teachers, therefore, the experiences of the students regarding the failure they have experienced during their teaching practice may be used when constructing and improving the training programmes of the future teachers of physical education, whilst providing for more effective support and self-help tools in the process of their studies and during their teaching practice. The purpose of the study was to analyse the experiences of the students of physical education and their behaviour after experiencing failure during their teaching practice. The purpose of the study was to answer the following questions of the study: What failure did the students of physical education experience during their teaching practice? What were emotional reactions of the students and their behaviour in a failure situation? How is this experience assessed by the students when designing their further pedagogical career?

Methods

Qualitative research access was chosen, because it was sought to reveal the individual experiences of the students regarding the failure they experienced during their teaching practice, to better understand and to explain student emotions, feelings, decisions taken in the light of a complicated educational situation, to reveal the value of such experience for the personal and professional growth of the students. After autonomous teaching practice, a semi-structured interview method was used to interview 29 students of physical education of Lithuanian University of Educational Sciences in their fourth year of studies. When conducting an interview the requirements for research ethics were complied with: the students were informed regarding the purpose of the study, consent to make the audio recording of the interview has been obtained, the information was provided that the study findings would be used only for research purposes without disclosing a personal identity. To analyse the findings of the study, qualitative content analysis, which was performed on the basis of the distintion of the most appropriate semantic units – phrases or words - in the text and their encoding, was used. The text was examined consistently by distinguishing semantic units applying the inductive method, formulating them into subcategories which were aggregated into categories employing the deductive method. The analysis of the findings of the study was based on the principle of peer review.

Results

The content and circumstances of the experienced failure. The failure experienced by the students is related to the difficulties incurred by the students during a lesson of physical education: due to classroom management failure; inability to create an interest in the subject they teach; lack of trust in their competences; insufficient preparedness for a lesson (failure to thoroughly consider a lesson plan, to forecast possible events)**.**

Classroom management failure is emerging as one of the essential elements of the content of the failure experienced by the students: *...they did not respect me, did not accept me as a teacher, ...would not obey me, S27; children did not perfom my tasks, S25.* The students experienced distress that due to their inability to manage pupils the latter incurred injuries during a lesson: *I failed to manage the situation, and a pupil incurred an injury, S19.* The conflicts between the pupils, which were encountered by a student, are also interpreted by the students as a failure and are considered as the consequence of improper classroom management: *during the lesson two pupils began fighting, S28.*

The students considered it a failure that they were not able to create an interest in the subject they teach *(I was not able to create an interest in children who thought that physical education is unnecessary and would not participate in the lesson, S23),* what stifle the student‘s motivation *(when you see that you understand that they are not interested, that, possibly, you yourself feel as if you are also, possibly, not interested, S10*).

The students experienced a failure due to the lack of trust in their own competences *(I was not able to explain precisely the rules of a sport game, S9),* although they also perceived their own insufficient preparedness for the lesson *(I was not prepared to select another game to play, if they were not interested in the latter, S7; I had not prepared a lesson plan for a smal group of the pupils, my plan was only for a large one, S20).*

Emotional response. A failure during their teaching practice incite a lot of negative emotions in the students: they experience anxiety and stress, fright, anger, the feeling of guilt, sadness, apathy, disappointment. The students experienced anxiety and stress due to their inability to control a situation (*…that I cannot control a situation, S2);* due to their own choice of the profession (*I will possibly not be able to work as a teacher of physical education, pupils and I are not on the same page, S12; Shall I be a bad teacher? Why did I study for so long? Why did I not understand that earlier? S13*). The experienced failure incites the feeling of fear regarding their further activity during teaching practice (*I was at a loss, the feeling of fear, that I would not be able to manage a situation during another lesson, arose, S21).* The students felt sadness due to the remarks made by their teacher-mentor (*there is some disappointment, sadness ensues after the remarks of the teacher, S2*), due to the lightweight attitude of the pupils towards a lesson of physical education (*it was sad because of the pupils who do not treat the lessons of physical education seriously, S20)*, their inability to create an interest in pupils (*it was sad, because I thought that I did not know how to make children interested in that, S29*) and to manage them (*I was distressed and sad because of what happened (scuffle between children). I was thinking what I had done in a wrong way that I failed to prevent that. S28*). The students experienced helplessness and apathy having being disappointed in pupils (*I lose my heart and it seems that I want nothing, let them do what they want to, I loose interest in anything, apathy S4; apathy ensued, I became disappointed... No matter what I try, pupils are not interested, S11*), *they wanted to leave and do nothing (S3).* The disappointment of the students was connected with self-distrust regarding being a teacher which evoked doubts with respect to their choice of the profession (*I experienced unpleasant experiences and distrust in my own strength, there was reluctance to participate in practical lessons and to lead them. S27); I got disappointed in myself, I thought I could perform the duties of a teacher better, S8; there was a great reluctance to come back to the school, S27).* In some students, the disappointment strengthened the desire to put more effort in order to achieve the set goals *(hopelessness was linked to optimism. That I would learn that, that I would implement that. And that I would do that, S10).*

The student behaviour in a failure situation. Two qualitative categories, which describe student behaviour in a situation attributed to a failure, have been established: restraint (*My heart was sad, whereas the outward appearance was cheerful, S10; I showed my disappointment and other negative feelings neither to the teacher-mentor nor to the pupils, S11)*; change/choice of behaviour strategies. In the case of a failure students tried to look for decisions in the current situation by changing/ choosing new strategies for their behaviour*:* to create an interest in children regarding the subject they teach (*I tried to look for alternative tasks, S25)*; certain establishment of behaviour rules (*we established common learning and behaviour rules during a lesson, S12);* communication with pupils by providing them with knowledge (*I tried to explain to the pupils, while giving a task, why they need to understand that I teach them, S27),* the use of another teacher‘s assistance when a pupil incurred an injury (*there was another teacher close by <...>, I asked that he would supervise the pupils while I would take that child to a nurse, S19*). The students, when a conflict between pupils broke out, did not get lost, they managed the stress and took proper pedagogical decisions (*I immediately separated the pupils and sought to clarify why the conflict broke out, S28).*

Student decisions related to the experienced failure. The most important decisions, in order to foresee, what should be done, that a similar situation would not reoccur in the future, have been described by the distinguished four qualitative categories: the acknowledgement of own mistakes and learning from them (*l understood why l was wrong, another one, the experienced person, sees it better from aside, S11;* positive approach to criticism *(in order to learn anything you need to pay attention to constructive criticism, S9)*; submission of proposals regarding the teaching practice by a student (*when I writing a report on the teaching practice l made proposals, S1, S12);* a student‘s search, consideration and choice for the appropriate strategies. Actions foreseen by the students aimed at: engaging the pupils in an activity, to create an interest in the taught subject*(: l looked for new games, methods, new ways how to make them interested in that, S23);* learning the needs of the pupils while communicating *(during the breaks l endeavour to focus on pupils, to enquire what they are concerned about, what their attitudes to life are, S12)*; search for new knowledge *(l researched how such children should be dealt with, S19)*; informal learning, raising qualification *(l understood that l need to read loads of specialised literature, to attend courses and seminars, to take advantage of the experiences of teachers-practitioners, S8)*; to appropriate good practice of other teachers, consultations with other teachers in order to *gradually know pupils, to examine how other teachers work, what traditions of teaching physical education are, what the pupils are best at, S9).* The students reflected on and foresaw strategies, which are appropriate when resolving conflicts between pupils (*to encourage cooperation of the pupils and mutual respect during a lesson in a greater measure. S28).*

Discussion

The process of a student‘s identification with a teacher‘s profession is related to his emotions and is able to affect his future career (Yuan, Lee, 2015). Our study revealed and confirmed the findings of other researchers (Kirbulut, Bektas, 2011) that one of the main difficulties during teaching practice is classroom management. The future teachers of physical education, which were researched by us, experienced failures due to the fact that the pupils did not obey them, refused to perform their tasks, it was difficult to create an interest in them and to engage them in a physical activity. Other researchers also maintain that students experience the greatest amount of difficulties while reacting to inappropriate conduct of the pupils (Maskan, Efe, 2011), when seeking to engage pupils in a physical activity (Özdemir, 2010). Despite the fact that the study shows that the students went through a great deal of emotional encounters, but, in some students, the failure experienced during their teaching practice strengthens the desire to achieve the objectives set by them – to become good pedagogues – with growing insistence. Caires et al. (2012) also established that students perceive teaching practice as an intensive period of searches, the knowledge and exploration of self and others. However, strong negative experiences of the students, which were revealed by us, are related to the weak motivation of the pupils regarding physical education when the students exerted the effort, but they would not meet any response of the pupils towards their endeavours, may make students doubt in the choice of their profession. When discussing the limitations of the study one of them is the fact that the gathered qualitative findings cannot be generalized in another context, although they also confirmed the conclusions of other researchers regarding the most important difficulties which are encountered by the students during their teaching practice. The students of only one Lithuanian university, which prepares the teachers of physical education, were interviewed. The fact that the study was focused on a narrow aspect – emotional response and behavior in a situation attributed to a failure, without revealing the student system of values, their motivation regarding their professional activity when choosing studies, during their studies, after their teaching practice, without analyzing their social context, i.e. their school environment, in which they underwent teaching practice – would also be considered by us as a limitation. Further studies could be oriented towards the reflections on negative and positive experience during their teaching practice and professional motivation, the interrelations of professional identity.

Conclusion

The students of physical education studies, who experienced a failure during their teaching practice, undergo different negative emotions, and, in the presense of an emotional stress, they choose various modes, which are oriented towards self, towards pupils, towards other teachers, to resolve a problematic situation. The results of the study orient to the fact that, when improving the process of the studies, more strategies and methods, which are aimed at classroom management during a lesson of physical education, also be given the possibility to make mistakes and correct them while taking a decision on his own. The findings of the study suggest that students understand the adequacy of their reactions and actions in different educational situations better when reflecting on their own emotional encounters. Therefore, the reflection of the students on the experiences of their own and others, the analysis of failure situations with mentors and tutors would enable to foresee possible situations during a lesson and to discuss strategies how to cope with emotional challenges.

References

1. Caires, S., Almeida, L.., Martins, S. (2010). The socioemotional experiences of student teachers during practicum: a case of reality shock. *The Journal of Educational Research*, 103, 17-27.
2. Caires, S, Almeida, L., Vieira, D. (2012). Becoming a teacher: student teachers' experiences and perceptions about teaching practice. *European Journal of Teacher Education*, 35 (2), 163-178.
3. Evelein, F., Korthagen, F., Brekelmans M.. (2008). Fulfilment of the basic needs of student teachers during their first teaching experiences. *Teaching and teacher Education*, 24: 1137-48.
4. Ferber, T., Nillas, L. A. (2010). *Through the eyes of student teachers: Successes and challenges in field teaching experiences*. Chicago: Wesleyan University Press.
5. Hormenu, T., Agyei, M., Ogum, P. N. (2014). Challenges and prospects of off campus practicum: The experience of the physical education student teacher. *The International Journal of Humanities & Social Studies*, 2 (5), 347-354.
6. Yuan, R., Lee, i. (2015). The cognitive, social and emotional process of teacher identity construction in pre-service teacher education programme. *Research Papers in Education*, 30, 469-491.
7. Kirbulut, Z. D., Bektas, O. (2011). Prospective chemistry teachers' experiences of teaching practice. *Social and Behavioral Sciences*, 15, 3651-3655.
8. Klassen, R. M., Chiu, M. M. (2011). The occupational commitment and intention to quit of practicing and pre-service teachers: Influence of self-efficacy, job stress and teaching context. *Contemporary Educational Psychology*, 36 (2), 114-129.
9. Maskan, A., Efe, R. (2011). Prospective teachers' perceptions of teaching practice experience in school placements. *Journal of Turkish Science Education*, 8(2), 64-77.
10. Midford, R., Buckworth, J. (2015). Investigation the stress levels of early childhood, primary and secondary pre-service teachers during teaching practicum. *Journal of Teacher Education for Sustainability*, vol. 17, no. 1, 35-47.
11. Özdemir, S. M. (2010). Evaluating the ability of prospective teachers to involve passive students in the lesson during practice teaching. *Social and Behavioral Sciences*, 2, 1761-1766.

THE FREQUENCY OF FALLS IN CHILDREN JUDO TRAINING

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Abstract

Purpose: Falling techniques are inseparable part of youth judo training. Falling techniques are related to avoiding injuries exercises (Nauta et al., 2013). There is not good evidence about the ratio of falling during the training in children. **Methods:** 26 children (age 8.88±1.88) were video recorded on ten training sessions for further indirect observation and performance analysis. **Results:** Research protocol consisted from recording falls and falling techniques (Reguli et al., 2015) in warming up, combat games, falling techniques, throwing techniques and free fighting (randori) part of the training session. While children were taught almost exclusively forward slapping roll, backward slapping roll and sideward direct slapping fall, in other parts of training also other types of falling, as forward fall on knees, naturally occurred. **Conclusions:** Judo coaches should stress also on teaching unorthodox falls adding to standard judo curriculum (Koshida et al., 2014). Various falling games to teach children safe falling in different conditions should be incorporated into judo training. Further research to gain more data from groups of different age in various combat and non-combat sports is needed.

Key words: *combat sport, martial arts, injury prevention, sport performance*

Introduction

It is believed that judokas tend to have a predominant directions of the fall forwards and backwards in the competition (Paillard, Montoya, & Dupui, 2005). Even the ability not to fall is influenced by good postural stability, which is important also in non-combat sports (Struhar & Dovrtelova, 2013), the knowledge of proper falling techniques should be included in basic judo training (Kalina et al., 2008). Previous research showed that we should distinguish the term fall from the term falling technique (Reguli, Senkyr, & Vit, 2015). Here, the fall is any movement of the body as a whole and its segments in the direction of the gravitational force. Falling technique is a movement skill acquired by intentional training. According to comparison between experienced and novice judokas, knee joint movement and the impact skill may be important components of the judo backward breakfall motion (Koshida, Ishii, Matsuda, & Hashimoto, 2014).

Teaching falling techniques is important for children, as the trend was found suggesting that a school-based educational programme to improve falling techniques may be beneficial for prevention of falling/related injuries (Nauta et al., 2013). It is not known, wat is the rate of falls during training session in judo. Therefore, the aim of this descriptive study is to determine the frequency of various types of falls in children judo training.

Methods

9 girls and 17 boys aged 6 to 12 (8.88±1.88) from local judo club participated in the study. All children were beginners in judo. Indirect observation was used. For further analysis, ten training sessions were recorded. Wide camera covering all training surface was used. Not all children participated at all ten sessions. Average participation was 16.2±2.27 per one training, which lasted for 60 minutes. Structure of one training session generally consisted from warming up, combat games, falling techniques, throwing techniques and free fighting (randori). Videos were carefully analysed and re-observed as many times as needed to score all falls of every participant. In result descriptive statistic was used.

Results

Terminology of falling techniques distinguished direction, type of contact and presence of slapping According to the taxonomy of falling techniques, three direction as forward, backward, sideward were recognized. For the type of contact, fall can be executed with or without rolling as well as with or without slapping for partial damping of impact force. If the fall was not recognised in any of that way, it was recognized as other. For all 26 participants, 10044 simple falls (489.66±23.53 per one participant) was counted. Average number of different falls per person and training session was 62, which is quite high number. It is important to know the part of training session and what type of fall, or falling technique occurred. In the Table 1, the numbers of falls for each part of training session are showed. Falls and falling techniques with higher rate are highlighted in bold.

Table 1: Average number of falls per person in ten training sessions

			Warming-up	Combat games	Falling techniques learning	Throwing techniques learning	Free fight	Sum
Forward	Direct	Slapping	0.00±0.00	0.43±0.06	0.00±0.00	0.00±0.00	0.31±0.04	0.74±0.10
		Soft	0.68±0.07	1.36±0.11	0.00±0.00	0.80±0.11	2.40±0.19	5.24±0.48
	Roll	Slapping	4.93±1.54	0.00±0.00	**107.21±9.52**	0.12±0.04	0.00±0.00	**112.27±11.10**
		Soft	2.84±0.75	0.37±0.06	19.79±1.82	0.06±0.02	0.00±0.00	23.06±2.64
	Other	On knees	**5.30±0.31**	**6.04±0.51**	0.00±0.00	8.63±0.86	**14.86±0.74**	34.83±2.42
Backward	Direct	Slapping	3.33±0.56	1.23±0.10	11.96±3.20	4.25±0.41	4.50±0.26	25.28±4.53
		With jump	0.00±0.00	0.00±0.00	9.56±1.67	0.00±0.00	0.00±0.00	9.56±1.67
		Soft	2.16±0.38	2.10±0.20	0.00±0.00	12.39±1.37	12.89±0.63	29.53±2.57
		With jump	0.00±0.00	0.00±0.00	3.58±0.67	0.00±0.00	0.00±0.00	3.58±0.67
	Roll	Slapping	1.29±0.26	0.00±0.00	**86.07±8.04**	0.55±0.08	0.68±0.07	**88.59±8.44**
		Soft	0.37±0.05	0.31±0.06	0.00±0.00	0.74±0.10	0.43±0.08	1.85±0.29
	Other	On rear	**5.30±0.31**	2.77±0.29	0.00±0.00	5.36±0.46	7.95±0.46	21.39±1.52
Sideward	Direct	Slapping	0.25±0.04	2.40±0.20	**118.31±7.35**	**71.21±7.96**	**35.76±1.12**	**227.93±16.67**
		Soft	2.03±0.19	4.19±0.39	0.00±0.00	11.10±1.03	**18.06±1.15**	35.39±2.75

Discussion

Judo curriculum count on three basic falling techniques as forward slapping roll, backward slapping roll and direct slapping on the side. These three falling techniques were mostly taught during training sessions. Contrary, in warming up and combat games parts of the training session, children felt on knees and rear. For children is natural to fall in that way. Although there is no evidence that this fall pattern is more dangerous than others (Pitone & Attia, 2006), falling on knees and rear is bad sport-related habit. It can be seen in the free fight part of training. Due to still low knowledge of throwing and falling techniques, children tend to fall on knee. They were not able to use single forward slapping roll and very little number of backward slapping roll. Some other martial arts uses different types of soft forward roll (Soltoggio, Blaesing, Moscatelli, & Schack, 2016) that could help to prepare children for harder judo falling techniques. For evaluation of the progress in learning how to fall safely, some specific diagnostic scales (Zvonar, Reguli, & Vit, 2011) based on General Falling Techniques (GFT) principles are recommended (Reguli et al., 2015).

Previous research showed a moderate relation between hip impact velocity and force in sideward fall, which was depend on technique (Groen, Weerdesteyn, & Duysens, 2008). The force was lower in soft falls, therefore is recommended to teach also this type of falling techniques in judo training. In free fight, one third sideward techniques were recognised as soft. Children were able to use this technique although they were not taught it intentionally.

The most vulnerable part of body during falls is the head (Conn, Annest, & Gilchrist, 2003). There were not falls with primary impact on head counted, which implies that falling techniques helps in injury prevention.

Conclusion

Children naturally uses different patterns of falling. Therefore, judo coaches should stress also on teaching unorthodox falls adding to standard judo curriculum, which is forward slapping roll, backward slapping roll and direct slapping on the side (Koshida et al. 2014). Various falling games to teach children safe falling in different conditions should be incorporated into judo training. This can be not only beneficial for injury prevention especially in groups with specific needs (Cihounkova, Skotakova, Kohoutkova, & Bugala, 2016), games are also fun and motivational for children. Further research to gain more data from groups of different age in various combat and non-combat sports is needed. This article deals only with average number of falls and falling techniques. For further research searching for of inter-individual differences is needed. There is a hypothesis that a child skilful in falling techniques falls significantly less on knees or rear.

Acknowledgements

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References

1. Cihounkova, J., Skotakova, A., Kohoutkova, J., & Bugala, M. (2016). Evaluation of self-defence for people with visual impairments - methodology aspects. *Archives of Budo*, *12*, 275–285.
2. Conn, J. M., Annest, J. L., & Gilchrist, J. (2003). Sports and recreation related injury episodes in the US population, 1997-99. *Injury Prevention*, *9*(2), 117–123. https://doi.org/10.1136/ip.9.2.117
3. Groen, B. E., Weerdesteyn, V., & Duysens, J. (2008). The relation between hip impact velocity and hip impact force differs between sideways fall techniques. *Journal of Electromyography and Kinesiology*, *18*(2), 228–234. https://doi.org/10.1016/j.jelekin.2007.06.002
4. Kalina, R. M., Barczynski, B., Jagiello, W., Przezdziecki, B., Kruszewski, A., Harasymowicz, J., … Szamotulska, K. (2008). Teaching of safe falling as most effective element of personal injury prevention in people regardless of gender, age and type of body build - the use of advanced information technologies to monitor the effects of education. *Archives of Budo*, *4*, 82–90.
5. Koshida, S., Ishii, T., Matsuda, T., & Hashimoto, T. (2014). Biomechanics of the judo backward breakfall: comparison between experienced and novice judokas. *Archives of Budo*, *10*, 187–194.
6. Nauta, J., Knol, D. L., Adriaensens, L., Wolt, K. K., van Mechelen, W., & Verhagen, E. A. L. M. (2013). Prevention of fall-related injuries in 7-year-old to 12-year-old children: a cluster randomised controlled trial. *British Journal of Sports Medicine*, *47*(14). https://doi.org/10.1136/bjsports-2012-091439
7. Paillard, T., Montoya, R., & Dupui, P. (2005). Influence of postural regulation in male judokas' direction of falls'. *Perceptual and Motor Skills*, *101*(3), 885–890. https://doi.org/10.2466/pms.101.3.885-890
8. Pitone, M. L., & Attia, M. W. (2006). Patterns of injury associated with routine childhood falls. *Pediatric Emergency Care*, *22*(7), 470–474. https://doi.org/10.1097/01.pec.0000226869.41803.50
9. Reguli, Z., Senkyr, J., & Vit, M. (2015). Questioning the Concept of General Falling Techniques (GFT). *Health and Martial Arts in Interdisciplinary Approach*, 63–67.
10. Soltoggio, A., Blaesing, B., Moscatelli, A., & Schack, T. (2016). The Aikido inspiration to safety and efficiency: an investigation on forward roll impact forces. In P. Chung, A. Soltoggio, C. W. Dawson, Q. Meng, & M. Pain (Eds.), *Proceedings of the 10th International Symposium on Computer Science in Sports (iscss)* (Vol. 392, pp. 119–127). Berlin: Springer-Verlag Berlin.
11. Struhar, I., & Dovrtelova, L. (2013). Implementation of core stability programme for footballers in middle school aged. *Sport and Quality of Life 2013*, 328–334.
12. Zvonar, M., Reguli, Z., & Vit, M. (2011). Specific Rating Scale For Evaluating Back Roll Fall. *Medicine and Science in Sports and Exercise*, *43*(5), 732–732.

SEX DIFFERENCES IN PERCEIVED PHYSICAL ACTIVITY CHARACTERISTICS IN 11-19 YEARS OLD ITALIAN STUDENTS

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Abstract

Purpose*:* This study aimed to investigate sex and age differences in selected physical characteristics assessed with questionnaires in a cohort of middle and high school students.

Methods*:* 1051 students (497 girls and 654 boys) aged 11 to 19 years completed the following questionnaires: Physical Activity Questionnaire for Adolescents (PAQ-A), Task and Ego Orientation in Physical Education Questionnaire (TEOSQ), Physical Activity Enjoyment Scale Questionnaire (PACES), Teacher-Initiated Motivational Climate in Physical Education Questionnaire (TIMCPEQ), Physical Self Description Questionnaire (PSDQ), and Psychobiosocial states questionnaire (PBS). For all questionnaires, scores were compared by sex and age with two-way ANOVAs.

Results*:* Overall, boys showed higher scores than girls in the PAQ-A, TEOSQ (ego orientation), TIMCPEQ, PBS (both pleasant and unpleasant descriptors), PACES (positive items), and PSDQ. Conversely, girls showed higher scores than boys in the PACES (negative items).

A trend of questionnaires scores to decrease across ages was observed, both in boys and girls, in the PAQ-A, PBS (pleasant descriptors), and PACES (positive items). Furthermore, decreases across ages of TEOSQ (task orientation) and PACES (negative items) were observed only in boys, while the PSDQ score decreased only in girls. Finally, boys showed an increase across age of the TEOSQ (ego orientation) score.

Conclusions*:* The present study confirms a decrease of motivation towards PA and PA enjoyment across adolescence and in particular in the transition between the middle and high school (at age 14). The study findings provide suggestions to PE teachers about the importance of using motivational strategies towards students, differentiated by sex and age groups.

Key words: *Adolescents, physical education, questionnaires, motivation, enjoyment*

Introduction

It is well known that, in the general population, participation in physical activity (PA) is affected by a number of environmental and psychological factors (Roberts et al., 2007). Similarly, in the school, participation and interest of students in physical education (PE) is influenced by the enjoyment of PA (Hagberg et al., 2009), the motivational climate during PE classes (Escartí & Gutiérrez, 2001), and by how students perceives some aspects of their physical activity (Biddle & Mutrie, 2007).

Questionnaires are widely used in the literature to assess PA characteristics (e.g. Biddle & Mutrie 2007, Neilson et al., 2008), though sex and age differences in the perception of PA characteristics have not yet extensively assessed in middle and high school students. Nevertheless, understanding the trends across age and sexes of motivation towards PA, perception of motivational climate during PE classes, and PA enjoyment, is important to plan and assess specific long-term interventions intended to enhance positive attitude toward exercise and promote the adoption of active lifestyles. Therefore, the aim of this study was to investigate sex and age differences in the scores of a selection of six questionnaires commonly used to assess the perception of PA characteristics in adolescents.

Methods

1051 school students (497 girls and 654 boys) aged 11 to 19 years and attending first or second grade schools in northern Italy were involved in the study. The purpose and procedures of the study was explained to the school teachers and principals, who gave approval to conduct the study. All the students (and their parents for U18 participants) provided their consent to participate.

The following questionnaires were administered to all the participants:

- Physical Activity Questionnaire for Adolescents (PAQ-A, Kowalsky et al., 2004), providing a general measure of individual physical activity based on a 7-day recall. A score of 1 in the PAQ-A indicates low physical activity, whereas a score of 5 indicates high physical activity.

- Task and Ego Orientation in Physical Education Questionnaire (TEOSQ, Walling & Duda 1995), composed of 16 items comprising two scales on the individual disposition for Ego and Task Orientation, respectively.
- Physical Activity Enjoyment Scale Questionnaire (PACES, Bortoli & Robazza 2005), consisting of 9 positive and 7 negative items, where high scores on the positive items and low scores on the negative items indicate a high enjoyment of physical activity.
- Teacher-Initiated Motivational Climate in Physical Education Questionnaire (TIMCPEQ, Papaioannou, 1998), consisting of 12 items with two subscales focused on either a mastery-oriented or a performance-oriented teacher-initiated motivational climate.
- Physical Self Description Questionnaire (PSDQ short version, Marsh et al., 2010), composed by 40 items comprising 11 factors (health, coordination, physical activity, body Fat, activity, global Physical, appearance, strength, flexibility, global esteem, sports competence, physical activity, and endurance).
- Psychobiosocial states questionnaire (PBS, Bortoli et al. 2009), consisting of a 20-item list of pleasant and unpleasant descriptors to gauge PBS states in the context of physical education.

For all questionnaires, scores were compared by sex and age with two-way ANOVAs and Tukey's post-hoc tests. Significance was set at $p<0.05$.

Results

In the PAQ-A, both boys and girls showed a decrease in PA with increasing age, except for age 15 (Fig. 1). Boys aged 11, 12 and 13 years showed significantly ($p<0.01$) higher PAQ-A scores than boys aged 16, 17 and 19 years. Girls aged 11 and 12 showed scores higher than girls aged 16, 17 and 18 years. Therefore, students of both sexes in the middle school showed higher PA levels than students attending the last three years of the high school.

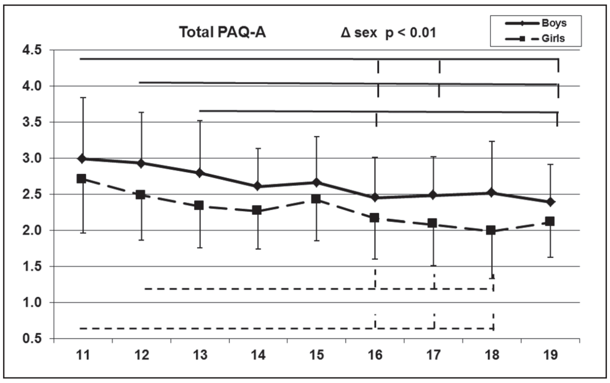
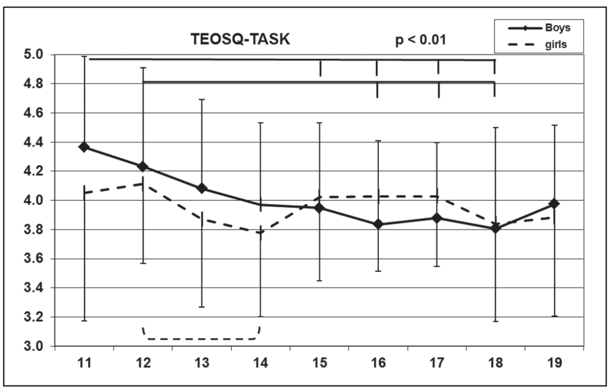
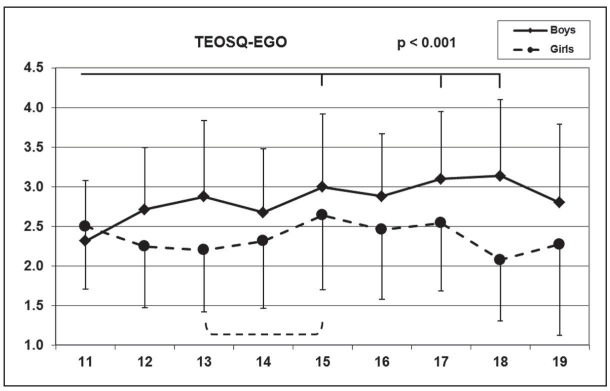


Figure 1: PAQ-A scores across ages.

Overall, boys showed higher PA levels than girls, with an average difference of 0.25 points ($p=0.001$).

The scores and trends related to task and ego orientation are displayed in Figures 2 and 3.





Task (Figure 2) and Ego (Figure 3) orientation scores across ages.

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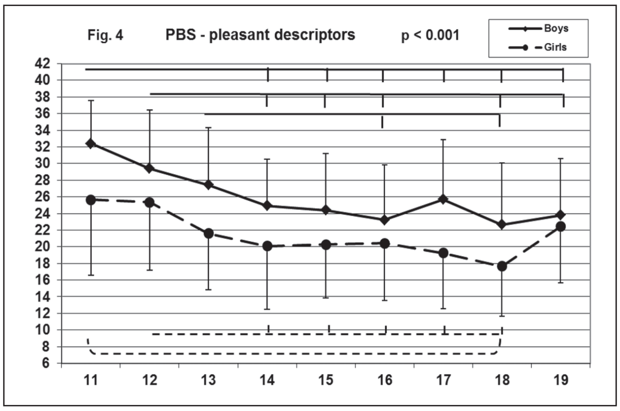
The highest task orientation mean score (about 4.4) was observed in boys at 11 years, with a gradual decrease and a plateau at the age of 15 years. In boys, scores were higher at 11 and 12 years compared to scores at 15, 16, 17, and 18 years ($p< 0.01$). Girls showed a fluctuating trend: task orientation scores decreased between 12 and 14 years of age, thereafter showing an increase and levelling off from age 15 and 17, with final decrease in the last examined age groups. In girls, scores were significantly different only between the ages of 12 and 14 years.

A significant interaction between sex and age ($p=0.013$) was found, especially due to the different behavior of male and female students at ages of 11 and 12 and at ages of 14 and 15.

Ego orientation, in boys, showed minimum scores at 11 years, increasing gradually up to 18 years. In 11 year old boys, scores were significantly lower than at ages 15, 17 e 18, showing an opposite trend to that of task orientation scale. In girls, the trend for ego orientation was similar to that of task orientation, with a decline from age 11 to 13, and oscillating scores at age 15 to 19. Significant differences were found only between ages 13 and 15. Overall, the ego orientation scores were higher in boys than in girls ($p=0.001$).

Concerning the TIMCPEQ questionnaire, the mean score for boys in the mastery-oriented climate was almost constant between age 12 and age 16 (3.8). Girls showed an oscillating trend with mean values similar to those shown by boys. The scores in the performance-oriented climate scale showed slight non-significant changes across ages in both boys (2.3 to 2.6) and girls (2.0 to 2.4). Boys showed overall higher scores than girls ($p=0.001$).

In the PBS questionnaire, the mean scores for pleasant descriptors tend to decrease across ages in boys from age 11 up to age 16 (fig. 4), and thereafter it levels off. Mean scores at 11 and 12 years were significantly higher than at 14, 15, 16, 17, 18 and 19 years. Furthermore, at 13 years, mean scores were significantly higher than at 16 and 18 years. In girls, pleasant descriptors showed the highest values at 11 and 12 years, with a subsequent decrease up to the age of 18 (Figure 4). Overall, boys showed higher scores than girls ($p=0.001$), with a difference of approximately 4 points. No significant differences between ages were observed for unpleasant descriptors, both in boys and girls. Boys showed higher scores (22.3 to 32.0 at the different ages) than girls (18.0 to 26.0), with marked differences especially in the younger age groups.



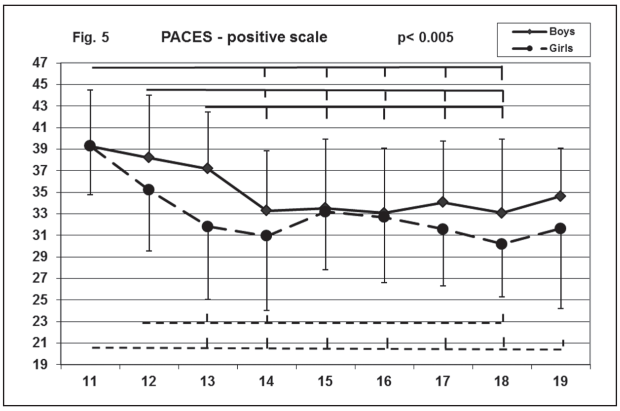


Figure 4: PBS (positive states) and Figure 5: PACES (positive scale) scores across ages

In boys, enjoyment of PA was higher at 11 years and tended to decrease up to 14 years to then level off (fig. 5). On average, the PACES score on positive items was higher in middle school students than in high school students (Figure 5). In girls, the mean score was higher between 11/12 years vs. all subsequent ages. Boys showed overall higher ($p=0.001$) scores compared to girls, with an average difference of about 2 points. The score in negative items showed a trend to increase in boys from 11 to 14 years, although no significant differences were observed. Girl showed quite low values at 11 years. Thereafter, the average score increased up to 14 years to show then an oscillating trend up to 19 years. Significant differences were observed between the ages of 12 and 18 years, and between the age 11 vs. ages 14, 15, 16, and 18 years.

Girls showed overall higher scores than boys ($p=0.005$), with an average difference of approximately 2 points.

The PSDQ questionnaire showed no significant differences between age groups in boys, with overall mean scores of about 4.5 points. Conversely, a decreasing mean score was observed in girls, from 4.4 points (11/12 years) to 3.3 points (18/19 years). The mean score at 12 years was significantly higher than at 18 and 19 years. Overall, boys showed higher scores than girls ($p=0.001$), with differences of approximately 0.5 points.

Discussion

The study findings show a trend of scores to decrease in many of the examined scales in PAQ-A, PBS (pleasant descriptors), PACES and TEOSQ (task orientation). These results are consistent with previous studies showing an overall decline of physical activity during adolescence (Dumith et al., 2011). This decline, linked to decreased PA enjoyment, positive psychobiosocial states, and task orientation, demonstrates a decreased interest and motivation towards physical activity in the transition between the middle and high school. Likely, the increase of time dedicated to studying, social networking or playing electronic devices at the beginning of the high school is a major determinant of the observed decreased interest for PA. In general, boys showed at all ages higher interest towards PA, PA enjoyment and ego orientation than girls, in agreement with previous studies (Walling & Duda, 1995; Bortoli & Robazza, 2005). Taken together, these findings suggest that teachers should attempt to motivate students (and in particular girls) to rediscover interest in physical activity and sport, especially in the first years of the high school.

Conclusions

In conclusion, the present study confirms a decrease of motivation towards PA and PA enjoyment across adolescence and in particular in the transition between the middle and high school (at age 14). The study findings provide suggestions to PE teachers about the importance of using motivational strategies towards students, possibly differentiated by sex and age groups.

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References

1. Biddle, S. J., & Mutrie, N. (2007). *Psychology of physical activity: Determinants, well-being and interventions*. Routledge.
2. Bortoli, L., & Robazza, C. (2005). Italian version of the task and ego orientation in physical education questionnaire. *Perceptual and motor skills*, *101*(3), 901-910.
3. Bortoli, L., Bertollo, M., & Robazza, C. (2009). Dispositional goal orientations, motivational climate, and psychobiosocial states in youth sport. *Personality and Individual Differences*, *47*(1), 18-24.
4. Dumith, S. C., Gigante, D. P., Domingues, M. R., & Kohl, H. W. (2011). Physical activity change during adolescence: a systematic review and a pooled analysis. *International journal of epidemiology*, *40*(3), 685-698.
5. Escartí, A., & Gutiérrez, M. (2001). Influence of the motivational climate in physical education on the intention to practice physical activity or sport. *European Journal of Sport Science*, *1*(4), 1-12.
6. Kowalski K. C., Crocker P. R. E., Donen R.M. (2004). The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) Manual, Saskatoon, SK, Canada: University of Saskatchewan.
7. Hagberg, L. A., Lindahl, B., Nyberg, L., & Hellénius, M. L. (2009). Importance of enjoyment when promoting physical exercise. *Scandinavian journal of medicine & science in sports*, *19*(5), 740-747.
8. Marsh, H. W., Martin, A. J., & Jackson, S. (2010). Introducing a short version of the physical self description questionnaire: new strategies, short-form evaluative criteria, and applications of factor analyses. *Journal of Sport and Exercise Psychology*, *32*(4), 438-482.
9. Neilson, H. K., Robson, P. J., Friedenreich, C. M., & Csizmadi, I. (2008). Estimating activity energy expenditure: how valid are physical activity questionnaires?. *The American journal of clinical nutrition*, *87*(2), 279-291.
10. Papaioannou, A. (1998). Students' perceptions of the physical education class environment for boys and girls and the perceived motivational climate. *Research Quarterly for exercise and sport*, *69*(3), 267-275.
11. Roberts, G. C., Treasure, D. C., & Conroy, D. E. (2007). Understanding the dynamics of motivation in sport and physical activity: An achievement goal interpretation. *Handbook of Sport Psychology, Third Edition*, 1-30.
12. Walling, M. D., & Duda, J. L. (1995). Goals and their associations with beliefs about success in and perceptions of the purposes of physical education. *Journal of Teaching in Physical Education*, *14*(2), 140-156.

TREND OF THE CARDIORESPIRATORY FITNESS OF THE EIGHTH GRADE STUDENTS OF PRIMARY SCHOOLS IN THE PERIOD FROM 1999 TO 2012

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Abstract

The main aim of this study was to show the trend of the cardiorespiratory fitness in eighth-grade students between 1999 and 2012. In the world and in Croatia, there are decreasing levels of physical activity among children and youth, especially in adolescence. Not enough is known about the trend in the level of the cardiorespiratory fitness among children of primary school age in the Republic of Croatia in the period of the last 15 years. The participant sample consisted of a total of 687 subjects (304 male students and 383 female students) of the eighth grade of primary schools in Zagreb. The 6-minute run tests were conducted as initial testing at the beginning of the school year, and the results are shown in meters. The test assesses the level of cardiorespiratory fitness. The data show that the results of the 6-minute run tests in schoolgirls in 1999 (1178.1 ± 174.5 m) were significantly better than the results in 2012 (1030.2 ± 205 m). Also, the boys recorded better results in 1999 (1281.9 ± 163.9 m) than in 2012 (1185.6 ± 200.3 m). It may be concluded that, in general, each subsequent generation is getting worse in cardiorespiratory fitness and that we must take all the necessary measures on the national level to solve this problem.

Key words: *6-minute run test, adolescence, functional abilities*

Introduction

The health fitness as a functional ability level related to health consists of several components which affect the overall health. These are: cardiorespiratory fitness, flexibility, muscular strength and endurance as well as body composition (ACSM, 2008).

The cardiorespiratory fitness is an important indicator of health, significantly associated with mortality from cardiovascular diseases, and it can be improved with regular physical activity (Kodama et al., 2009). It reflects the ability of the oxygen transport system (the cardiovascular and the respiratory system) to deliver the adequate amount of oxygen to active muscles (ACSM, 2008). The cardiorespiratory fitness is one of the measures of general fitness which is important for athletes at all levels for engaging in physical activity, both recreational and top athletes, and all the people who want to improve and maintain their health as well as the sports form. The high level of fitness also has a number of positive effects on health with an impact on the prevention of various diseases such as diseases of the heart and blood vessels, of the lungs, osteoporosis, colon cancer, high blood cholesterol levels, high blood pressure as well as the prevention of the onset of obesity, anxiety and depression (Laukkanen et al., 2001).

So far in the world, there have been numerous studies on the trend of cardiorespiratory fitness in children and adolescents. Various time periods were observed and different tests were used to determine the cardiorespiratory fitness (Tomkinson and Olds, 2007.; Muthuri et al., 2014; Petrić, Cetinić, & Novak, 2010; Hong and Hamlin, 2005; Dollman et al., 1999; Dyrstad, Berg, & Tjelta, 2011; Møller et al., 2007; and others). The results obtained are very heterogeneous and it is useful to continue to conduct these kind and similar studies in order to determine the general state and the trend of cardiorespiratory fitness.

The aim of this study is to describe the trend of the results of the 6-minute run test as an indicator of the cardiorespiratory fitness in eighth-grade students of two primary schools in the city of Zagreb in the period from 1999 to 2012. We will present the trends of the average results of generations of girls and boys tested in that period and compare the average results of 1999 and 2012 for both genders.

Methods

The sample consisted of the eighth-grade students (N=687), of which 70.1% (383) female students and 29.9% (304) male students of the “Ivan Mažuranić” and “Ivan Cankar” primary schools in the city of Zagreb, generations from 1999 to 2012.

The analysed variable was the result of the 6-minute run test (F6) expressed in meters, used for the assessment of cardiorespiratory fitness. The tests were conducted from 1999 to 2012 by physical education teachers as initial testing of cardiorespiratory fitness at the beginning of each school year. The 6-minute run test (F6) is a standard field test for the assessment of cardiorespiratory fitness. It is a shorter version of the Cooper 12-minute run test. The test is used for the assessment of cardiorespiratory fitness, i.e., the ability of the body to use oxygen as an energy source in children and adolescents in primary and secondary schools. The metric characteristics of the test were found to be satisfactory (Bolonchuk, 1975).

The basic descriptive parameters of the F6 test results (the arithmetic mean (AS), the median, the standard deviation (SD)) in the sample of male and female students were calculated per year. The average values of the results of the F6 test are shown in the period from 1999 to 2012. The normality of the distribution of variables was tested by the Kolmogorov-Smirnov test. The difference between the values of the F6 test results in eighth-grade male students in 1999 and 2012 was tested by the Student's t-Test for independent samples. The difference between the values of the F6 test results in eighth-grade female students in 1999 and 2012 was tested by the non-parametric Mann-Whitney U test, because the values of the F6 test results in 1999 did not follow normal distribution. The statistical significance was set at $p<0.05$. For the analysis, the STATISTICA program, vers. 12 (StatSoft, Inc. Tuls, OK, USA) was used.

Results

The Figure 1 shows the arithmetic means and the standard deviations of the F6 test results of female and male students in the period from 1999 to 2012. In female students, there is a visible slight downward trend in the average values of the results, while in male students no clear downward trend of average values was noticed.

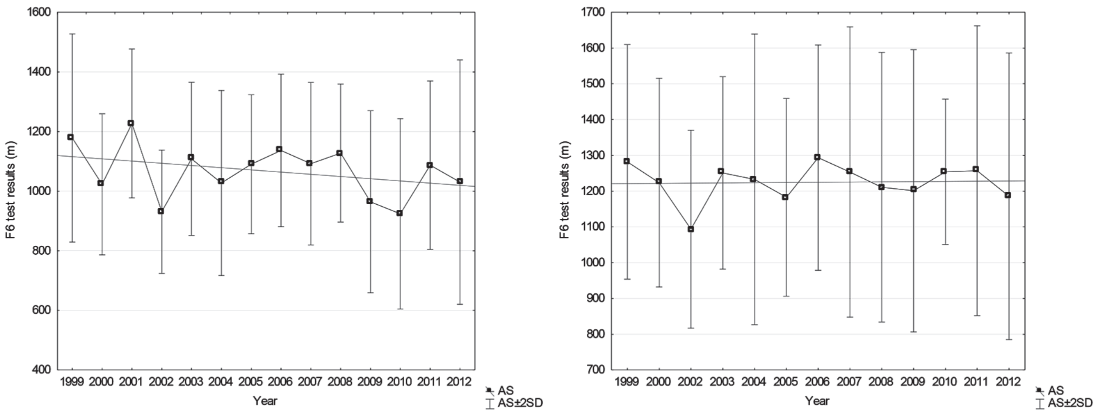

Figure 1: The F6 test results (arithmetic mean (AS) ± SD) for female and male students in the period from 1999 to 2012

The difference between the F6 test results of female and male students obtained in 1999 and 2012 is shown in Table 1. Since the values of the F6 test in 1999 did not have a normal distribution, the non-parametric Mann-Whitney U Test was applied for the analysis of differences. The results of the female student generation of 2012 were statistically significantly lower compared to the results of the female student generation of 1999.

The results of the t-Test for independent samples for determining the differences between the results of the F6 tests of male students obtained in 1999 and 2012 are also shown in Table 1. The 2012 results are statistically significantly lower compared to the results in 1999.

Table 1: The difference between the values of the F6 test results of eighth-grade female and male students in 1999 and 2012

	Year	Median (m)	U	z-value	p
Female students	1999	1122			
	2012	1025	544.50	3.14	0.00

	Year	Arithmetic mean (m)	Difference	t-value	p
Male students	1999	1.281,86			
	2012	1.185,61	96.25	2.05	0.04

Discussion

The results indicate a general decline in the cardiorespiratory fitness in eighth-grade male and female students, i.e., each succeeding generation achieved poorer results. Similar results were obtained in the Muthuri et al. (2014) study. They are also comparable to the results of the Dollman et al. (1999) study, which found poorer results in Australian children aged 10-11 in 1.6 km-run test between generations measured in 1985 and 1997, and to the results of the study by Dyrstad, Berg, & Tjelta (2011), who found lower scores of the 3000 m-run tests in secondary school students between generations tested in 1969 and 2000. Tomkinson and Olds (2007) found a significant decline in aerobic capacity in children aged between 6 and 9 at the level of 27 world countries in the period after 1970. The decline is precipitous and every year, the aerobic capacity in children declines by 0.36%.

The differences in the trend of the results of the cardiorespiratory fitness test between boys and girls were noticed by Dollman and Olds (2007), who compared the results of 1.6-km runs in Australian children in 1985 and 1997. The analysis was conducted on 965 boys and 935 girls in 1985 and 661 boys and 553 girls in 1997. The children were between 10 and 11 years old. In boys, a significant increase in the coefficient of variation of the arithmetic means of the results was noticed, i.e., a more significant decline in boys who were in the category with average scores. In girls, the decline of results was evenly distributed across all categories.

Searching for possible determinants of success in physical fitness tests, Tomkinson, Olds and Borms (2007) analysed 67 studies that reported on the variability of the Eurofit data on children and adolescents from different parts of Europe. The data were collected based on 1.185,656 Eurofit tests in children aged 7 to 18 from 23 European countries. The study showed that the most successful children were those from Northern and Central Europe. As a possible determinant of the success in testing, the study also observed the socio-economic status of the country, but no significant correlation of indicators of the socio-economic status and the success in testing was established. The study also confirmed a significant association of BMI and the test performance for the assessment of the cardiorespiratory fitness in a larger sample of countries surveyed.

It is important to note that the possibility of drawing a conclusion based on the results obtained in this study is limited. We used a convenience sample with a relatively small number of participants, it included students of just two primary schools in the city of Zagreb and the number of tested male and female students in some years varied significantly. Therefore, it is impossible to generalize the obtained results and, in future studies it would be necessary to include a larger, more representative and random sample of students for the purpose of establishing the trend of cardiorespiratory fitness. However, it is to be expected that, even with a larger sample, the obtained results would be similar.

Conclusion

Considering the results as a whole, we can conclude that there is an overall decline of the cardiorespiratory fitness in male and female students of the eighth grade of primary school, i.e., generations to come have an increasingly poor cardiorespiratory fitness. Further studies should focus on finding ways to stop and improve this negative trend. If we want to influence the entire population, one of the proven ways are the obligatory physical education classes in which all students participate. The health of the entire population is at stake and these classes are already established, but they require significant changes. One of them is certainly to increase the number of lessons per week from the current two or less. Furthermore, during the classes, a greater emphasis should be set on non-competitive kinesiological activities and activities in nature, which are fundamental for adopting habits of regular and lifelong physical exercises (Novak et al., 2014).

References

1. American College of Sports Medicine (ACSM) (2008). *ACSM's Health-Related Physical Fitness Assesment Manual*, 2nd ed. Philadelphia: Lippincott Williams & Wilkins.
2. Bolonchuk, W.W. (1975). *The Accuracy of the Six Minute Run Test to Measure Cardiorespiratory Fitness.* Grand Forks: University of North Dakota.
3. Dollman, J., Olds, T., Norton, K., & Stuart, D. (1999). The Evolution of Fitness and Fatness in 10-1 1 -Year-Old Australian Schoolchildren: Changes in Distributional Characteristics Between 1985 and 1997. *Pediatric Exercise Science, 11*, 108-121.
4. Dollman J., & Olds T.S. (2007). Distributional changes in the performance of Australian children on tests of cardiorespiratory endurance. *Medicine and Sport Science, 50,* 210-225.
5. Dyrstad, S.M., Berg, T., & Tjelta, L.I. (2011). Secular trends in aerobic fitness performance in a cohort of Norwegian adolescents. *Scandinavian Journal of Medicine & Science in Sports.* doi: 10.1111/j.1600-0838.2011.01315.x.
6. Hong, S.W., & Hamlin, M.J. (2005). Secular trends and contemporary differences in physique and health-related fitness levels of 11-12 year-old South Korean and New Zealand children. *The Southeast Asian Journal of Tropical Medicine and Public Health, 36*(5), 1339-1345.
7. Kodama S, Saito K, Tanaka S et al. (2009). Healthy Men and Women: A Meta-analysis All-Cause Mortality and Cardiovascular Events in Healthy Men and Women: A Meta-analysis. *JAMA 301*(19), 2024-2035.

8. Laukkanen, J.A., Lakka, T.A., Rauramaa, R., Kuhanen, R., Venäläinen, J.M., Salonen, R., & Salonen, J.T. (2001). Cardiovascular fitness as a predictor of mortality in men. *Archives of internal medicine, 161*(6), 825-831.
9. Møller, N.C., Wedderkopp, N., Kristensen, P.L., Andersen, L.B., Froberg, K. (2007). Secular trends in cardiorespiratory fitness and body mass index in Danish Children: The European Youth Heart Study. *Scandinavian Journal of medicine and science in sports, 17*(4), 331-339.
10. Muthuri, S., et al. (2014). Temporal Trends and Correlates of Physical Activity, Sedentary Behaviour, and Physical Fitness among School-Aged Children in Sub-Saharan Africa: A Systematic Review. *International Journal of Environmental Research and Public Health, 11,* 3327-3359.
11. Novak, D., Petric, V., Jurakic, D., & Rakovac, M. (2014). Trends and Future Visions of Physical Education: Croatian Challenges. In M-K. Chin & C.R. Edginton (Eds.), *Physical education and health. Global Perspectives and Best Practice* (pp. 121-133). Urbana, IL: Sagamore Publishing.
12. Petrić, V., Cetinić, J., & Novak, D. (2010). Razlike u funkcionalnim sposobnostima između učenika iz urbane i ruralne sredine. *Hrvatski Športsko-medicinski Vjesnik 25*(2)*,* 117-121.
13. Tomkinson, G.R., & Olds, T.S. (2007). Secular Changes in Pediatric Aerobic Fitness Test Preformance: The Global Picture. *Medicine and Sport Science, 50*, 46-66.
14. Tomkinson, G.R., Olds, T.S., & Borms, J. (2007). Who Are the Eurofittest? *Medicine and Sport Science, 50,* 104-128.

THE IMPORTANCE OF PHYSICAL ACTIVITY FOR THE PREVENTION OF PEER VIOLENCE - RESEARCH OF THE PRESCHOOL TEACHERS' OPINION

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Abstract

Aggression and various types of violence are becoming increasingly present in communication and interaction among children, but also among children and adults. Physical activity (PA) contributes to the increase in life quality for both children and adults (health, self-confidence, social relationships) and influences the development do different aspects of child development. Scientific studies show that PA is an important means in the prevention of peer violence. The goal of this paper was the exploration of preschool teacher opinions on the importance of physical activity in the prevention of peer violence at the preschool age. By implementing a specially constructed questionnaire on a sample of 165 preschool teachers, 12 variables directed towards the study of the importance of PA for the prevention of peer violence were examined. Most of the scores (which move in the range from 4.27 to 4.91) were on the five level Likert type scale (from 1 – it is not important to 5 it is very important). In this research, PA was recognized to be an important means for the prevention of peer violence. From the preschool teachers' opinion analysis a need for additional sensitization and education when it comes to implementing every day PA and its forms in the prevention of peer violence has arisen.

Key words: *physical activity, peer violence, preschool teachers*

PHYSICAL EDUCATION IN EUROPE: TIMETABLE IN COMPULSORY EDUCATION

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Abstract

The aim of this research was to determine rank and differences in physical education between specific countries in Europe. Sample for this research was comprised of countries with prescribed fixed and flexible timetable. For determining results, basic descriptive statistics and simple t-test were used. Results indicate that France (1080 hours of physical education/year) and Hungary (1064 hours of physical education/year) have the biggest total annual compulsory physical education timetable with more than 1000 hours, while Ireland (398 hours/year), Turkey (408 hours/year) and Latvia (416 hours/year) have the lowest with approximately 400 hours /year. Countries differ on total sample (p= 0.00) and within the groups with fixed (p= 0.00) and flexible (p= 0.00) timetable. Based on the results, it can be seen that compulsory timetable of physical education is very heterogenous in European Union, according to the annual schedule. On one side, positive thing is that several countries, like Hungary, recognized how much is this subject and it's timetable essential for contributing to the health of the entire population, but also, sad fact is that the vast majority of countries still haven't brought that conclusion to consciousness. Countries with lower annual compulsory physical education timetable should try harder to reach the publich-health problems from the inside, scientists from this field need to publish scientific insights, design and lead quality projects with the goal of education action which will come to people's consciouness that compulsory teaching of physical education and much bigger timetable significant for health and well-being of entire population.

Key words: *European Union countries, primary school, education, health, well-being*

Introduction

Problem of physical inactivity represents actual question of modern way of life, and in last several decades has become one of the biggest scientific challenges all around the world (Petrić et al., 2012; Chin & Edginton, 2014). This is not surprising, while it's well-known that, also with overweight, belongs to one of the most significant factors of health risk and mortality for human (World Health Organization, 2014). Particulary worrying phenomena pronouncedly negative trend of that factors has occured among children and youth (Currie et al., 2012). Based on that, physical education can and must have very important role in prevention and suppression of mentioned factors. For many children, school is the main environment for being physically active, through physical education and sport programs or after-school activities (Telama et al., 1997).

All positive effects of this type of class are well-known and through it we can directly affect on health of all students. But still most countries in Europe suprisingly prescribe modest schedule. Based on that, each country, who cares about health population and better future should, without any kind of hesitation, increase compulsory physical education timetable. It is neccesary that compulsory education lasts as long as possible, because students could gain quality habits and necessary knowledge for independent life span exercise, especially for health function and quality of life. This study could be significant, because it gives review and combines physical education timetable in compulsory education of almost all countries of European Union.

The aim of this study is to show rank of specific countries of European Union in total and average annual compulsory physical education timetable, years of compulsory education duration and determine differences among the same.

Methods

Data base for this study is based on the Recommended Annual Taught Time in Full-time Compulsory Education in Europe 2012/2013 document. According to mentioned document, 19 countries from European Union are allocated with prescribed fixed compulsory physical education timetable and 8 countries with flexible prescribed timetable. For fixed timetables, number of hours for each school year during the duration of compulsory education was prescribed. For example, 6th grade of primary school with 70 hours of compulsory timetable in Republic of Croatia. Specified number of hours among flexible timetable was prescribed for two or more school years together. For example, Sweden prescribes 500 hours from 1st to 9th grade, and school decides on its own about default range of how many hours will give to each class annually. Countries with prescribed variable and combined timetable were omitted from the study, because it is not possible to define correct number of hours. In this type of countries, school system acts by decentralized system (for example, England), where schools decide on their own number of hours for each subject.

Sample of variables were comprised of total prescribed timetable during compulsory education duration, number of years in compulsory education duration and average annual compulsory education of physical education.

Data processing was performed by the program STATISTICA (data analysis software system), version 7.1., StatSoft, Inc. (2005). Data were shown like charts and tables as means and standard deviations and significant difference was set up at $p<0.05$. Data did not significantly differ from normal distribution and to determine differences single simple t-test and t-test for independent samples were used.

Results

In chart 1., the results showed prescribed total compulsory physical education timetable based on 45 minutes among different countries of Europe. Lightened columns represented countries with fixed physical education timetable (n=19) and darker columns represented countries with flexible physical education timetable (n=8).

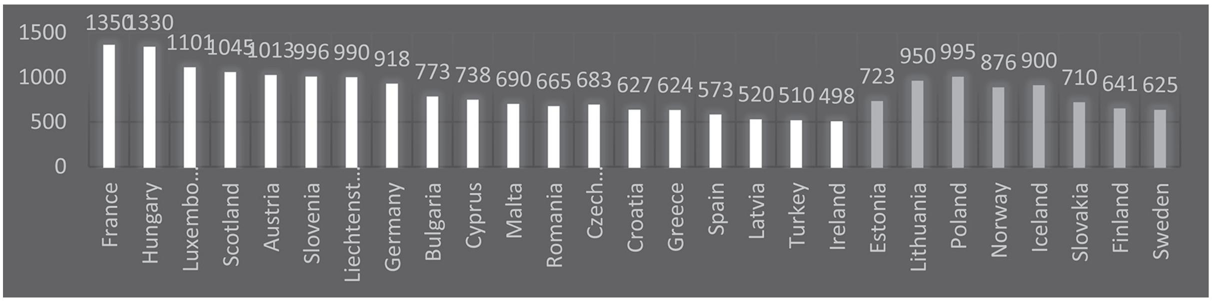

Chart 1: European Union countries and their total number of compulsory physical education

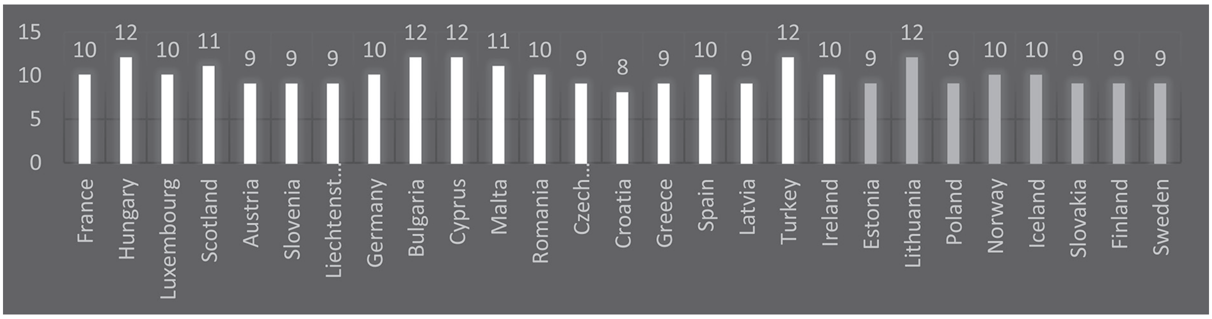

Chart 2: Compulsory education duration (physical education) shown in school years

Results of total number of physical education timetable (Table 1) showed that countries like France (1350 hours) and Hungary (1330 hours), which represent countries with fixed physical education timetable, have the highest total number of physical education per year. As opposed to that, Turkey (510 hours) and Ireland (498 hours) have the smallest total number of physical education per year. Looking at the countries with flexible timetable, Poland with 995 hours and Lithuania with 950 hours are leaders, opposed to Scandinavian countries Sweden with 625 hours and Finland with 641 hours which have the smallest number of hours based on 45 minutes per one year. Looking at results differences within the whole sample were statistically significant ($p<0.05$), as like the differences within group of countries with fixed ($p<0.05$) and flexible ($p<0.05$) timetable.

Table 1: Results of differences

	Criterion	Mean	Std.Dv.	t-value	df	p
Differences in total physical education timetable	Total sample	817,2	235,2	21,475	27	0,00
	Countries with fixed timetable	802,5	261,3	17,072	19	0,00
	Countries with flexible timetable	823,4	265,9	15,705	8	0,00
Differences in compulsory education duration	Total sample	10,1	1,29	48,286	27	0,00
	Countries with fixed timetable	10	1,32	37,148	19	0,00
	Countries with flexible timetable	9,7	1,11	23,098	8	0,00

$p<0.05$

Results in chart 1. showed that countries with fixed timetable like Hungary, Bulgaria, Cyprus and Turkey had 12 years of compulsory physical education duration, followed by Scotland and Malta with 11 years. Lithuania, as flexible timetable presenter, had also 12 years of compulsory physical education duration, followed by Norway and Iceland with 10 years and the rest of the countries with 9 years of compulsory education. Table 1. showed that within each group were significant differences ($p<0.05$), which means that countries did not have similar compulsory education duration across the Europe.

Discussion

Based on the obtained results, it was found that, in each and every variable, there were significant differences. When we looked at the results of total number of compulsory education, we could conclude that there is width range between the highest (France: 1350) and the lowest (Iceland: 498) country representing fixed timetable group, where France almost has three times more hours of compulsory physical education than Iceland ($p<0.05$). Looking at the countries in flexible timetable group, it was observed that Poland, with almost 1000 hours of compulsory education in physical education, had 1.5 time more hours than the lowest ranking country Sweden, with 625 hours of compulsory education per year. Reasons for that situation in Sweden were statements, for example Annerstedt (2005), who reported that on 10 and 11 year of schooling 20% of schools had two lessons per week, but there is no mandatory physical education in year 12. According to Halbert and MacPhail (2005), despite of a recommended 60 minutes per week, physical education is not provided in all primary schools and 75% of classes have less than 30 minutes. Also, in Cyprus, 2 times of 40 minutes physical education per week is often abandoned when time is required for the main school subjects, such as math and languages (Tsangaridou and Yiallourides, 2008). As mentioned before, statistical differences were obtained in total compulsory education in all groups ($p<0.05$), so it is generally clear that countries from European Union have great heterogenous differences. It is very interesting that, although countries with fixed timetable have established their school schedule, countries with flexible timetable, as Poland, Lithuania and Iceland, have higher total number of compulsory physical education than countries like Bulgaria and Ireland (chart 1.).

Results from compulsory education duration showed that the highest number of compulsory education was 12 years in some fixed timetable countries like Bulgaria, Cyprus, Hungary, Turkey and the lowest number was 8 years in Croatia. Similar situation is among countries with flexible timetable, where, for example Lithuania also has 12 years of compulsory education and most countries have 9 years of compulsory education, which can be shown from the chart 2. Significant differences were obtained ($p<0.05$) within each group and can also be concluded that countries have great heterogenous formed education. Looking at the means of each froup (fixed+flexible timetable= 10.1 ± 1.29; fixed timetable= 10.1 ± 1.32; flexible timetable= 9.7 ± 1.11), there was no great heterogenous differences among each group of countries.The results told us that, despite the same type of timetable (fixed or flexible), countries in their system had different, in our case, physical education schedule distribution during the whole period of compulsory education.

Conclusion

Based on given results, we could conclude that differences occur between each country in European Union. This does not surprise, because, in some countries, governments haven't „donated" too much time for public-health problems, which have become main issue all over the world. According to World Health Organisation (WHO, 2012), ischaemic heart disease, stroke, hypertensive heart disease, respiratory infections are one of the 10 most common diseases in the world. Most of them can be threated and prevented with physical activity. Children have also become overweight and obese, because of inactivity and modern way of life. Governments should focus on solving this kind of problems, which occur at young people's age. Lack of physical activity, in the first place, organised physical activity as physical education in schools should be changed through scientific research on that topic and presenting obtained results to the whole population, cooperating with hospitals and pointing the problem. Some countries like England (elective timetable which was not part of our research) had costs around £19 billion for cardiovascular diseases (British Heart Foundation, 2012), by 2050, the cost of overweight and obesity could rise to £9.7 billion, with the wider cost to society being £49.9 billion (Government Office for Science, 2007). People must be aware of risks that physical inactivity brings, and those risks cause diseases and higher rate mortality. Maintenance of monitoring of developments in physical education across the world is an imperative. “Promises” need to be converted into “reality” if threats are to be surmounted and a safe future for physical education in schools is to be secured for next generation (Hardman, 2005, 2008).

References

1. Annerstedt, C. (2005). Physical Education and Health in Sweden. In U. Puhse & M. Gerber (Eds.). International Comparison of Physical Education. Concept - Problems - Prospects. Aachen, Meyer & Meyer Verlag, 604-629.
2. Boreham C., Twisk J., Neville C., Savage M., Murray L., Gallagher A. (2002). Associations between physical fitness and activity patterns during adolescence and cardiovascular risk factors in young adulthood: the Northern Ireland Young Hearts Project. International Journal of Sports Medicine, 23(1), 22-26.
3. British Heart Foundation (*BHF*). (*2012*). Coronary Heart Disease Statistics: A Compendium of Health Statistics in England, 2012. London: BHF.
4. Centers for Disease Control. (1997). Guidelines for school and community programs to promote lifelong physical activity among young people. Morbidity and MortalityWeekly Report, 46(6), 1-35.
5. Chin, MK, Edginton, C. (2014). Physical Education and Health: Practices Around the World. In MK. Chin & C Edginton (Eds.) Physical Education and Health – Global Perspectives and Best Practice. Sagamore Publishing LLC
6. Currie, C., Zanotti, C., Morgan, A., Currie, D., de Looze, M., Roberts, Ch., Samdal, O., Smith, R., Barnekow, V.(2012). Social determinants of health and well-being among young people. Health Behaviour in School-aged Children (HBSC) study: international report from the 2009/2010 survey. Copenhagen, WHO Regional Office for Europe.
7. Department of Education and Science. (1999a). Primary School Curriculum: Science. Dublin: Stationery Office.
8. *Government Office* for *Science*. (*2007*). Tackling obesities: Future choices, Foresight, London: *Government Office* for *Science*.
9. Gyermek Ifjusagi- es Sporminiszterim. (2003). Nemzeti Sportstrategia (Ministry of Children, Youth and Sport: National Sport Strategy).
10. Halbert, J., & MacPhail, A. (2005). Physical Education in Ireland. In U. Puhse & M. Gerber (Eds.). International Comparison of Physical Education. Concept - Problems - Prospects. Aachen, Meyer & Meyer Verlag, 380-399.
11. Hardman, K. (2005). Global Vision of the Situations, Trends and Issues of Sport and Physical Education in Schools. Paper presented at the International Conference on Sport and Physical Education. Bangkok, Thailand, 30 October-2 November.
12. Hardman, K. (). Physicale Education in Schools: A global perspective. Kinesiology, 40, 1:5-28
13. Hassmen, P., Koivula, N., & Uutela, A. (2000). Physical exercise and psychological well-being: A population study in Finland. Preventative Medicine, 30, 17-25.
14. Petrić, V., Novak, D., Matković, B., Podnar, H. (2012). Differences in the physical activity level of adolescent female students. Croatian Journal of Education, 14, 275-291.
15. Recommended Annual Taught Time in Full-time Compulsory Educationin Europe 2012./2013. European Commission, Eurydice - Facts and Figures, Education and Training. Avaliable from http://eacea.ec.europa.eu/education/eurydice/documents/facts_and_figures/taught_time_EN.pdf
16. Telama, R., Yang, X., Laakso, L., & Viikari, J. (1997). Physical activity in childhood and adolescence as predictors of physical activity in young adulthood. American Journal of Preventive Medicine, 13, 317-323.
17. Tsangaridou, N., & Yiallourides, G. (2008). Physical Education and Education through Sport in Cyprus. In G. Klein & K. Hardman, Physical Education and Sport Education in the European Union. Paris, Editions Revue EP.S, 69-83.
18. World Health Organisation. (2012). World Health Statistics.
19. World Health Organisation. (2014). World Health Statistics.

DIFFERENCES IN MORPHOLOGICAL FEATURES BETWEEN FOURTH GRADE FEMALE PUPILS IN URBAN AND RURAL ENVIRONMENTS IN LIKA

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Abstract

Based on the number of 100 female pupils who attend the fourth grade primary schools in Lika (50 pupils from rural and 50 pupils from urban environments) aged 10, 19 morphological measures were applied so as to determine the differences in manifest and latent dimensions of morphological features through the application of disciminant analysis. Values of discriminant analysis point out statistically important differences in manifest measures of morphological features in relation to the rural and urban affiliation. The most significant discriminant function could be defined as the soft tissue factor. The most significant positive connection to the factor is seen on the variable abdominal skinfold, upper arm skinfold, lower leg skinfold, back skinfold, lower leg circumference, thighs circumference, upper arm circumference, central chest circumference, elbow diameter. The most significant negative connection with the function is seen with the variables wrist diameter and hand lenght. The position of centroid of female groups in rural and urban environments shows statistically important differences in morphological measures. Based on the obtained disciminant analysis values, it can be concluded that female pupils from urban environments show higher values in 17 out of 19 manifest measures. Defining latent structure of morphological features of pupils was done by the factor analysis, the method of principal components according to Guttman Kesir criteria. Two principal components were extracted, the soft tissue factor and transversal skeleton dimensionality together with longitudinal skeleton dimensionality. Values of discriminant analysis show statistically important differences in latent dimensions of morphological features in connection with rural and urban affiliation. Pupils from urban environments show higher values in both latent dimensions. The conclusion is that there are statistically important differences between fourth grade female pupils aged 10 based on rural and urban environments affiliation. Female pupils from urban environments show higher values and enter the pre-puberty period earlier.

Key words: *female pupils, age 10, discriminant analysis, morphology, town, village*

Introduction

Researches at the beginning of the 20th show that the growth and the development of antrophological features of female pupils change under the influence of biological legality which marks certain phases of their development.

Later kinesiological researches aim towards pointing out the efficiency of PE classes and the influences of environment. Unfortunatelly it has been noticed that classes focused on learning and acquiring a large fund of motor knowledges do not quarantee the transformational efficacy i.e. pre-conditions for optimal growth and development, which is the fundamental aim of teaching. (Malacko, 2002)

Researches on the influence of environment on the proper development of kinantropological and other anthropological features of female pupils show that by improving living conditions in the 30s, and especially by enabling access to health institutions, by improving socio-economic and psychological factors and accomodation, differences between motor and morphological features of female and male pupils in urban and rural environments, decreased. Malina points out that today differences in living conditions between rural and urban environments are negligible so there is no difference in growth and maturity between pupils who live in rural and those who live in urban environments in the USA, Canada and Western Europe (Malina 2004; Meszaros et al., 2008)

As opposed to this some East European countries as Poland, Romania and Greece continue showing differences in growth and maturity of pupils in rural and urban environments. Hoffmann et al., (2011) show that adolescent female pupils in urban environments are more active in sport. Along with the PE classes, they actively participate in sports activities in their free time. In rural environments PE classes are the only type of physical activites.

Researches show that female pupils with urban lifestyle show morphological features which are significantly higher than those of female pupils who live in rural environments but worse results in motor abilities tests (Pena and Mallina, 2003; Dževad et al., 2014; Liu, 2009). According to the research (Woods, 2007; Moore et al., 2008) the level of physical activity decreases and the level of obesity increases among 6 to 11 year olds. Pupils in rural environments are more active, they spend more time doing activities in the open but they participate less in organized sports activities; female pupils who live in urban environments spend more time in front of television.

The aim of this research is to determine if there are differences in the level of morphological features of fourth grade female pupils according to the rural-urban affiliation in towns in Lika.

Methods

The number of participants was taken from the population of fourth grade female pupils who attended primary schools in Lika by random group choice, and therefore the number of 100 female pupils from rural and urban environments was created. The number of participants from urban environment was based on 50 female pupils in central primary schools in Gospić and Otočac. The number of participants in rural environment was based on 50 female pupils from primary schools in Gračac, Lički Osik, Brinje and Korenica. During the research period, the age of participants was 10 +/- 6 months.

The number of morphological variables used in this research was formed out of 19 morphological measures, which were selected so as to be compatible with the structural model of antropometric status, The International Biological Programme IBP- Weiner and Lourie, 1969 (Mišigoj-Duraković, 2008). Longitudinal skeleton dimensionality was estimated based on four measures: *Height* (LDV), *Arm lenght* (LDR), *Leg lenght* (LDN), *Foot lenght* (LDS). Body volume and mass were estimated based on five measures: *Weight* (VMT), *Central chest circumference* (VMOK), Upper arm circumference (VMN), *Thighs circumference* (VMNAT), *Lower leg circumference* (VMPOT). Subcutaneous fat tissue was estimated based on four measures: *Back skinfold* (PML), *Abdominal skinfold* (PMT), *Upper arm skinfold* (PMN), *Lower leg skinfold* (PMPOT). Transversal skeleton dimensionality was estimated based on six measures: *Elbow diameter* (TDL), *Wrist diameter* (TDRZ), *Bicristal breadth* (TDBR), *Biacromial breadth* (LDBR), *Knee diameter* (TDK), *Foot width* (TDS).

Disciminant analysis method was applied. In order to present arithmetic means, standard deviations, maximal and minimal value for every variable of female pupils from urban and rural environment, descriptive statistics was used. Differences in latent and manifest space of morphological measures of female pupils from urban and rural environments were determined by discriminant analysis. Latent structure of morphological measures of female pupils was determined by factor analysis by determining principal components based on GK-criteria. The level of statistical significance was set by the level $p<0,05$.

Results

Descriptive indicators of morphological measures of female pupils in urban and rural environments in this research are shown in table 1. Through the insight into the arithmetic means of morphological measures of female pupils it can be noticed that, taking into consideration the criteria place of residence, female pupils from urban environments show greater values in measures: Longitudinal skeleton dimensionality: *Height* (LDV), *Leg lenght* (LDN) and *Foot lenght* (LDS) except for the *Arm lenght* (LDR); Body volume and mass: *Weight* (VMT), *Central chest circumference* (VMOK), Upper arm circumference (VMN), *Thighs circumference* (VMNAT), *Lower leg circumference* (VMPOT); Subcutaneous fat tissue: *Back skinfold* (PML), *Abdominal skinfold* (PMT), *Upper arm skinfold* (PMN), *Lower leg skinfold* (PMPOT); Transversal skeleton dimensionality: *Elbow diameter* (TDL), *Bicristal breadth* (TDBR), *Biacromial breadth* (LDBR), *Knee diameter* (TDK), *Foot width* (TDS) except for the *Wrist diameter* (TDRZ). Female pupils from urban environments show greater values in 17 out of 19 measures, which is the indicator of entering the pre-puberty phase earlier.

The results of discriminant analysis of manifest variables, structure matrix of discriminant functions of fourth grade female pupils is shown in table 2. The results of discriminant analysis of manifest variables confirm statistically significant dominanace of measures of female pupils from urban environments, in longitudinal skeleton dimensionality, body volume and mass, subcutaneous fat tissue and transversal skeleton dimensionality. Female pupils from rural environments show higher values in variables arm lenght, wrist diameter and foot width. It is clearly visible that the variable values are mainly positioned on the positive pole, and the other smaller part on the negative pole.

Table 1: Descriptive indicators of morphological measures of fourth grade female pupils in rural and urban environments

Variables	Entity number	Descriptive indicators of morphological features of fourth grade urban environment female pupils				Descriptive indicators of morphological features of fourth grade rural environment female pupils			
		Arithmetic means	Minimal value	Maximum value	Standard deviation	Arithmetic means	Minimal value	Maximum value	Standard deviation
LDV	50/50	143,71	126,77	161,37	6,85	141,87	130,60	155,60	5,78
LDBR	50/50	33,16	29,40	39,43	2,19	32,65	23,30	38,40	2,56
LDR	50/50	61,60	54,37	69,70	3,67	62,18	55,47	69,43	3,37
LDN	50/50	81,89	71,37	92,67	4,70	80,74	74,53	90,50	4,05
LDS	50/50	22,73	20,33	26,07	1,33	22,35	20,40	25,43	1,28

VMT	50/50	40,39	25,00	69,50	10,52	39,33	25,30	60,60	10,05
VMOK	50/50	72,86	58,57	97,77	8,72	69,33	58,07	85,50	6,81
VMN	50/50	23,60	17,83	34,60	3,55	22,09	18,23	27,43	2,66
VMNAT	50/50	45,04	34,97	62,00	6,02	42,27	34,07	54,73	4,94
VMPOT	50/50	32,20	25,27	47,60	3,96	30,34	25,57	37,50	3,25
PML	50/50	16,58	7,00	30,47	6,07	13,30	6,30	27,40	5,90
PMT	50/50	17,72	4,53	30,83	6,23	13,55	4,30	25,17	6,10
PMN	50/50	17,00	8,17	31,13	5,05	14,09	5,83	22,57	4,05
PMPOT	50/50	16,50	7,03	30,03	5,38	13,59	5,37	23,03	4,29
TDL	50/50	5,67	4,09	7,68	0,62	5,45	4,79	6,40	0,39
TDRZ	50/50	4,49	3,94	5,13	0,33	4,55	3,97	5,24	0,32
TDBR	50/50	25,98	20,40	35,63	2,96	25,54	21,43	31,43	2,48
TDK	50/50	8,63	7,52	10,67	0,82	8,40	7,33	9,65	0,67
TDS	50/50	8,68	7,30	10,53	0,75	8,72	7,37	10,43	0,68

Height (LDV), Arm lenght (LDR), Leg lenght (LDN), Foot lenght (LDS). Body volume and mass were estimated based on five measures: Weight (VMT), Central chest circumference (VMOK), Upper arm circumference (VMN), Thighs circumference (VMNAT), Lower leg circumference (VMPOT). Subcutaneous fat tissue was estimated based on four measures: Back skinfold (PML), Abdominal skinfold (PMT), Upper arm skinfold (PMN), Lower leg skinfold (PMPOT). Transversal skeleton dimensionality was estimated based on six measures: Elbow diameter (TDL), Wrist diameter (TDRZ), Bicristal breadth (TDBR), Biacromial breadth (LDBR), Knee diameter (TDK), Foot width (TDS)

Based on correlations between manifest variables and discriminant function, of female pupils from rural and urban environments, soft tissue factor contributes the mostly to the functions discrimination.

Table 2: Factor structure and centroids of discriminantion functions of groups of fourth grade female pupils in rural and urban environments

Variables	Structure matrix/female pupils 4th grade Correlation var. with dis. functions
	Function1
LDV	0,20
LDBR	0,15
LDR	-0,11
LDN	0,18
LDS	0,19
VMT	0,07
VMOK	0,31
VMN	0,33
VMNAT	0,34
VMPOT	0,35
PML	0,37
PMT	0,46
PMN	0,43
PMPOT	0,41
TDL	0,29
TDRZ	-0,12
TDBR	0,11
TDK	0,21
TDS	-0,03
GROUPS	
G	0,73
S	-0,73

Height (LDV), Arm lenght (LDR), Leg lenght (LDN), Foot lenght (LDS). Body volume and mass were estimated based on five measures: Weight (VMT), Central chest circumference (VMOK), Upper arm circumference (VMN), Thighs circumference (VMNAT), Lower leg circumference (VMPOT). Subcutaneous fat tissue was estimated based on four measures: Back skinfold (PML), Abdominal skinfold (PMT), Upper arm skinfold (PMN), Lower leg skinfold (PMPOT). Transversal skeleton dimensionality was estimated based on six measures: Elbow diameter (TDL), Wrist diameter (TDRZ), Bicristal breadth (TDBR), Biacromial breadth (LDBR), Knee diameter (TDK), Foot width (TDS)

The most important connections with the function, on the positive pole are seen in variables abdominal skinfold (0,46), upper arm skinfold (0,43), lower leg skinfold (0,41), back skinfold (0,37), lower leg circumference (0,35), thighs circumference (0,34), upper arm circumference (0,33), central chest circumference (0,31), elbow diameter (0,29). The most important connection with the function on the negative pole is seen through variables wrist diameter (-0,12) and arm lenght (-0,11). Position of the centroid of the rural and urban groups of female pupils (G 0,73, S -0,73) show that in this period, there are significant differences in morphological measures.

Two factors have extrapolated with both groups. The gratest connection to the first factor is seen with the subcutaneous fat tissue, back skinfold 0,93, upper arm skinfold 0,90, abdominal skinfold 0,86 and lower leg skinfold 0,88. Insignificantly weaker connections with the first factor are seen with the body volume and mass, upper arm circumference 0,87, thighs circumference 0,86, lower leg circumference 0,82 and chest circumference 0,79. Transversal skeleton dimensionality and bicristal breadth 0,75 are also extracted. High connectivity in the first factor of measures, subcutaneous fat tissue, volume and body mass, creates the name soft tissues and transversal skeleton dimensionality factor. High connectivity with the second factor is seen with height 0,85, arm lenght 0,86, leg lenght 0,79 and foot lenght 0,79. Such high connectivity between measures of longitudinal skeleton dimensionality creates the name longitudinal skeleton dimensionality factor.

The longitudinal skeleton dimensionality factor 0,80 contributes to the difference in latent space of morphological features within the matrix structure of discriminant function of the fourth grade female pupils, table 3. The second latent dimension which significantly contributes to the difference between female pupils in rural and urban environments in the latent space of morphological features is the factor of soft tissues and transversal skeleton dimensionality 0,36. Based on the selected values of discriminant analysis it can be concluded that female pupils from urban environments show higher values in latent dimension of morphological features of longitudinal skeleton dimensionality, soft tissues and transversal skeleton dimensionality.

Table 3: Factor structure and centroids of discriminantion functions

Varijables	Factor
Soft tissues and transversal skeleton dimensionality	0,36
Longitudinal skeleton dimensionality	0,80
Mens of Canonical Variables	
G	0,62
S	-0,62

Discussion and conclusion

The influence of the place of living on the growth, development and maturity of female pupils through the visible improvement in living conditions related to health institutions access, accomodation, nutrition and exercising have not led to lowering the differences in morphological features of fourth grade female pupils in urban and rural environments in Lika.

The results of this research suggest statistically important differences between fourth grade female pupils based on the place of living. Better morphological profile is seen with female pupils from urban environments which corresponds to similar research results domestically and in the world. ((Pena i Mallina, 2003; Dževad et al., 2014; Liu, 2009).

Specifically it means that female pupils from urban environments show higher values in manifest measures abdominal skinfold, upper arm skinfold, lower leg skinfold, back skinfold, lower leg circumference, thighs circumference, upper arm circumference, central chest circumference, elbow diameter, knee diameter, bicristal breadth, weight, leg lenght, foot lenght, biacromial breadth. Female pupils from rural environments show higher values in manifest measures wrist diameter, foot width and arm lenght.

Female pupils from urban environments show higher values in latent dimensions of morphological features of longitudinal skeleton dimensionality together with transversal skeleton dimensionality and soft tissues. Differences in morphological features point out the possibility that fourth grade female pupils from urban environments have better living conditions and nutrition so their growth becomes faster which leads to secular trend and faster female pupils maturation.

References

1. Džibrić, D., Ahmić, D., Milanović, D., Bajrić, O. (2014). *Differences among first-grade students of urban and rural areas in motor and functional characteristics.* Sport Science vol. 7. 99-105.
2. Hoffman, K., Bryl, W. Marcinkowski, J-T., Strazynska, A., Pupek-Musialik, D. (2011). *Estimation of physical activity and prevalence of excessive body mass in rural and urban polish adolescents.* Annals of Agricutural and Environmental Medicine, vol 18, no 2, 398-403.
3. Liu, J., Bennett, K-J., Harun, N., Probst, J-C. (2008). *Urban-rural differences in overweight status and physicalIn activity among US children aged10-17 years publisher.* Journal of Rural Health, vol. 24, 407-415.
4. Malacko, J. (2002). *Relations of coordination, morphological characteristics and motor abilities.* Proceedings Book 3rd International scientific conference „Kinesiology-new perspectives“, 291-295. Zagreb: Faculty of Kinesiology, Univesity of Zagreb.
5. Malina, R. M., Bouchard, C., Bar-or, C., (2004). *Growth, maturation, and physical activity. USA:* Human Kinetics.
6. Meszaros, Z. et al. (2008). *Primary schoolchild development–issues of socioeconomic status.* Kinesiology vol.40, 153-16.
7. Moore, JB., Davis, CL., Baxter, SD., Lewis, RD., Yin, ZN. (2008). *Physical activity, metabolic syndrome, and overwight in rural youth.* Journal of rural health, vol. 24, 136-142.
8. Peña Reyes, M. E., Tan, S. K., Malina, R. M. (2003). *Urban-rural contrasts in the growth status of school children in Oaxaca, Mexico.* Annals of Human Biology, vol. 30 issue 6, 693-713.
9. Woods, R. (2007). *Social issuesin sport.* Human Kinetics.

THE OCCURRENCE OF THE PERSISTENT PRIMITIVE REFLEXES IN SCHOOL AGE CHILDREN (6-11)

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Abstract

Purpose: Primitive reflexes are essential for the baby´s survival in the first few weeks of life, and they provide the rudimentary training for many voluntary skills. However, in the course of the development of the nervous system these reflexes should be inhibited or controlled by higher centres of the brain. According to current evidence, persistence of primitive reflexes could be also related to specific learning difficulties or attention deficit hyperactivity disorder which is very often linked with some kind of motor problems. The objectives of this pilot study were to determine the occurrence of selected persistent primitive reflexes and to find out to which extent these reflexes can interrelate to specific learning difficulties and motor abnormalities. **Methods:** A total of 52 children (20 females, 32 males) at the age of 6 to 10 from different classes were involved in this study. To find the occurrence of persistent Asymmetrical Tonic Neck reflex (ATNR), Symmetrical Tonic Neck Reflex (STNR) and the Tonic Labyrinthine Reflex (TLR), standardised tests were used. Semi structured interviews with class teachers concerning core-academic skills (reading and writing) were conducted. To assess the differences in children motor demonstration, the observations were carried out. For statistical purposes, frequency analysis was used. **Results:** Based on the testing it was found that in 83% of the pupils demonstrated the presence of at least one persistent primitive reflex. Based on information from the interviews and observations, it was found that the obtained results in most cases are consistent with difficulties in school skills that describe the class teachers and which can be observed in motor behaviour of children. **Conclusion:** Most of the methods dealing with persistent primitive reflexes focus only on solving the consequences of these disorders. In our further research we will concentrate on possibilities of application of some program concerning movement (neuro-developmental therapy) targeted at the cause of given difficulties.

Key words: *Brain, reflexes, specific learning difficulties, movement program*

Introduction

Primitive reflexes are essential for the baby´s survival in the first few weeks of life, and they provide rudimentary training for many later voluntary skills. They are involuntary stereotyped responses to specific stimuli, and they allow no leeway for variation or choice of action. The primitive reflexes comprise one of the earliest, simplest, and most frequently used tools among child neurologists to assess the central nervous system integrity of infants and young children. However, in the course of the development of the nervous system these reflexes should be inhibited or controlled by higher centres of the brain. Konicarová & Bob (2013c) in their review present the findings of recent and historical surveys. These findings suggest that later-developed functions during brain ontogenesis related to higher levels of cognitive and motor integration tend to replace the older, more primitive, ones, and the persistence of the older functions may be linked to specific neuropsychiatric disorders. Other results of different studies (Konicarova & Bob, 2013a) also confirm that persisting primitive reflexes may be specifically linked to attention-deficit and hyperactivity disorder (ADHD). Other authors pursue the influence of persistent primitive reflexes to specific reading difficulties (McPhillips & Jordan-Black, 2007). Reflexes that respond to changes in position can all have effect on balance, posture, and coordination, which collectively provide support to higher centres involved in the control of eye movements and in visual perception. Other primitive reflexes respond to tactile stimulation influencing fine motor skills as well as balance, body awareness, sensitivity and spatial awareness (Goddard, Beuret, & Blythe, 2009).

The major primitive motor reflexes or patterns that have been described include Moro Reflex, Palmar and Plantar Grasp Reflexes, Rooting Reflex, Suckling and Sucking Reflexes, The Spinal Galant Reflex, Asymmetric Tonic Neck Reflex (ATNR), Tonic Labyrinthine Reflex (TLR) and Symmetrical Tonic Neck Reflex (STNR) (Zafeiriou, 2004). For our research we have chosen the Asymmetric Tonic Neck Reflex (ATNR), Tonic Labyrinthine Reflex (TLR) and Symmetrical Tonic Neck Reflex (STNR). These reflexes have consistently been shown to be present in a high percentage of children with specific learning difficulties (Goddard et al., 2009).

The main objective of this pilot study was to determine the occurrence of selected persistent primitive reflexes (ATNR, STNR, and TLR) and to find out to which extent these persisting reflexes can interrelate to specific learning difficulties and motor abnormalities.

The Asymmetrical Tonic Neck Reflex occurs in response to rotation of the head. It emerges circa 18 weeks' gestation. Rotation of the head to one side is followed by extension of the arm and leg on the same side and flexion of the opposite limbs (Blythe, 2009). The ATNR should be inhibited 6 months after birth (McPhillips & Jordan-Black, 2007). If the ATNR persists in school aged child, the ability to cross the midline can be affected. This difficulty has implications for writing (hand-eye coordination) and reading (visual skill). The control of upright balance is affected and the cross-laterality persists (Goddard, 2005; Goddard et al., 2009) .

The Tonic Labyrinthine Reflex is being present from approximately 30 weeks' gestation. TLR is elicited by movement of the head forwards or backwards, above or below the level of the spine. The TLR should be fully developed in both positions from birth. The inhibition of the TLR forwards should be accomplished by 4 months of life. The inhibition of TLR backwards is more gradual process, involving the emergence of several postural reflexes and taking up to age 3 to be completed. Retention of Tonic Neck and Labyrinthine Reflexes in the older child can result in a disagreement or "mismatch" of signals passing between the three vestibular loops (Quirós & Schrager, 1978). Symptoms of a strongly residual TLR backwards could be hypertonus, vestibular related problems, oculomotor dysfunction, poor organization skills, poor balance and coordination. The person with strongly persisting TLR dislikes sport activities, physical educational classes, running etc. (Goddard, 2005).

The Symmetrical Tonic Neck Reflex presents for a very short period of time at birth. It returns as a transient reflex between 8 and 11 months of life. It helps the baby to defy gravity by getting up off the floor on to hands and knees from the prone position (Goddard, 2005). STNR affects the coordination of the upper and lower sections of the body depending on the position of the head. Flexion of the head elicits bending of the arms and extension of the legs: conversely, the extension of the head results in the extension of the arms and bending of the legs (Goddard et al., 2009). If this is present in the school-aged child it can affect posture when sitting or standing, the ability to sit still, and the muscle tone and coordination needed for activities such as learning to swim and do forward rolls (Goddard et al., 2009). Other researchers have found a link between retention of the STNR and Attention Deficit Hyperactivity Disorder (ADHD) (O'Dell & Cook, 2004) and problems with speed and accuracy of copying (Blythe P, McGlown DJ., 1979).

Methods

A total of 52 children (20 females, 32 males) at the age of 6 to 10 from different classes were involved in this study: 1st class 20 children (7 girls, 13 boys) at the age of 6 - 7 years, 2nd class 10 children (4 girls, 6 boys) at the age of 7 – 8 years, 3rd class 11 children (5 girls and 6 boys) at the age 8 – 9 years, 4th class (11 children – 4 girls and 7 boys) at the age of 9 – 10 years. To find the occurrence of the persistent ATNR, STNR and the TLR standardised tests were used. The scale is 0 – 4. Pupils were tested individually in order not to imitate movements of others tested children. Semi structured interview with class teachers concerning the level of the core-academic skills (reading and writing) were conducted. To assess the differences in children motor demonstration, the observations were carried out.

For statistical purposes, frequency analysis was used. Parents of all the participants gave the written informed consent. The level of persisting reflexes was tested by experienced examiners.

Measurements of primitive reflexes

Description of the ATNR test in kneeling position with hands on the floor:

Starting position: A child is kneeling with hands on the floor; the head is in line with the spine.

Execution: Testing person is holding the child's head on both sides and turning very slowly their head to the right and to the left. The child is passive.

We observe compulsory movements of the right arm and the shoulder in case of turning the head to the left (we assess ATNR left) and left arm and shoulder in case of turning the head to the right (we assess ATNR right).

Assessment: scale 0-4

0 – Without problems, the movement in neck spine is loose, without co-movements.

4 – Distinct bent arm, trunk rotation until the loss of balance

Description of the TLR test in standing position:

Starting position: A child is standing with legs little bit apart, arms down at their sides/along the body.

Execution: A child is slowly bending the head backward and forward holding the final position for few seconds. The movement is executed with opened eyes.

We observe slight co-movements, compulsory movements of legs, arms, and trunk till the loose of balance caused by changed position of the head.

Assessment: scale 0-4

0 – Without problems.

4 – The loss of balance caused by the change of the head position.

Description of the STNR in kneeling position with hands on the floor:

Starting position: A child is kneeling with hands on the floor; the head is in line with the spine.

Execution: A child is slowly bending the head backward and forward holding the final position for few seconds.

We observe slight co-movements, compulsory movements of arms and backs, movements in hips, bending of arms and raising of insteps as a result of the bending the head forward and arms extension and legs flexion in consequence of the bending the head backward.

Assessment: scale 0-4

0 – Head movements do not cause any co-movements of arms, legs even trunk

4 – Bending of arms to the extent that the child bending the head forward put the head on the floor. Bending the head backward the child has the tendency to sit down to the heels.

Results

Overall results

The findings of this pilot study indicate the persistence of at least 1 primitive reflex in 43 children (83%) from overall 52 tested persons. The retained symptoms of more than 2 primitive reflexes have been found in 28 children (54%).

The results according to classes (at least 1 persisting reflex)

The highest number of at least 1 persisting primitive reflex was found in children in 1st class – 95%, in 2nd class - 90%, in 3rd year – 82%, in 4th year in 55% of children.

The results according to classes (2 and more persisting primitive reflexes)

Regarding the persistence of 2 and more primitive reflexes, the results show the highest occurrence of symptoms in 1st class 75% of children in, in 2nd class in 50% of tested pupils, in 3rd year in 55% of children and in 4th year in 18% of tested persons.

The results of the occurrence based on the individual reflexes

Concerning the occurrence of individual tested primitive reflexes, the most frequently STNR occurred - 32 children showed the symptoms of STNR (27%). ATNR right was registered in 22 cases (18%), TLR in 20 pupils (17%), ATNR left in 19 children (16%).

The results of the primitive reflexes occurrence according to sex

Compared the results of girls and boys, the higher number of at least 1 persisting primitive reflex is evident in girls – 90% of cases. The occurrence in boys was 78%. But in case of the occurrence 2 and more persisting reflexes, boys reached the higher number (62%) than girls (45%).

The results of the interviews, observations and tests of primitive reflexes

Based on testing of the primitive reflexes, the interviews with class teachers and the observation of the motor activity, there is an evidence that in 13 tested children of different age the symptoms of at least 1 primitive reflex persist together with difficulties in learning areas (such as a reading and writing), attention and motor activity. In 3 cases specific learning disorders were diagnosed (ADD, ADHD, dysortografia). The most frequent manifestations were:

In reading: syllabication, spelling, poor pronunciation of some sounds, the skipping line.

In writing: ambivalent laterality, slow pace at copying tasks from the blackboard, increased pen/pencil pressure, inability of maintaining letters in line, disharmony between speaking and writing, letters and words skipping, slow working pace, illegible writing, wrong pen grip, orthographic mistakes.

In motor activity: uncoordinated movements, clumsiness, poor balance, throwing and catching the ball, reduced cooperation of upper/lower, and right/left part of the body.

In attention: weakened ability to work, sensitivity on sounds, impulsiveness, interrupting teachers, being easily distracted, support of the head, tendency to "slump" when sitting at the desk.

Discussion

The findings of this study show the very high number of persistent primitive reflexes, primarily in case of two or more persisting primitive reflexes. According to Volemanová (2013) the presence of 2 or more reflexes could negatively affect the neurological development and later could cause the ADD, ADHD or some difficulties in learning (Konicarova & Bob, 2013a; Konicarova, Bob, & Raboch, 2013).

Although there have already been findings of some studies concerning primitive reflexes which confirm that ADHD, ADD or some special learning difficulties (dyslexia) could be associated with only one persisting primitive reflex (Konicarova & Bob, 2013b; McPhillips & Jordan-Black, 2007), there is no evidence that these studies focused only on children with only one specific persisting reflex and the occurrence of other reflexes was excluded by the criteria in their research.

Our results of persisted primary reflexes related to sex indicate more frequent occurrence of these reflexes in boys. We can support the statement of McPhillips & Jordan-Black (2007) which found out more frequent occurrence of persisted primary reflexes in boys and in children from socially disadvantages backgrounds. If we take into account the relationship between the occurrence of primitive reflexes and learning difficulties and attention disorders, we have to support the study of Rief & Staňková (2010), which says that attention and learning disorders are more frequent in boys.

The results of our testing correspond to the actual difficulties described by interviewed class teachers. Based on these interviews we can confirm that pupils with persisted more primitive reflexes or worse test result than 2, have some difficulties in academic skills. These difficulties were mostly proved in more than one learning area (reading, writing, attention). This findings support the study of Volemanová (2013). In motor behaviour we observed the difficulties with coordination of the upper and the lower body part, the difficulties with synchronisation of right and left body part and very often the balance difficulties were registered. These findings correspond with the results of the research concerned the balance deficit and ADHD symptoms in school aged boys (Volemanová, 2013). Most of us have at least one persistent primitive reflex (Volemanová, 2013). It confirms the study of Bruijn et al. (2013) who found out that effects of STNR and ATNR are also visible in healthy adults.

In future researches we are going to focus on the treatment of persisted primitive reflexes. We will use the principles of the neuro-development therapy. The treatment is based on simple work-out that very often imitates the movements called by primitive reflexes. Due to this fact the brain can gradually learn to check correctly the functions of the body.

Conclusion

Each reflex has been identified as playing a part in specific aspects of learning and behaviour (Blythe, 2005; Goddard, 2005). According to Volemanová (2013) at least one primitive reflex persists in all people. If two or more primitive reflexes persist, these reflexes could be counterproductive for optimal neurological development. The sensorial perception, the level of balance, the coordination of movement and learning skills can be affected due to persisted primitive reflexes. Diagnosis in the area of educational difficulties tells us what is wrong, but rarely reveals why it has happened. We know that these educational difficulties could be caused by persisting primitive reflexes. If problems caused by primitive reflexes persist till adulthood, the ability to cope with daily stress can be affected. Most of the methods dealing with persistent primary reflexes focus only on solving the consequences of these disorders. Neuro-developmental therapy finds the causes of these difficulties in persisting primitive reflexes and worsened sensorial functions. It is based on findings of INPP method, STNR program, reflex therapy, Braingym and also others therapeutical techniques. Due to specially aimed exercises very often imitating the movement caused by the primitive reflexes, Neuro-developmental therapy tries to inhibit naturally the activity of the persistent primitive reflexes (Volemanová, 2013).

In our further research we will focus on possibilities of the application of the movement program (the neuro-developmental therapy) targeted at the cause of given difficulties concerning specific learning disorders.

References

1. Blythe P, McGlown DJ. (1979). An Organic Basis for Neuroses and Educational Difficulties. *Chester: Insight Publications*.
2. Blythe, S. G. (2009). Attention, Balance and Coordination. The A.B.C. of Learning Success
3. Blythe, S. G. (2005). Releasing Educational Potential Through Movement: A Summary of Individual Studies Carried Out Using the INPP Test Battery and Developmental Exercise Programme for use in Schools with Children with Special Needs. *Child Care in Practice*, *11*(4), 415-432. https://doi.org/10.1080/13575270500340234
4. Bruijn, S. M., Massaad, F., MacLellan, M. J., Van Gestel, L., Ivanenko, Y. P., & Duysens, J. (2013). Are effects of the symmetric and asymmetric tonic neck reflexes still visible in healthy adults? *Neuroscience Letters*, *556*, 89-92. https://doi.org/10.1016/j.neulet.2013.10.028
5. Goddard, S. (2005). *Reflexes, learning and behavior: a window into the child's mind*. Eugene, OR: Fern Ridge Press.
6. Goddard, S., Beuret, L. J., & Blythe, P. (2009). *Attention, balance, and coordination: the A.B.C. of learning success*. Chichester ; Malden, Mass: Wiley.

7. Konicarova, J., & Bob, P. (2013a). ADHD in Children, Balancing Deficits and Primitive Reflexes. *Biological Psychiatry*, *73*(9), 98S-99S.
8. Konicarova, J., & Bob, P. (2013b). Asymmetric tonic neck reflex and symptoms of attention deficit and hyperactivity disorder in children. *International Journal of Neuroscience*, *123*(11), 766–769. https://doi.org/10.3109/00207454.2013.801471
9. Konicarova, J., & Bob, P. (2013c). Principle of dissolution and primitive reflexes in ADHD. *Activitas Nervosa Superior*, *2013*(55), 74-78.
10. Konicarova, J., Bob, P., & Raboch, J. (2013). Persisting primitive reflexes in medication-naïve girls with attention-deficit and hyperactivity disorder. *Neuropsychiatric Disease and Treatment*, *9*, 1457–1461. https://doi.org/10.2147/NDT.S49343
11. McPhillips, M., & Jordan-Black, J.-A. (2007). Primary reflex persistence in children with reading difficulties (dyslexia): a cross-sectional study. *Neuropsychologia*, *45*(4), 748-754. https://doi.org/10.1016/j.neuropsychologia.2006.08.005
12. O'Dell, N. E., & Cook, P. (2004). *Stopping ADHD* (Rev Upd edition). New York: Avery.
13. Quirós, J. B. de, & Schrager, O. L. (1978). *Neuropsychological fundamentals in learning disabilities*. San Rafael, Calif: Academic Therapy Publications.
14. Rief, S. F., & Staňková, L. (2010). *Nesoustředěné a neklidné dítě ve škole: praktické postupy pro vyučování a výchovu dětí s ADHD*. Praha: Portál.
15. Volemanová, M. (2013). *Přetrvávající primární reflexy*.
16. Zafeiriou, D. I. (2004). Primitive reflexes and postural reactions in the neurodevelopmental examination. *Pediatric Neurology*, *31*(1), 1-8. https://doi.org/10.1016/j.pediatrneurol.2004.01.012

STUDENTS ASSESSMENT ON TEACHER SKILLS IN PHYSICAL EDUCATION THROUGH THE ASPECT OF ACCEPTABILITY AS AN INDICATOR OF RIGHT TO EDUCATION

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Abstract

Nature of teaching needs to be clarified in terms of development of teaching skills especially undertaking in mind of some simulation of that experience for students. In various area of teaching PE, skills become the means of assessing progress toward the fulfilment of the objectives. In this paper we will discuss the opinions of the third year students of the Faculty of Kinesiology (N =100) regarding skills needed for performance in PE classes. Emphasis is placed on skills that supports Right to Education in its' acceptability as one of four indicators. Skills are only one aspect in assuring protection and development of Right to Education in educational institutions that should be universalized in order to encompass all children. Results of the analysis showed that participants in the study do not see skills (as part of competence) as a unique collection specified skills, but that there is a tendency towards quite independent assessment of the four groups in the incidence of skills, where conceptual skills largely explain complex construct skills of PE teachers.

Key words: *students evaluation, conceptual skills, teacher competences, indicators of Right to Education*

Introduction

Education is a fundamental human right, one that enables access to other human rights, be the cultural, social, economic, civil or political rights, such as the right to a good livelihood, to health and to political participation, among others (Freeman, 2004). The 1948 Universal Declaration of Human Rights established the purpose of education as "full development of the human personality and … the strengthening of respect for human rights and fundamental freedoms." The right to education, through indicators, is most commonly explored at the macro level with the aim of monitoring at the level of the state or some individual segments of this large area. In terms of research goal setting, attention needs to be paid to the ways in which what and how we measure affect what we are trying to achieve. The questionnaire for the assessment of minimum quality of the educational process and general teachers competences (UPminKOOP) is designed to access then recognition of the quality of educational processes through indicators of acceptability as one of the aspects of the right to education. In addition to the acceptability, the right to education is reflected in three more dimensions, namely: availability, accessibility and adaptability (Tomaševski, 2006). From the educational system as a whole is expected to meet the requirements of acceptability, which includes its every segment including the field of physical education that is the main field of research. Indicators of acceptability of the right to education form a group of segments which include: skills, tolerance, teacher qualification, gender, religion, language and discipline (Rishmawi & Keable-Elliot, 2012). Teachers attitudes, according to the prescribed program and its implementation and outcomes are an important source of information and valuable indicators about the opportunities and the quality of the program (Šumanović, 2012). In this paper we are exploring skills, precisely teachers skills necessary for conducting the educational process in schools. Synthesis of the most important parts of many investigated definitions of competence of teachers (Jurčić, 2012) concludes that the competencies of teachers expertise are recognized by those with whom he/she works (students and parents), based on knowledge, skills and values. Some research of competences related with teaching PE, were conducted in terms of insight and comparison of curricula, plans and programs in PE in some countries in Europe (Ružić, Badrić, & Prskalo, 2008), as well as the competencies resulting from such documents (Kostanić, Prlenda, & Cigrovski, 2011). In mentioned before, topic was studied through the assessment of students' current proficiency and adoption of individual competence through teaching PE (Markuš, Neljak, & Trstenjak, 2011), then the evaluation of validity (Neljak, et al., 2011), as well as the aspect of teacher evaluation plan and program of PE (Šumanović, Tomac, & Rastovski, 2013). Jurčić (2012) explains teacher skills in competence framework: "The primary task of teachers to apply their knowledge by studying and later professional training, practically in educational work in school. In this way, teacher is developing its own capacity, which is reflected in the practical application of the theories and concepts of pedagogical science. The teacher develops an ability that is reflected in the construction of the curriculum, didactic and methodical organization and conduct of teaching hours and the enterprising measures for internal differentiation, motivating students in collaborative learning, analysis and evaluation of educational work, innovation, use of techniques, technology and electronics in the function development of the educational process."

Methods

Data for this pilot study was collected in 2014 during regular lessons at the Faculty of Kinesiology. Before completing the questionnaire, the participants were introduced with the aim of the research. The participation in the research was on voluntary basis and anonymous and the participants were informed that they were free to stop participating in the research at any moment. The research was carried out on the sample of 100 third-year students at the Faculty of Kinesiology of Zagreb University, consisting of 37 women and 63 men of the average age of 21.

The questionnaire for the evaluation of the minimum quality of the educational process and general teacher's competences was made with the aim to evaluate the recognition of the educational quality process by the indicator of acceptability as the aspect of the right to education. The final version of the questionnaire consisted of 122 items (9 qualification items and 114 items about the application of individual quality indicators). The task of the participants was to assess, using the Likert scale of 5 levels (1 - strongly agree, 2 - mostly agree, 3 - not sure, 4 - mostly disagree, 5 - strongly disagree), the level of importance and presence of certain acceptability indicators of the right to education in PE classes. For the needs of this article, the analysis of instrument measuring features which refer to the part of the questionnaire of 21 items related to the group of questions connected with skills of PE teachers in the aspect of acceptability as the dimension of the right to education.

The constructive validity of the questionnaire was verified by the component model of factor analysis using Cattell's scree test and Guttman-Kaiser criterion for the reduction of main components and the rotation with Varimax normalization. Thereby, the following was calculated: the variances of significant main components, the percentage of the total variance of items explained by the significant main components and each of the extracted factors and the matrix of the factorial set. The reliability of the questionnaire's internal consistency type has been expressed in Cronbach's alpha. The contribution of each individual item to the questionnaire's reliability was expressed in Cronbach's alpha in case the item was excluded from the analysis. The sensitivity of items and the total result of the questionnaire was analysed by descriptive statistical parameters: arithmetic mean and standard deviation, and measures of the result distribution form: the asymmetry coefficient and the distribution skewness coefficient.

Results

The component model of factorial analysis, carried out on 21 items of the UPminKOOP questionnaire confirmed 4 significant main components according to Guttman-Kaiser criterion, as well as Cattell's *scree--test* (Chart 1). 72% of the total variance of questionnaire items were explained by significant main components, of which 47% (λ=9.89) by the first main component, 9% (λ=1.94) by the second, 9% (λ=1.79) by the third and 7% (λ=1.53) by the fourth.

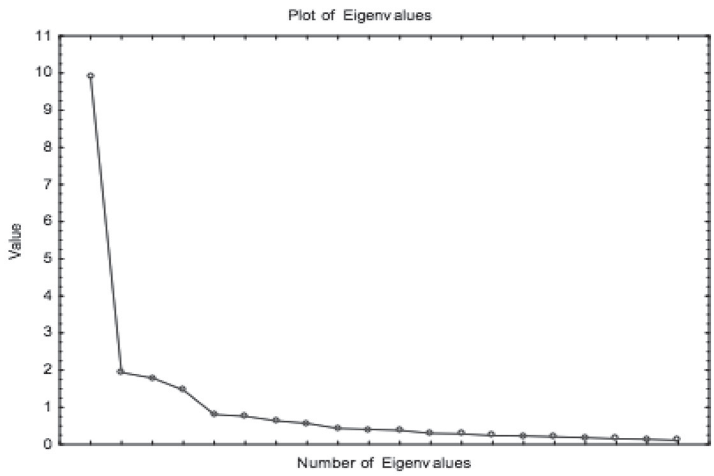

Figure 1: Variances of main components defined by the factorial item analysis (Scree plot)

The rotation of the significant main components defined the factorial structure of the questionnaire with relating items for each factor (Table 1). Parallel projections of items which dominantly saturate certain factors were in the range from 0.62 to 0.84 for the first factor, from 0.48 to 0.78 for the second factor, from 0.45 to 0.85 for the third factor and from 0.57 to 0.82 for the fourth factor (Table 1).

Table 1: Questionnaire factorial structure – factorial set matrix

	Item	Factor			
		1	2	3	4
S1	I believe that PE teachers are fully trained after graduation to work in the classroom	0,28	0,60	0,39	-0,04
S2	I believe that PE teachers have well-developed athletic skills	0,45	0,48	0,23	0,00
S3	I believe that PE teachers have well-developed motivational skills	-0,06	0,78	-0,02	0,27
S4	I believe that PE teachers have well-developed organizational skills	0,35	0,76	0,23	0,11
S5	I believe that PE teachers have well-developed teaching skills	0,27	0,76	0,27	0,06
S6	I believe that PE teachers have well-developed communication skills	0,13	0,70	0,21	0,27
S7	I think that a PE teacher should be linguistically literate	0,44	0,20	0,69	0,02
S8	I think that a PE teacher should have developed numerical skills	0,07	0,06	0,77	0,28
S9	I think that a PE teacher in their work should be focused on solving problems	0,30	0,22	0,80	0,15
S10	I think that a PE teacher should master oral and written skills	0,28	0,12	0,85	0,13
S11	I think that a PE teacher must meet the minimum educational standards (university degree)	0,39	0,26	0,72	0,12
S12	I believe that the objectives of PE classes support the development of critical thinking	-0,20	0,26	0,55	0,57
S13	I think that in his work, PE teacher develops awareness and capabilities of the local environment	0,20	0,44	0,45	0,43
S14	I think that in his work PE teacher develops awareness of the importance of health and healthy habits	0,62	0,11	0,37	0,40
S15	I think that in his work PE teacher develops awareness of sexual and reproductive rights	0,30	0,17	0,07	0,76
S16	I think that in his work PE teacher uses methods for the development of critical thinking	0,28	0,01	0,26	0,82
S17	I think that in his work PE teacher uses strategies of cooperative learning	0,51	0,14	0,22	0,59
S18	I think that in his work PE teacher supports the students in the creative expression of one's opinion	0,32	0,26	0,03	0,74
S19	I think that in his work PE teacher uses strategies of non-violent conflict resolution	0,76	0,15	0,27	0,31
S20	I think that in his work PE teacher develops a competitive spirit among students	0,84	0,17	0,27	0,19
S21	I think that in his work PE teacher develops fair play and mutual respect	0,82	0,21	0,22	0,25

The reliability of total results of the questionnaire has been estimated by the method of internal consistency. Cronbach's coefficient of reliability of the questionnaire's total result defined on the analyzed sample of participants was 0.94, standardized coefficient was 0.94 and average intercorrelation of items was 0.45.

The results of the analysis of questionnaire's sensitivity have been shown in Table 2.

Table 2: Descriptive statistical parameters and asymmetry measures and the skewness of the questionnaire results distribution

Item	Mean	Std.Dev.	Skewness	Kurtosis
S1	2,05	0,99	1,18	1,24
S2	2,32	1,03	0,83	0,03
S3	2,61	1,02	0,10	-0,96
S4	2,10	0,90	1,14	1,47
S5	2,10	0,95	1,03	0,92
S6	2,37	1,07	0,67	-0,16
S7	1,53	0,90	2,50	7,00
S8	2,13	0,95	0,82	0,84
S9	1,63	0,85	2,11	5,96
S10	1,62	0,84	2,18	6,46
S11	1,37	0,85	3,05	9,75
S12	2,32	1,04	0,41	-0,77
S13	2,06	0,84	0,93	1,76
S14	1,72	0,92	1,85	3,94
S15	2,60	1,04	0,43	-0,29
S16	2,41	1,07	0,66	-0,07
S17	2,07	0,97	1,02	1,40
S18	2,47	1,23	0,48	-0,90
S19	1,88	0,97	1,48	2,56
S20	1,56	0,88	2,17	5,58
S21	1,58	0,92	2,28	5,80

Discussion

The first factor dominantly saturated the items: “I think that in his work PE teacher develops awareness of the importance of health and healthy habits”, “I think that in his work PE teacher uses strategies of non-violent conflict resolution”, “I think that in his work PE teacher develops a competitive spirit among students” and “I think that in his work PE teacher develops fair play and mutual respect”. The second factor dominantly saturated the items: “I believe that PE teachers are fully trained after graduation to work in the classroom”, “I believe that PE teachers have well-developed athletic skills”, “I believe that PE teachers have well-developed motivational skills”, “I believe that PE teachers have well-developed organizational skills”, “I believe that PE teachers have well-developed teaching skills” and “I believe that PE teachers have well-developed communication skills”. The third factor dominantly saturated the items: “I think that a PE teacher should be linguistically literate”, “I think that a PE teacher should have developed numerical skills”, “I think that a PE teacher in their work should be focused on solving problems”, “I think that a PE teacher should master oral and written skills”, “I think that a PE teacher must meet the minimum educational standards (university degree) ” and “I think that in his work, PE teacher develops awareness and capabilities of the local environment”.The fourth factor dominantly saturated the items: “I believe that the objectives of PE classes support the development of critical thinking”, “I think that in his work PE teacher develops awareness of sexual and reproductive rights”, “I think that in his work PE teacher uses methods for the development of critical thinking”, “I think that in his work PE teacher uses strategies of cooperative learning”, and “I think that in his work PE teacher supports the students in the creative expression of one’s opinion”. The items have been grouped in four sub-factors: conceptual skills (including skills and the ability to apply ideas in specific situations and solving complex situations), social skills (beyond the level of the profession, and are necessary in a relationship and how to deal with people, behaviour in the presence of others, and communication in a professional environment), technical skills (knowledge and skills specific to a profession) and pedagogical skills. Results of the analysis showed that participants in the study do not see skills (as part of competence) as a unique collection specified skills, but that there is a tendency towards quite independent assessment of the four groups in the incidence of skills to the previously mentioned division, where conceptual skills largely explain construct complex skills of PE teachers. Students in this research agree or completely agree with the statements in the questionnaire (AS 1.37 to 2.61), with very small variations in the estimates of the individual particles (SD 0.84 to 1.23). While such results are awaited, low arithmetic mean and standard deviation (in the direction of complete or partial agreement) indicate low sensitivity

Conclusion

This pilot study was conducted on a heterogeneous sample of students from the Faculty of Kinesiology in Zagreb. Due to the characteristics of the sample, ie. their lack of involvement in PE classes at school, the results of the pilot studies can not be generalized with total security. In future research it would be useful to establish the measurement characteristics of the questionnaire on and for PE teachers employed in schools. By using this questionnaire on a variety of patterns probability will allow a better understanding of this complex phenomenon and identification factors related to the teacher perception of competencies within the acceptability as an indicator of the right to education in educational system.

References

1. Freeman, M. D. A. (2004). *Children’s rights*, Volume I. Dartmouth, England: Asgate Publishing Limited.
2. Jurčić, M. (2012). *Pedagoške kompetencije suvremenog učitelja*. [Pedagogical competence of the modern teacher. In Croatian.] Recedo, Zagreb.
3. Kostanić, D., Prlenda, N., & Cigrovski, V. (2011). Razlike u kompetencijama u nastavi tjelesne i zdravstvene kulture u nekim zemljama Europe. [The differences in the competences in physical education in some European countries. In Croatian.] In Prskalo, I., Novak, D. (Eds.), *Proceedings of the 6th Congress FIEP - Europe, Poreč 2011, “Physical Education in the 21st Century - competence of students”*. (pp. 262-270). Zagreb: Hrvatski Kineziološki savez.
4. Markuš, D., Neljak, B., & Trstenjak, B. (2011). Kompetencije u tjelesnom i zdravstvenom odgojno obrazovnom području: procjena učeničke trenutačne osposobljenosti. [Competencies in the field of physical education: current competency assessment of students. In Croatian.] In Prskalo, I., Novak, D. (Eds.), *Proceedings of the 6th Congress FIEP - Europe, Poreč 2011, “Physical Education in the 21st Century - competence of students”* (pp. 301-308). Zagreb: Hrvatski kineziološki savez.
5. Neljak, B., Markuš, D., Trstenjak, B., & Višković, S. (2011). Kompetencije u tjelesnom i zdravstvenom odgojno obrazovnom području: učenička procjena važnosti. [Competencies in the field of physical education: student assessment of the importance. In Croatian.]. In Prskalo, I., Novak, D. (Eds.), *Proceedings of the 6th Congress FIEP - Europe, Poreč 2011, “Physical Education in the 21st Century - competence of students”* (pp. 345-353). Zagreb: Hrvatski kineziološki savez.
6. Rishmawi, M.& Keable-Elliott, C. (2012). *Right to education project indicators.* Stocktaking Report.
7. Ružić, E., Badrić, M.& Prskalo, I. (2008). Stanje i razlike u kurikulumu nastave tjelesne i zdravstvene kulture u nekim europskim zemljama. [Situation in and differences among some countries in Europe concerning their physical education curricula. In Croatian.] *Napredak, 149 (4),* 442-459.

8. Šumanović, M. (2012). *Evaluacija provedbe nastavnog plana i programa tjelesne i zdravstvene kulture u osnovnoj školi.* [Curriculum evaluation of primary school physical education. In Croatian.] (Unpublished doctoral dissertation, University of Zagreb) Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
9. Šumanović, M., Tomac, Z., Rastovski, D. (2013). Vrjednovanje općega programa tjelesne i zdravstvene kulture u osnovnoj školi – učitelji razredne nastave. [Evaluation of PE curriculum – elementary school teachers. In Croatian.] *Život i škola, 29*, 434-450.
10. Tomaševski, K. (2006). *Human Rights Obligations in Education: The 4-A Scheme*. Nijmegen, Wolf Legal Publishers.

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THE EFFECTS OF PHYSICAL EXERCISE AND DANCE ON BRAIN HEALTH AND PREVENTION OF DEMENTIA

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Abstract

Recent reviews summarizing epidemiological, cross-sectional and Interventional studies have indicated that physical exercise may play a key role in healthy aging and in the prevention of cognitive decline and neurodegenerative diseases[1]. Thereby, cardiovascular, coordinative and cognitive training induces different neoplastic processes. Especially the results from animal research suggested that a combination of physical exercise with sensory enrichment has the strongest effect on the neurogenesis – primary in the hippocampus – and that only this combination ensures the enduring survival of the newborn cells[2]. Dancing has been suggested to constitute a human homolog to this enriched environmental conditions as it poses demands both on physical, coordinative and cognitive functions. During dancing much afferent (perception of melody and rhythm in context of time pressure) and efferent (transformation into complex movements, which involved different body parts) information must be processed in the brain. Moreover, dancing involves different balance situations (one leg standing position, single leg turns, and bipedal leg turns) which require the integration of input from the vestibular, visual and sensory systems. Based on these considerations, we recently performed a randomized controlled trial with 26 healthy seniors who took part either in an 18-month dance or a traditional sport program[3]. The dance program was especially designed to boost constant learning by presenting participants with new choreographies all the time. Compared to participants of the sports group, the dancers showed volume increases in the gray matter of the brain in parahippocampal and precentral regions (Fig. 1).

Especially the aspect of music as an additional stimulus is very essential when considering the impact of dancing on the brain plasticity. Rhythm, articulation and dynamics are direct prescriptions for variability in motor control; they influence the execution.

The current state of research suggests that physical exercise in general and dance, in particular, can counteract age-related cognitive decline and reduce the risk of neurodegenerative diseases such as Alzheimer's disease. In an actual pilot study, we investigate the impact of dancing with dance walkers in patients with dementia on cognitive and physiological parameters.

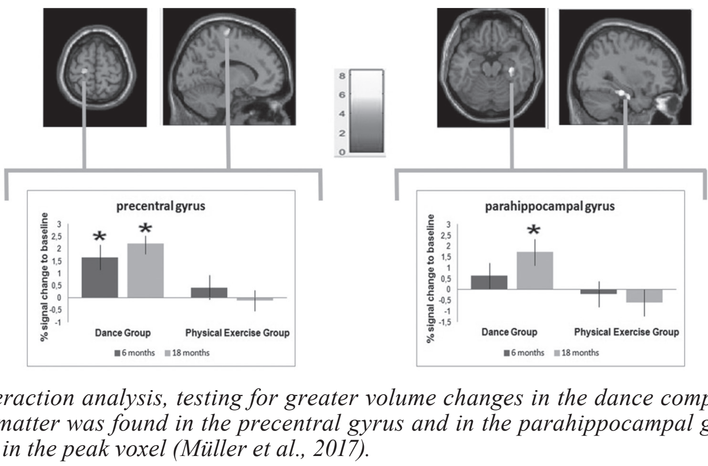

Figure 1: Time by group interaction analysis, testing for greater volume changes in the dance compared with the sport group. A significant increase in gray matter was found in the precentral gyrus and in the parahippocampal gyrus. The box plots show the relative gray matter changes in the peak voxel (Müller et al., 2017).

References

1. Müller, P., Schmicker, M. & Müller, N.G. (2017). Präventionsstrategien gegen Demenz. *Zeitschrift für Gerontologie und Geriatrie*, doi: 10.1007/s00391-017-1202-x.
2. Kempermann G, Kuhn HG, Gage FH. (1997) More hippocampal neurons in adult mice living in an enriched environment. *Nature.* 1997 Apr 3;386(6624):493-5.
3. Müller, P., Rehfeld, K., Schmicker, M., Hökelmann, A., Dordevic, M., Lessmann, V., Brigadski, T., Kaufmann J. & Müller, N.G. (2017). Evolution of neuroplasticity in response to physical activity in old age: the case for dancing. *Front. Aging Neurosci.* 9:56. doi: 10.3389/fnagi.2017.00056

PHYSICAL ACTIVITY AND HEALTHY AGING

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Abstract

There is a need to learn more about healthy lifestyle of older adults.

Purpose: The main aim of this thesis is to describe the physical culture and retirement of seniors.

Methods: The focus of this research was on older adults who are retired and living in Georgia (USA), Czech Republic, and Croatia. This interpretive paradigm incorporated various research methods in order to collect the data. Participant observations, questionnaires, interviews, and focus groups were all utilized to ascertain the findings of this study.

Results: As a result of this study we found a growing number of older adults who have rejected previous notions of aging and are incorporating physical culture as a healthy lifestyle.

Conclusion: Social dance, walking, and exercise class are several ways that seniors have chosen to pursue physical activity and a healthy lifestyle.

Key words: *older adults, physical culture, social dance, exercise class*

The Significance of Physical Activity in Aging

Introduction

Many older adults have difficulty with various aspects of becoming older. People will eventually encounter some type of frailty through the loss of physical function or various aspects of pain. In contrast, there are some older adults who are creating a different perspective on aging. Rather than retiring and letting go, instead of giving up and becoming frustrated, many older adults are learning how to use the framework of recreation and education in order to improve their lives. As a result of this study, we found older adults who are choosing to continue to engage with life specifically by gardening, dancing, exercising, and self-directed learning. Although this is a small part of their lives, however, it indicates they are no longer being pushed aside and waiting for death.

Method

We have shown three specific aspects of this combination of recreation, education, free time, and physical activity through the lens of social dancing, walking, and exercising in a class. In each of these studies there was a similar process of observation, questionnaire, interview, and focus group. In each situation one field of information led to the next. This natural progression allowed us to be more focused as we continued the research and gained data from several sources.

Results

Swimming. I focused on three classes of older swimmers at a community exercise center in Zagreb, Croatia. One hundred and five participants were asked to complete a short questionnaire. This questionnaire had questions on demographics, use of free time, as well as the context of the class. In addition eight participants were interviewed for more detailed information. The findings indicated that these older adults are primarily motivated to maintain and improve their health. Also important is the social dynamic of participating within a class. And these older adults were very active in various projects outside of the exercise class. Interesting data also provides insightful information on the details of the swimming class, descriptions of health, and use of free time.

Dancing. The purpose of this study is to identify the ways in which social dancing contributes to the well-being of seniors. To this end we observed, surveyed, and formed a focus group from two dance locations in Olomouc, Czech Republic. As a result of participant observation, questionnaires, and a focus group there were three main findings. 1). Social dance can be a health enhancing physical activity. 2). As opposed to a dance class, social dance promotes a playful and spontaneous atmosphere. 3). This weekly scheduled event of dancing adds a positive reconnection and continuation with one's memory, youth, and history. Communities should be encouraged to establish social dance as an option for all ages, especially older adults.

Walking. The purpose of this study was to understand more about the experience of those who exercise in the natural environment, through hiking and walking on

Medvednica Mountain Nature Park near Zagreb, Croatia. To this end we interviewed 122 hikers and walkers on-site, asking general questions about the walking experience on Medvednica. The findings center around three main experiences: (1) affinity with nature and the outdoors; (2) mental and physical benefits; and (3) interaction with others and development of self-knowledge.

Discussion

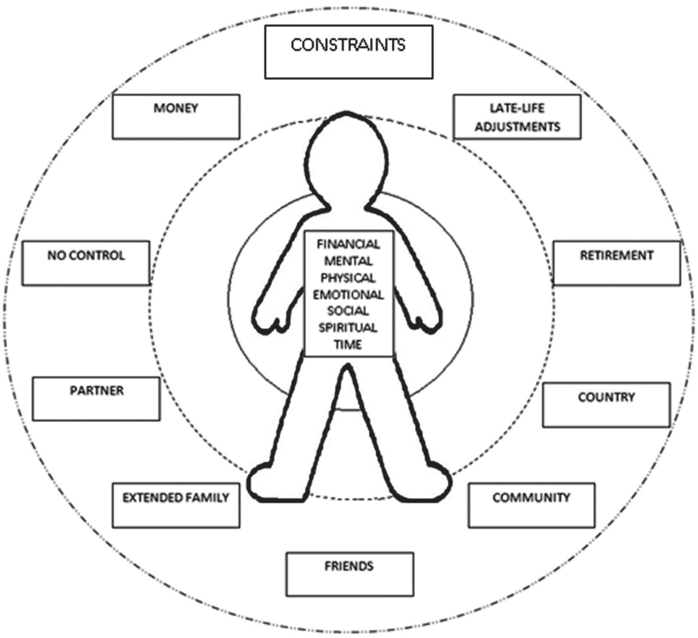
Our research along with Verghese (2006), Jenkins (2003), and Keogh, Kilding, Pidgeon, Ashley, and Gillis (2009) discussed how dancing is a physical activity that offers people, and especially older adults, a fun way to improve their lives by improving aerobic power and lower-body muscle endurance, strength and flexibility, balance, agility, and gait. And, there is evidence to show that dancing can improve lower body bone mineral content, muscle power, prevent falls, and promote cardiovascular health. Keogh et al. (2009) and Sofianidis et al. (2009) stated that the social interaction of dance provides a sense of belonging to a community.

Walking is one of the most natural forms of recreation and exercise and accessible to many people (Cox et al., 2010; Jancey et al., 2011; Morgan et al., 2010). Furthermore, the dynamics of being with others during walking and hiking can also add a significant social aspect to walking as a leisure time activity. This study explored these issues through qualitative research into exercise that has taken place with participants from Croatia, a previously unstudied group. The use of on-site interviews captures the immediacy of walkers' and hikers' experiences and in this way contributes more broadly to recreation and leisure research. Reflecting ideas of Heintzman (2002, 1999), this information helps to show how being outdoors in natural settings influences the individual in a positive manner.

Similar to Maciaszek, Osinski, Szeklicki, and Stemplewski's (2005) focus on Tai Chi, and Borer, Cornelissen, Halberg, and Hughes' (2003) focus on walking, this research indicated how the specifics of water exercise can improve the overall physical health of older adults. Although my research used a self-inventory for explanations, most of the participants discussed how water exercise improved their mobility, range of motion, and lessened the pain in aching joints. Akin to other water exercise classes, these older adults 'loved' being in the water and the ensuing benefits.

Conclusion

I have created a model of aging based on the internal and external issues of the individual. This 'inside/outside' model of aging is a series of circles that helps to explain and to determine many of the factors concerning the older person's life. The internal part of the individual is comprised of six internal elements: physical, mental, social, emotional, spiritual, and financial. The focus of these topics lies within the internal locus of control of the individual. Each of these has been discussed in length in this research. Important concerns for the older adult includes answering the following questions.



References

1. Borer, K. T., Cornelissen, G., Halberg, F. & Hughes, C. (2003). Health impact of training intensity in older individuals. *International Journal of Fundamental and Applied Kinesiology, 35*(2), 210-218.
2. Cox, K. L., Burke, V., Beilin, L. J., & Puddey, I. B. (2010). A comparison of the effects of swimming and walking on body weight, fat distribution, lipids, glucose, and insulin in older women – the sedentary women exercise adherence trial 2. *Metabolism Clinical and Experimental, 59*, 1562-1573.
3. Heintzman, P. (1999, May). *Leisure and spiritual well-being relationships: A qualitative study.* Paper presented at the Ninth Canadian Congress on Leisure Research, Wolfville, Nova Scotia.
4. Heintzman, P. (2002). A conceptual model of leisure and spiritual well-being. *Journal of Park and Recreation Administration, 20*(4), 147-169.
5. Jancey, J. M., Lee, A. H., Howat, P. A., Burke, L., Leong, C. C., & Shilton, T. (2011). The effectiveness of a walking booster program for seniors. *American Journal of Health Promotion, 25*(6), 363-367.
6. Jenkins, S. (2003). Just your cup of tea: Tea dances. *Pavilion, 7*(4), 21-24.
7. Keogh, J. W. L., Kildimg, A., Pidgeon, P., Ashley, L., & Gillis, D. (2009). Physical benefits of dancing for healthy older adults: A review. *Journal of Aging and Physical Activity, 17*, 479-500.
8. Maciaszek, J., Osinski, W., Szeklicki, R., & Stemplewki, R. (2005). Effect of Tai Chi on bone mineral density and dynamic body balance among elderly men with osteopenia or osteoporosis. Proceedings from *4th International Scientific Conference on Kinesiology*, Opatija, Croatia, 336-337.
9. Morgan, A. L., Tobar, D. A., & Snyder, L. (2010). Walking toward a new me: The impact of prescribed walking 10,000 steps/day on physical and psychological well-being. *Journal of Physical Activity and Health, 7*, 299-307.
10. Sofianidis, G., Hatzitaki, V., Douka, S., & Grouios, G. (2009). Effect of a 10-week traditional dance program on static and dynamic balance control in elderly adults. *Journal of Ageing and Physical Activity, 17*(2), 167-180.
11. Verghese, J. (2006). Cognitive and mobility profile of older social dancers. *Journal of American Geriatric Society, 54*(8), 1241-1244.

STUDENTS‘ ATTITUDES TOWARDS SPORTS AND RECREATIONAL ACTIVITIES IN SPARE TIME

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Abstract

Spare time is prerequisite for various activities, of which the majority affect social and economic lifestyles of individual. The aim of this research is to find out how the students spend their free time, the extent to deal with recreational activities and whether there are differences between the genders. The study was conducted on 192 first-year, and second-year students of the Faculty of Economics in Zagreb, of which 155 female students and 37 male students. The average age of students is 19,23 years. Survey research method was used. The questionnaire was consisted of 9 questions related to the spending spare time and activity. The questionnaire included answers, and each student could chose one answer or could write his/her own answer in order to clearly define his/her attitude. Results in this study indicate low level of students‘ physical activity. Chi-square test revealed statistically significant differences between the genders in the variables PSRA p=0.007, WPSA p=0.043, HOPA p=0.006, FPSA p<0.001. This survey points out how young female students are passive, and significantly low number of female students participate in some kind of sports activities. Moreover, results highlight the fact that students are aware of physical activity importance, but great number did not find the adequate activity.

Key words: *importance of physical activities, sedentary lifestyle, quality of life*

Introduction

Today‘s society suffers from the shortage of spare time. Spare time is prerequisite for various activities, of which the majority affect social and economic lifestyles of individual. Efficient time managament refers to the participation in diversified cultural and sports activities. One of the major issue for modern society is the sedentary lifestyle. Technology improvement and innovations have high contribution to this issue. Generally, young and old generations are lacking physical activity. Students are pillars of the nation, and it is crucial for them to be aware of the importance of physical, and recreational activities. Minimum recommended physical activity affecting the health status could not be met even among students of medical science (Tecely et al., 2003). Exercise, and physical activity is crucial in prevention of diseases. Life- long habits learnt in chilhood are often reflected in one s health status during adulthood, commonly appearing as the initial risk factors of many diseases (Tirodimos et al., 2009). Evidences show positive effect on psychophysical health (Petrić, 2011). Physical education is only course that focuses on health of young people, and it is an efficient method for creating healthy lifestyle. The purpose of this research is to examine the extent of students‘ involvement in sports and recreational activities, and to explore how students spend their spare time.

Methods

The study was conducted on 192 first-year, and second-year students of the Faculty of Economics in Zagreb, of which 155 female students and 37 male students. The average age of students is 19,23 years. Survey research method was used. The questionnaire was consisted of 9 questions related to the spending spare time and activity. The questionnaire included answers, and each student could chose one answer or could write his/her own answer in order to clearly define his/her attitude. Survey was consisted of questions: 1. How do you spend spare time - (**HSST**), 2. How many hours do you spend watching television, or on computer - (**HMWT**), 3. Do you participate in any sports and recreational activities in your spare time - (**PSRA**), 4. In which sports and recreational activities do you participate in your spare time - (**WSAP**), 5. Why do you participate in sports and recreational activities in your spare time - (**WPSA**), 6. How often do you participate in these activities - (**HOPA**), 7. Do you think that sport and recreational activity is important- (**IOFA**), 8. Why it is important - (**WISA**), 9. Are you going to participate in sports and recreational activities in the future- (**FPSA**)? Based on the conducted survey, results are presented in tables: frequency analysis (F) and percentage (%) for each sports and recreational activity in spare time. Gender differences in the results towards physical activity and spar times were determined Chi-square test.

Results and discussion

In table 1 are shown results from first question in the survey. It is concerning fact that 67,57% of male students, and 72,9% of female students spend their spare time watching television and surfing the Internet, and only 18,92% male students and 12,9% female students practicing sport.

Table 1: Shows frequencies, percentages answer and Chi-square test in total sample; based on question: How do you spend spare time?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
Watching TV	50	26,04	8	21,62	42	27,09
Reading books	18	9,38	2	5,41	16	10,32
Internet surfing	88	45,83	17	45,96	71	45,81
Practice sport	27	14,06	7	18,92	20	12,90
Playing videogames	3	1,56	2	5,41	1	0,65
Something else	6	3,13	1	2,70	5	3,23
chi-square test p=0.184						

Table 2: Shows frequencies, percentages answer and Chi-square test in total sample; based on question: How many hours do you spend watching television, or on computer?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
0 h	2	1,04	0	0	2	1,29
1 h	34	17,71	7	18,92	27	17,42
2 h	82	42,71	12	32,43	70	45,16
3 h	61	31,77	14	37,84	47	30,32
More than 3h	13	6,77	4	10,81	9	5,81
chi-square test p=0.239						

Analyzing data on second question (Table 2), it is evident how students spend two to three hours on whatching TV, or surfing the Internet. 37,84% of young male students spend mostly three hours, while female students spend two hours on whatching TV, or surfing the Internet.

Table 3: Shows frequencies, percentages answer and Chi-square test in total sample; based on question: Do you participate in any sports and recreational activities in your spare time?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
Yes	66	34,37	20	54,05	46	29,68
No	126	65,63	17	45,95	109	70,32
chi-square test p=0.007						

It is shown in Table 3 how only 54,05% of male studens and 26,98% of female students practice some kind of sport and recreational activity. This percentage does not benefit the female students. Chi-square test showed a statistically significant difference (p = 0.007) between the genders.

Table 4: Shows frequencies, percentages answer and Chi-square test in partial sample, based on question: In which sports and recreational activities do you participate in your spare time?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
Football	7	0,11	7	35	0	0
Handball	0	0	0	0	0	0
Volleyball	0	0	0	0	0	0
Basketball	2	3,03	2	10	0	0
Running	12	18,18	3	15	9	19,57
Swimming	5	7,57	2	10	3	6,52
Tennis	3	4,55	1	5	2	4,35
Fitness	21	31,82	4	20	17	36,96
Dancing	11	16,67	0	0	11	23,91
Hiking	2	3,03	0	0	2	4,35
Combat s.	1	1,52	1	5	0	0
Something else	2	3,03	0	0	2	4,35
chi-square test p= 0.773						

Table 4 shows how of total 66 students that practice sport, male students favour mostly football (35%), fitness (20%) and running (15%). Female students favour fitness (17%), and dancing (11%).

Table 5: Shows frequencies, percentages answer and Chi-square test in partial sample, based on question: Why do you participate in sports and recreational activities in your spare time?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
Achievement	3	4,55	2	10	1	2,17
Health	15	22,73	3	15	12	26,09
Entertainment	16	24,24	10	50	6	13,04
Friendship	32	48,48	5$	25	27	58,70
chi-square test p= 0.043						

From total of 66 students that practice some kind of sport and recreational activity most of the male students (50%) practice it for the purpose of entertainment, while female students (58,7) do it for the purpose of friendship. This data shows how consciousness of activity importance for health has not enough evolved. Chi-square test showed a statistically significant difference ($p = 0.043$) between the genders.

Table 6: Shows frequencies, percentages answer and Chi-square test in partial sample, based on question: How often do you participate in these activities?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
Every day	8	12,12	3	15	5	10,87
2-3 times per week	42	63,64	11	55	31	67,39
Sometimes	16	24,24	6	30	10	21,74
chi-square test p= 0.006						

This table shows that 55% of male students, and 67,39% of female students practice sport two to three times per week. It is evident how physical activity is not priority. Chi-square test showed a statistically significant difference ($p = 0.006$) between the genders.

Table 7: Shows frequencies, percentages answer and Chi-square test in partial sample, based on question: Do you think that sport and recreational activity is important?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
Yes	49	74,24	17	85	32	69,57
No	3	4,55	1	5	2	4,35
Maybe	14	21,21	2	10	12	26,08
chi-square test p= 0.175						

Table 7 shows how 85% of male students and 69,57% female students are aware of physical activity importance. Eventhough, great number of students are aware of the physical activity importance, it is not an motivation to start being more active.

Table 8: Shows frequencies, percentages answer and Chi-square test in total sample; based on question: Why it is important?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
Health	70	36,46	15	40,54	55	35,48
Appeal	15	7,81	4	10,81	11	7,10
Friendship	20	10,42	5	13,51	15	9,68
Entertainment	16	8,33	2	5,41	14	9,03
Everything listed above	71	36,98	11	29,73	60	38,71
chi-square test p=0.273						

Table 8 indicates that 40,54% of male students, and 38,71% of female students consider physical activity as important for health. Moreover, 29,73% of male and 38,71% of female students answered ‚'All of the above'' which shows that they are aware of physical activity importance, but they did not find sport activity that suits them.

Table 9: Shows frequencies, percentages answer and Chi-square test in total sample; based on question: Are you going to participate in sports and recreational activities in the future?

Activity	Total frequency	Total frequency%	Frequency M	Percentage M	Frequency F	Percentage F
Yes	80	41,67	27	72,97	53	34,19
No	5	2,60	3	8,11	2	1,29
Maybe	107	55,73	7	18,92	100	64,52
chi-square test p<0.001						

Table 9 demonstrate how students will, or are thinking about practicing sport in the future. 72,97% of male students is going to practice sport in the future, while 20% is thinking about practicing. 34,19% of female students answered how they will practice sport in the future, and 64,52% of them is thinking about practicing. Chi-square test showed a statistically significant difference ($p < 0.001$) between the genders.

Conclusion

Results in this study indicate low level of students' physical activity. World Health Organization report showed how 31% of world's population is insufficiently physically active. Physical inactivity has been identified as the fourth leading risk factor for global mortality. It is advised for people to take at least 30 minutes of moderate-intensity excercise 3 times per week. However, a great number of people do not perform that advised minimum. The survey found that girls are more likely to passive spending free time, and significantly fewer girls play sports (29.68%) compared to men (54.05%), as determined by Chi-square test ($p = 0.007$). Those that are still active, preferring dance and fitness, while the male part of the population prefers to deal with football, running and also fitness. Milanovic et al., (2013) in his work report that there are differences in the selection of sports activities by gender. The students often choose competition, while girls more often choose individual sports is non competitive. Empirical evidences prove how people, due to the development in technology and a various facilities on internet and television, spend more time sitting than being physically active. This survey points out how young female students are passive, and significantly low number of female students participate in some kind of sports activities. Those female students that are more active prefer dancing and fitness, while male part of students prefer football, running, and also fitness. Moreover, results highlight the fact that students are aware of physical activity importance, but great number did not find the adequate activity. Survey shows how consciousness of activity importance for health has not enough evolved. This statement is proven by the fact how great portion of students participate in sports activities just because of entertainment and friendship. We can conclude that if society and environment changes, students will not anymore participate in specific sport activity. Survey results can be useful in creating and designing an effective sports and recreational facilities model, which would be included in mandatory Physical Education classes at Faculty of Economics in Zagreb. This model would improve the quality of students‘ capabilities and efficiency, and will also improve psychophysical health. Nowadays, students spend large amount of time sitting, and due to that their physical condition weakens. It is crucial to change students‘ habits and foster them to be more active. One more aim is to create a habit of daily excercise through sports and recreational facilities, which will have effect on improving the quality of life.

References

1. Andrijašević M. (2000). Slobodno vrijeme i igra, M. Andrijašević (ur.), Zbornik radova 9. Zagrebački sajam sporta i nautike, Zagreb, 2000, (pp. 7-15), Zagrebački športski savez, Zagrebački velesajam, Fakultet za fizičku kulturu.
2. Milanović, Z., Sporiš, G., Trajković, N., Vračan, D., Andrijašević, M., Pantelić, S., Baić, M. (2013). Attitudes towards exercise and the physical exercise habits of university of Zagreb students. Annales Kinesiologiae; 4 (1); 57.70.
3. Petrić, V. (2011). Razina tjelesne aktivnosti i standard uhranjenosti adolescenata u Istri. (Neobjavljena doktorska disertacija, Sveučilište u Zagrebu). Zagreb: Kineziološki fakultet, Sveučilište u Zagrebu.
4. Tecely, T., Tolnai, C. K., & Angyan, L. (2003). Physical activity and medical conditionof university students. Book of Abstracts of 8th Annual Congress of the ECSS, Salzburg (p. 434).
5. Tirodimos, I., Georgouvia, I., Savvala, T. N., Karanika, E., & Noukari, D. (2009). Healthy lifestyle habits among Greek university students: Differences by sex and faculty of study. East Mediterranean Health Journal, 15(3), 722.728.

PHYSICAL EXERCISE AND EMPLOYEE STRESS MANAGEMENT

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Abstract

Stress impacts all aspects of human functioning. Stress management is crucial in the maintenance of work potential, health preservation and overall better life quality. The goal of this research is to determine the amount of observed stress and its connection to health and physical activity in working people. Participants of this research were 554 working people (280 f, 274 m) between the ages of 18 and 64 that work in different services of social and private sectors in Croatia. Besides the demographic variables, a 10-item PSS scale (Choen and Williamson 1988) was also used as a measuring instrument. Multiple regressional analysis shows a significant statistical difference in percieved stress. Variables that are most influential in the differentiation are gender, educational status, personal health assessment and physical exercise. People who stated poorer health status and showed higher levels of percieved stress were also less physically active. It is neccessary to conduct a more extensive research that deals with the issue of stress levels and the effect stress has on the overall functioning of the employees. Multidisciplanary and longitudinal researches that are related to health perception, stress perception and the level of physical exercise in employees are missing. They are needed to gain a better understanding of the issues and to develop beneficial strategies of stress management while also taking into consideration the type of employement.

Key words: *stress, health, physical exercise, employees*

Introduction

We are living in times of increased stress levels in all areas of life. Stress affects an individual‘s mental and physical health in many ways and can significantly disturb a person‘s functioning in different areas of life. The effects of stress are decreased power efficiency of human potentials and the employee‘s productivity, as well as leaving long term negative consequences on a person‘s psychological well-being and quality of life. (Gayman at al. 2011). European research conducted on 21 703 workers showcases that more than ¼ of examined population (28%) shows prominent symptoms of stress (Heber at al. 2013). The number of scientific researches that are examining consequences of stress on a person‘s physical and mental health is increasing. A large proportion of reasearches are focused on examining stress at the work place. Stressful situations at work can become a negative experience that is connected with tension, anger, fatigue and a lack of motivation. It has also been proven that stress contributes to the development of a whole range of physical and mental ailments such as cardiovascular diseases, immunity imbalances, anxiety and depression (Klein at al. 2016, Weigner at al. 2015, Nielsen at al. 2008). Sources of stress depend on the type of employement, working conditions, lack of improvement, relationships with coworkers, difficulties balancing professional and private life and many others (Cooper, 2013). To better understand stress and its consequences, scientific researches deal with recovery from work as well (Sonnestag 2012). Recovery from work is a process in which certain systems inside an individual that were exposed to high amounts of stress are now being returned to their previous state. A few strategies of recovery that help people regulate their own mood are: psychological removal, relaxation, perfecting skills and control (Sonnestag i Fritz 2007). Perceived Stress Scale(PSS) is often used to evaluate global stress levels (Choen at al.1983). Global measurings of stress can give informations about the relationship between stress and people‘s well-being which affects the quality of life. The goal of this research is to determine global stress levels in working people and to explore the correlation between stress, self-assessment of health and the amount of physical exercise in the last month.

Methods

Participants

A sample of 554 working people (280 f, 274 m) between the ages of 18 and 64 was used for the needs of this research. Participants work in different services of social and private sectors in Croatia.

Measures

International 10-item questionnaire Perceived Stress Scale – a short version of the original 14-item scale was used (Choen i Williamson 1988). Factorial structure PSS-10 was researched by component analysis (Choen, Williamson 1988) and exploratory factorial analysis (Golden- Kreutz at al., 2004, Roberti at al., 2006) resulting in a 2-factorial model of Percieved Distress and Percieved Coping.

Perceived Distress comprises of six negatively phrased items that assess levels of distress and negative effect with respect to stressful situations. The other four items of Perceived Coping are positively phrased and reflect the perception of one's ability to deal with the stressors.

The research was conducted anonymously, voluntarily and in respect towards ethical procedures. Demographic informations include gender, age, marital status and level of education. Self-assessment scale of personal health was also used by the title "I would describe my health status as...". The answers were on a Likert scale ranging from 1 (bad), 2 (alright), 3 (good), 4 (very good) and 5 (excellent). Physical exercise asssessment was questioned by a variabe titled "In the last month I have exercised..." and the answers were on a Likert scale with possible answers never, almost never, sometimes, often and very often. In the processing of these informations methods of multiple regressional analysis and proportional analysis were used for descriptive indicators.

Results and discussion

Descriptive indicators show that the equal number of representatives of each gender (274 m, 280 f) between the ages of 18 and 64 was questioned. Most of the participants are married and are predominantly of a middle or high educational status. Based on the type of work, police and administration workers dominate in all aspects, followed by wood and textile industry, health and private sector workers. Participants mostly describe their personal health status as very good (40.79%) and good (29.78%). Less than 20% describes their health as excellent while around 10% of participants describe their health as satisfactory. A small number of participants says their health is bad. Analysis of participation in physical exercise shows that in this sample more than 35% of participants never or almost never exercises. Occasionaly 23.28% of participants exercise while 40.06% exercise regularly on a recommended level.

Table 1: Characteristics of the participants

VARIABLE		N	%
GENDER	MALE	274	49.45%
	FEMALE	280	50.54%
AGE	>19	8	1.44%
	20-34	231	41.69%
	35-49	241	43.5%
	50-64	72	12.99%
	65+	2	0.36%
MARITAL STATUS	SINGLE	72	12.99%
	IN A RELATIONSHIP	97	17.50%
	MARRIED	351	63.35%
	MARRIED BUT LIVING SEPARATELY	7	1.26%
	SEPARATED	27	4.87%
EDUCATION LEVEL	STUDENT	24	4.33%
	HIGH SCOOL	298	54.77%
	COLLEGE	87	15.99%
	UNIVERSITY	128	23.10%
	MASTER/ DOCTOR DEGREE	17	3.12%
TYPE OF PROFESSION	ADMINISTRATION	143	25.81%
	POLICE	153	27.61%
	EMERGENCY POLICE	81	14.62%
	HEALTH CARE	40	7.22%
	WOOD AND TEXTILE IND.	85	15.34%
	PRIVATE SECTOR	52	9.38%

HEALTH STATUS	BAD	8	1.44%
	SATISFACTORY	53	9.56%
	GOOD	165	29.78%
	VERY GOOD	226	40.79%
	EXCELLENT	102	18.41%
LAST MONTH PHYSICAL EXERCISE	NEVER	120	21.66%
	ALMOST NEVER	83	14,98%
	SOMETIMES	129	23.28%
	OFTEN	104	18.77%
	VERY OFTEN	118	21,29%

Descriptive indicators of stress cite that 36% od participants were often or very often upset during the course of last month while 20% of them said they couldn‘t control important aspects of their life. More than 40% felt upset and nervous, around 15% showed inability to deal with obligations, 35% were angry about events out of their control and 20% felt pressured by difficulties they weren‘t able to overcome. On the other hand, variables relating to dealing with stress show that in the last month 64% of participants managed to resolve their issues, 50% said situations resolved in their favor, 55% managed to control irritations in their lives and 35% were pleased by their own performance.

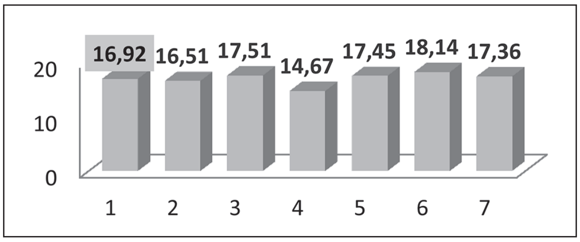
Table 2: Descriptive characteristics of PSS scale

PSS scale	**NEVER**		**ALMOST NEVER**		**SOMETIMES**		**OFTEN**		**VERY OFTEN**	
In the last month, how often…	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
have you been upset because of something that happened unexpectedly?	22	4.0	88	16.17	244	44.85	140	25.73	60	11.02
have you felt that you were unable to control the important things in your life?	82	14.8	177	32.53	190	34.92	70	12.86	35	6.31
have you felt nervous and "stressed"?	21	3.79	95	17.14	220	39.71	145	26.17	73	13.17
have you felt confident about your ability to handle your personal problems?	16	2.88	37	6.67	147	26.53	226	40.79	128	23.1
have you felt that things were going your way?	24	4.33	65	11.73	199	35.92	214	38.62	52	9.38
have you found that you could not cope with all the things that you had to do?	91	16.42	204	36.82	173	31.22	65	11.73	21	3.79
have you been able to control irritation in your life?	18	3.24	42	7.58	185	33.39	237	42.77	72	12.99
you felt that you were on top of things?	15	2.7	23	4.15	125	22.56	275	49.63	116	20.93
were you angry because of things that were outside your control?	47	8.48	109	19.67	201	36.28	130	23.46	67	12.09
have you felt difficulties were piling up so high that you could not overcome them?	78	14.07	183	33.03	185	33.39	74	13.35	34	6.13

Table 3: Physical exercise based on type of profession

	NEVER	ALMOST NEVER	SOMETIMES	OFTEN	VERY OFTEN
ADMINISTRATION	25.87%	11.18%	21.67%	19.58%	21.67%
POLICE	20.26%	18.95%	25.49%	15.03%	20.26%
EMERGENCY POLICE	8.64%	13.58%	18.51%	18.51%	40.74%
HEALTH CARE	32.50%	12.50%	32.50%	5.00%	17.50%
WOOD AND TEXTILE IND.	27.07%	16.47%	21.17%	23.52%	11.76%
PRIVATE SECTOR	17.30%	15.38%	25,00%	30.76%	11.53%

In table 3 it is visible that emergency police is the most active group (59.25%), which is to be expected due to their line of work demanding high levels of physical readiness. People working in administration show higher engagement in exercise (41.25%) than police (35.29%), wood or textile industry workers (35.28%). Health care workers show the least amount of participation in exercise which is concerning since their profession is supposed to promote healthy lifestyle. The level of percieved stress is calculated through the sum of scores. Higher score means higher level of stress. In graph 1. it is visible that workers in wood and textile industry experience the highest level of stress (18.14). Equal levels of stress experience workers in police, health care and private sector while the workers in emergency police (14.67) and administration (16.51) experience the least amounts of stress.



Graph 1: Levels of stress based on type of profession 1 – ARITHMETIC MEAN; 2 – ADMINISTRATION; 3 – POLICE; 4 – EMERGENCY POLICE; 5 – HEALTH CARE; 6 – WOOD AND TEXTILE INDUSTRY; 7 – PRIVATE SECTOR

Multiple regressional analysis shows a statistically sigificant difference in percieved stress.

(N= 554, R =,42361105 F = 19,93718; R2=,17944632, df =6,547; R2=,17044573; p = 0,000000)

Variables that contribute mostly to this difference are gender (b*=,134), educational status (b*=,05), self-assessment of health (b*=,26) and physical exercise (b*=-,20). In this research, women showcase a higher amount of stress, which is in accordance with other researches conducted in different countries (Abdollahi at al. 2014.; Nordin, 2013; Barbosa-Leiker at al. 2013.; Lasage at al. 2012). Based on certain researches female workers are not exposed to higher amounts of stress at the work place per se, but their stress levels are increased due to higher obligations outside of work (Klein at al. 2016). Exposure to stress in terms of gender shows that women tend to feel more emotionally drained while men feel depersonalized (Purvanova and Muros, 2010). Other researches show that age matters as well and that younger participants show a higher level of stress compared to older participants (Choen and Janicki-Deverts, 2012.; Leung at al. 2010). In our research age hasn't shown a statistically significant difference in the perception of stress. Correlations between stress and educational status and health are negatively connected, meaning that people of lower educational statuses reported higher levels of stress. People who reported higher number of health issues were more exposed to stress.

Multiple regressional analysis shows a significant difference in physical exercise. Variables that contribute the most to differentiation are amounts of stress, gender and perception of health. Those that stated poorer health condition and those that showed higher amounts of percieved stress were less physically active. Looking at differences in terms of gender, women participated less in physical exercise than men which is in accordance with most researches that showcase the lack of physical exercise in adult age (Holton at al. 2016; Martins, and Lopes, 2013).

Table 4: Display of correlations between stress and other variables

Variable 1	Variable 2	Correlations
STRESS	GENDER	0,172883
STRESS	EDUCATION	-0,088008
STRESS	HEALTH	-0,322269
STRESS	PHYSICAL EXERCISE	-0,309741
GENDER	PHYCICAL EXERCISE	-0,168931
HEALTH	PHYSICAL EHERCISE	0,308740

Conclusion

The scale of percieved stress is used as a measure around the world and is used on different samples. This research shows that there is a connection between perception of stress and physical exercise and the level of health. It is also visible that the amount of percieved stress has an impact on the overall functioning of a person at work and outside of it, impacting a person's quality of life and their well-being. It is neccessary to conduct more researches that examine stress levels. Multidisciplinary and longitudinal researches related specifically to the perception of health, perception of stress and the level of physical exercise as a mediator that lessens mental and physical ailments and contributes to maintenance of work abilities, a better well-being of an individual and overall quality of life are missing.

References

1. Abdollahi,A., Abu Talib, M., Yaacob,N., Ismail,Z. (2014). Hardiness as a mediator between perceived stress and happinessin nurse. *Journal of Psychiatric and mental Health Nursing*. 21:789-796.
2. Barbosa-Leiker, C., Kostick,M., lei,M., McPherson,S., Roper,V., Hoekstra,T. at al. (2013). Measurement invariance of the perceived stress scale and latent mean differences across gender ant time. Stress health. 29(3) 253-160.
3. Choen,S., Janicki-Deverts,D. (2012). Who`s stressed? Distributions of psychological stress in the United States in probability sampels from 1983, 2006 and 2009. J Appl Soc Psychol. 42(6): 1320-1334.
4. Cohen,S., Williamson,G.M. (1988). Perceived stress in a probability sample in the United States. *The social psychology of health*.31-67.
5. Cooper, C. L. i Marshal., J. (2013). Occupational sources of stress: A rewiev of the literature relating to coronary heart disease and mental ill health. U: C. D. Cooper (Ur.), From stress to wellbeing (str. 3-23). England: Palgrave Macmillan
6. Gayman, M.D., Brown, R.L:, Cui,M. (2011). Depressive symptoms and bodily pain: The role of physical disability and social stress. *Stress and Health*. 27(1):52-63.
7. Heber, E., Ebert,D., Lehr, D., Nobis, S., Berking,M., Ripper, H. (2013). Efficacy and cost-effectiveness of a web-based and mobile stress-management intervention for employees: design of a rendomized controlled trial. *BMC Public Health*, 13:655-664.
8. Holten,K.M., Barry,A.E., Chaney,D.J. (2016). Employee stress management: An examination of adaptive and maladaptive coping strategies on employee health. *Work* .53: 299-305
9. Klein,E.M., Brahler,E., Dreier,M., Reinecke,L., Muller,K.W., Schmutzer,G., Wolfling,K.,Beutel,M. (2016). The German version of the perceived stress scale- psychometric characteristics in a representative German community sample. *BMC Psychiatry* 16:159.
10. Lasage,F.X., Berjot,S., Deschamps,F. (2012). Psychometric properties of the French version of the Perceived Stress Scale. *Int J Occup Med Environ Health*. 25(2):178-184.
11. Leung, D.Y., Lam,T., Chan, S. (2010). Three version of Perceived stress scale: Validation in a semple of Chinese cardic patients who smoke. *BMC Public Health*, 10:513.
12. Martins , L.C. and Lopes, C.S. (2013). Rank, job stress, psychological distress and physical activity among military personnel. *BMC Public Health*,13:716-726
13. Nielsen, N.R., Kristensen, T.S., Schnohr,P., Gronbaek, M. (2008). Perceived stress and cause-specific mortality among man and women: result from a prospective cohort study. Am J Epidemiol. 168(5):481-491.
14. Nordin,M., Nordin, S. (2013). Psychometric evaluation and normative dana of the Swedish version of the 10-item perceived stress scale. *Scand J Psychol*. 54(6):502-507.
15. Purvanova,R.K., Muros,J.P. (2010). Gender differences in burnout: a meta-analysis. *J Vocat Behav*. 77(2):168-185.
16. Sonnentag, S. (2012). Psychological detachment from work during leisure time: The benefits of mentally disengaging from work. Current Directions in Psychological Science, 3, 114-118.
17. Sonnentag, S. i Fritz, C. (2007). The recovery experience questionnaire: development and validation of a measure for assessing recuperation and unwinding from work. Journal of Occupational Health Psychology, 12, 204-221.
18. Weigner,L., Hange,D., Bjorkelund,C., Ahloborg,G. (2015). Prevalence of perceived stress and associations to symptoms of exhaustion, depresion and anxiety in a working age population seeking primary care-an observation study. *BMC Fam Pract:* 16(1):38.

WEIGHT CONTROL BEHAVIORS AMONG CROATIAN UNIVERSITY STUDENTS

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Abstract

Results of studies that have been provided on the university student population have determined a great presence of unhealthy living habits. The aim of this study is to determine the presence of certain risk behaviours in weight control in the university student population and to investigate the differences regarding gender and age. The sample includes male students (219) and female students (585) of the University of Zagreb, between 19 and 27 years of age. We have used shortened, anonymous 16 - items questionnaire related to the problems of obesity in early life, attitude towards keeping a diet, possible ways of maintaining a desirable body weight and body shape, and overeating at one meal. The results have been analyzed by the analysis of proportions and logistic regression analyses. The results indicate the presence of multiple compensatory behaviours in maintaining body weight, such as: skipping meals, after meal vomiting, laxative use, and starvation. The results showed increasing incidence of taking large quantities of food at one meal, especially in female students. There was a statistically significant difference by gender. The authors have concluded that this problem should be given a more scientific attention in order to obtain a comprehensive view into the problem and on the basis of scientific knowledge suggested educational and preventive programs.

Key words: *eating behaviour, weight control, university student, health, diet*

Introduction

We can consider eating disorders as health risks and dangerous behavior disorders. They are the result of action of numbers of factors such as: emotional disorders, personality disorders, family pressures, and possible genetic and biological predisposition, socio-cultural environment in which there is an abundance of food and obsession with the idea of thinness (Curkovic, 2010). Various methods of weight loss are the most used in the adolescent and young adulthood population. Besides the moderate methods (reduced calorie intake, increased physical activity) the university student population also shows the restrictive methods (taking diet pills, starvation, deliberate vomiting after meals, etc.), that can lead young people to the risk of developing pathological eating disorders (Abebe et al., 2012, Stice et al., 2013, Jones et al., 2014).

In terms of socio-cultural aspects, research shows that from 8.5% to 35% of the female student population shows symptoms of the disorder and they fall to the risk of developing some form of eating disorder. Many factors influence the development of malnutrition and leads to two most widespread clinical forms such as anorexia nervosa and bulimia nervosa.

One of the factors that has a significant influence on the occurrence of risks is dissatisfaction appearance is called the "the cult of thinness" in the Western civilization (Argyrides and Keli, 2015). In addition, a number of called compensatory behaviors such as: taking laxatives, deliberate vomiting, and excessive exercise with the primary intention of changing the shape of the body and /or weight loss are often in focus of researching eating disorders. Research shows that this kind of behavior is consistently associated with symptoms of psychopathology and development of disorders (Schaumberg et al., 2014). According to Eenie et. al. (2013) eating disorders and body dissatisfaction is significantly widespread in the student population, especially among female students.

The aim of this study is to determine the presence of certain risk behaviors in weight control of the student population in Croatia and to investigate whether there is a statistically significant difference regarding gender and age.

Methods

The study was conducted on 804 students (585 female and 219 male) coming from all regions in Croatia and who are studying at the University of Zagreb, between 18 and 27 years of age.

For the purposes of this study we have used a shortened version of 16 – items questionnaire (Ćurković, 2010) related to the problems of being overweight during childhood and the relationship with diet, ways to maintain a desirable body weight and body shape and overeating at one meal. Analysis of the results were obtained with analysis of the proportions and multivariate data processing methods.

Results

The participants in this study were mostly undergraduate students (85.6%) and 14.4% of the participants were graduate students. According to age, most students at the age of twenty (25.9%), followed by those of the age of nineteen (24.1%) and twenty-one (23.7%).

Analysis of indicators related to the maintenance of body weight and the development of possible risks shows that 20.5% of students had difficulties in one period of their childhood, and that 17.9% still have problems with body mass.

Table 1: Problems with body mass during adulthood
Have you had excess weight in earlier years?

1.	2.	3.	4.	5.
Never	Untill 9 year old	Between 10. i 13.	Between 14. i 18.	I still have
61,5%	4,4%	7,8%	8,3%	17,9%

How would you describe your relationship with your diet?

1.	2.	3.	4.	5.
I never been on a diet	Earlier I was trying but not now	Occasionally I'm on a diet	I am often on a diet	Very often I was on a strict diet
63,6%	14,5%	18,5%	3,0%	0,3%

Although the majority of students (63.6%) responded that they had never practiced a diet, it is evident that those who are doing it, present unhealthy maintenance of body weight (starve themselves 7.8%; skipping meals 12%; deliberately vomit after meals 3.3%, taking laxatives or teas for cleaning 3.0%, etc.) (Table 2).

Table 2: Way of to maintain weight

If you have been ever before, or you are now on a diet, your body weight maintain as follows: (Please mark each true statement)	%
I use a diet recommended by doctor	3,4%
I do not eat bread	19,4%
I do not eat dinner	15,7%
I avoid late dinner	31,1%
I count calories	7,2%
I do not mix carbohydrates and proteins	9,2%
I do not eat – I am starving	7,8%
I eat more vegetables and fruit	30,2%
Deliberately throwing up after meals	3,3%
I'm careful with how much I eat at every meal	20,2%
Skipping meals	12,0%
I eat normally and moderately deal with sports activities	24,2%
I take laxatives or teas for detoxification	3,0%

According to the results shown in Table 3, half of the students, in this study, have occasionally had the need to enter large amounts of food in one meal. The large amounts of food in one meal have had often and very often been anwsered by 8.3% of students.

Table 3: Do you have "attacks" of taking large amounts of food (binge eating) in one portion and the need to overeat?

1.	2.	3.	4.
never	occasionally	often	very often
42,0	49,5	7,1	1,3

Analysis of the results of the question: How to maintain body weight? showed that the highest percentage of female students avoids dinner (23.5%) and takes more fruits and vegetables (22.65%) in their diet. Male students report that they exercise (8.12%) and avoid dinner and take more fruits and vegetables (7.57%). It is interesting that a small number of male students (0.91%) and female students (2.48%) talks with the doctor how to maintain their body weight.

Part of the studied population (particularly female students) have used restrictive measures to maintain body weight such as: skip meals (9.02%), vomiting after meal (2.73%) and taking laxatives and other cleaning products (2.24%). In addition to the results of the ways to maintain body weight, the main concern are the student needs to enter large amounts of food at one meal or overeating (Table 4) which at times appears in nearly 32.7% male and 25.58% female students.

Table 4: Do you need to enter large amounts of food in one meal?

		NEVER	OCCASIONALLY	OFTEN	VERY OFTEN
"**BINGE EATING**"	Male	19,56	21,38	3,21	0,97
	Female	22,47	28,16	3,88	0,66

For the variable related to the ways to maintain body weight according to the gender the results of logistic regression analysis showed that the tested model is statistically significant ($\chi2$ (8, N = 804) = 37.321, p <0.01; -2LL = 965.679). The contribution of individual predictors can be seen in Table 5.

Table 5: Analysis of the link between gender differences and maintaining body weight estimated by logistic regression analysis

		B	St. Err..	Wald	df	p	OR
Model 1[a]	I use a diet recommended by doctor	,019	,327	,004	1	,953	1,020
	I do not eat dinner	-,564	,186	9,200	1	,002	,569
	I count calories	-,272	,256	1,128	1	,288	,762
	I do not mix carbohydrates and proteins	-,837	,235	12,733	1	,000	,433
	I am starving	,306	,250	1,494	1	,222	1,358
	Deliberately throwing up after meals	-,603	,389	2,404	1	,121	,547
	Skipping meals	-,273	,217	1,587	1	,208	,761
	I take laxatives	-,020	,361	,003	1	,955	,980
	Constant	1,856	,657	7,987	1	,005	6,401

a. Predictors: I use a diet recommended by doctor, I do not eat dinner, I count calories, I do not mix carbohydrates and proteins, I am starving, Deliberately throwing up after meals, Skipping meals I take laxatives.

Correlations between predictors and criteria showed that female students use methods of maintaining weight more than male students. According to the β weights, significantly more female students take into the account not mixing carbohydrates and proteins (B = 837, Wald = 12.733, SD = 433, p <0.01). A greater number of female students than male students does not eat dinner (B = 564, Wald = 9.200, OR = 569, p <0.01). Other variables have statistically significant independent contribution to the creation of differences in methods of maintaining body weight observed by gender.

The study does not obtain statistically significant relationship between predictor age expressed in years of life and ways of maintaining body weight.

Discussion

The results of this study are consistent with the previous study results that have been provided on the university student population. All studies have determined the increasing number of risky behaviors that students obtain with the aim to maintain body weight (Arrigo et al., 2014; Schaumberg et al., 2014).

In this study, the authors have found that 25.9% of the sample had a problem with being overweight when they were in a period of growing up and 18% of them are still there. Some compensatory behaviors that are most frequent in this sample with the purpose to maintain the body weight are the following: starvation (7.8%), skipping meals (12%), intentional vomiting (3.3%) and taking laxatives and other preparations for cleaning the body (3%). The studies have shown the link between the presence of more compensatory behaviors in one person (taking laxatives, subjective bulimia episodes of binge eating, vomiting after meals etc.), this behavior puts the person in a high risk group for the development of disturbances in eating and psychological dysfunction (Abebe et al., 2012). The students of the University of Zagreb who have participated in this study tend to take a large amount of food at one meal (binge eating) while almost half of them occasionally resort to this type of feeding. The female students are in higher risk than male students because they are experimenting with different compensatory behaviors in an attempt to achieve ideal body weight. Research suggests that the deliberate vomiting has connected to the development of serious disturbances in eating (Schaumberg et al., 2014).

In conclusion, we can say that we have found more compensatory behaviors that lead students to the risk of developing disorders in feeding. The female students are much more vulnerable in comparison to their male colleagues. It is necessary to carry out several different studies that include socio-cultural, family and individual factors that may be connected to the development of disorders in the nutrition of student population and to be based on scientific knowledge that it is possible to create a preventive guidance to solve the problem.

References

1. Abebe, D.S., Lein, L., Torgersen, L., Von Soest, T. (2012). Being eating, purging, and non-purging compensatory behaviours decrease from adolescence to adulthood: a population- based, longitudinal study. *BMC Public Health*.12-32
2. Ambwani, S., Roche, M., Minnick, A., Pincus, A. (2015). Negative effect, international perception and bing eating behavior. An experiance sampling study. *Int J Eat Disord,* 48:715-726.
3. Arigo, D., Schmacher, L., Martin, L. (2014). Upward appearance comparison and development of eating patology in college women. *Int J Eat Disord*. 47:467-470.
4. Argyrides, M. and Kkeli, N. (2015). Predictive factors of disordered eating and body image satisfaction in Cyprus. *Int J Eat Disord 48: 431-435*.
5. Ćurković, S. (2010). Kineziološke aktivnosti i rizična ponašanja studenata. Doktorski rad. 2010. Kineziološki fakultet Sveučilišta u Zagrebu.
6. Jones, M., Kass, A.E., Trockel, M., Glass, AI., Wilfley, D.E., Taylor, CB. (2014). A population – wide screening and tailored intervention platform for eating disorders on college campuses: the healthy body image program. J Am Coll Health. 62:351-356
7. Stice, E., Rohde, P., Shaw, H., Marti, C.N. (2013). Efficacy trial of a selective prevention program targeting both eating disorders and obesity among female college students:1- and 2-year follow up effects. *J Consult Clin Psychol*. 81:183-189.
8. Zeeni, N., Gharibeh, N., Katsounari, I. (2013). The influence of sociocultural factors on eating attitudes of Lebanese and Cypriot students: A cross-cultural study. *J Hum Nutr Diet*, 26:45-52.

PILOT STUDY OF KNOWLEDGE AND SKILLS OF MANAGERS IN KINESIOLOGICAL RECREATION

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Abstract

Management is, among other things, the ability of the positive impact on other people, directing the activities of these people where they will achieve optimal results. "Brings together the resources - people, new equipment - needed for productive work. Management of design tasks and organizing work." *(Malik, F. 2012).*

Sports Management is considered relatively "young" scientific discipline. The first programs in sports management started introducing programs in higher education institutions in 1970-ies, but very quickly becomes the object of interest of many scientists. Management in sport can be explained as "a process of organization and management of sports and sports organizations in order to achieve sporting and other targets with the rational use of limited resources." *(Bartoluci, M., Škorić, S. 2009).*

The aim of the present study was to determine the main and specific knowledge, skills and traits of managers in kinesiological recreation. "Kinesiological recreation applied scientific discipline in kinesiology, which explicitly defines ways of applying sports and recreational programs in order to improve human health." *(Andrijašević, M. 2010).*

The total sample of twenty-one managers were randomly selected for the purpose of this study. The entire sample of respondents from the Croatian, and most of the participants come from Zagreb and the immediate environment. Almost all respondents work in kinesiology recreation.

Self-administrated questionnaire was given and than analyzed. Differences in proportions were analyzed by using Fisher's exact test. Significance was set up at $p<0.05$. Results showed that the most important abilities for running a firm were ability to organize business (66.7%), expertise (52.4%), inovation abilities (47.6%) and speed of decision making (47.6%). The most important traits that managers had to have were determination (90.5%), enthusiasm (66.7%) and honesty (66.7%). The lowest percentage was given to criticism (14.3%). Our findings suggest that the ability to organize business, expertise in the specific field and speed are the most important factors that managers in kinesiological recreation need to have.

Key words: *kinesiology, managers, skills and expertise*

Introduction

Managers of different skills and abilities differently mark the importance of individual abilities and skills for their business. The most important manager skill is the ability of predict with almost 50%, expertise and the ability to run business (with 46%). Also, both male and female managers agreed that the most important manager skill is the ability to communicate. Specifically, the greatest differences between male and female managers lay in the fact, that the most important skills and expertise in male managers are the ability of team wotk and the ability to motivate employees, while for female managers, the most important specific knowledge and skills are the ability to motivate employees and the ability to carry out changes within the company.

Nowdays, there are lacking of studies investigating specific skills and knowledge in managers running kinesiology recreational centers, as fitness centers. The main aim of the present study was to determine the main and specific knowledge, skills and traits of managers in kinesiological recreation.

Methods

For the purpose of this study, we enrolled twenty-one managers from both genders to participate in the study. All of the invited managers agreed to take part in the study. The inclusion criteria was that each manager runs business that is remotly related to kinesiological recreation and that has more than five employees. For the purpose of this study, we used self-administrated questionnaire specially developed to assess specific skills, expertise, knowledge and traits that managers from kinesiological recreation needed to have. The questionnaire was fulfilled on-line and was sent back to the author. The whole testing procedure (fulfilling the questionnaire) took about 15 minutes. All the procedure was anonymous and was in accordance to Declaration of Helsinki.

Descriptive statistics are presented as frequencies and percentages. Differences between categorical variables are calculared by using Fisher's exact test. All the procedures perfomed in this paper were done in statistical program SPSS ver. 18. Significance was set up at $p<0.05$.

Results

In total, 38% of participants were females and 62% were males. The highest percentage of participants were in the age category between 41-50 years old. Interestingly, around 75% of all participants finished at least 3 years of faculty, while almost 10% of them have PhD. title.

Roughly, 57% of participants stated that science was at medium importance for them in their firms and 33% at high level. Interestingly, only 14.3% of them reported that art was a dominant component for their management. More than 80% of them reported that skills were the most dominant factor influencing their business. Seventy-six percent of all participants stated that their personal abilities at higher level influence on successfulness in management, 52.4% of them perceived the abilities of their employees to have credit for the successfulness and 52.4% of them stated that situation was a medium factor for successfulness of their management ($p<0.05$).

Figure 1. represents the most important abilities, knowledge and skills to become a successful manager. Results showed that 66.7% of participants reported that the ability to organize the business was the most important factor, followed by expertise (52.4%), inovation abilities and speed of decision making (47.6%). Moreover, almost 43% of participant reported attending education presentations inside the firm and 2/3 of them reported attending seminars at the faculties $p<0.05$). Also, 47.6% of all participants have attended special manager programs, special trainings (61.9%), programs in abroad (42.9%) and programs of business simulation (23.8%).

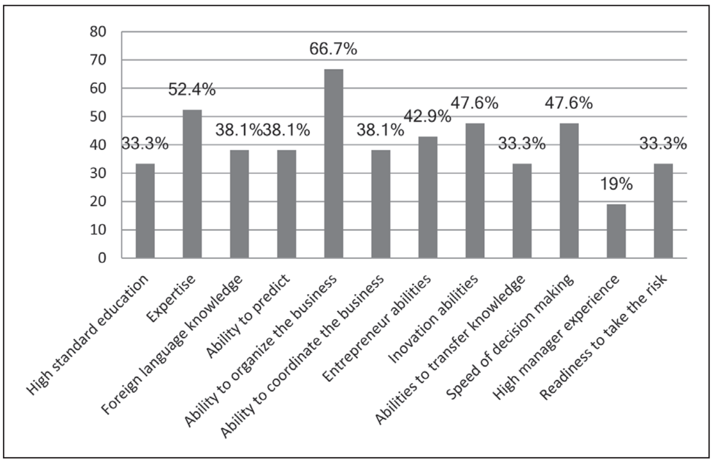

Figure 1: The most important abilities, knowledge and skills to become a successful manager

Figure 2. represents the most important traits of the managers to be successful. Our results showed, that determination (90.5%) was the highest rated trait of the manager, followed by honesty and enthusiasm (66.7%). The lowest percentage of respondents reported that criticism was the least important trait of a manager (14.3%).

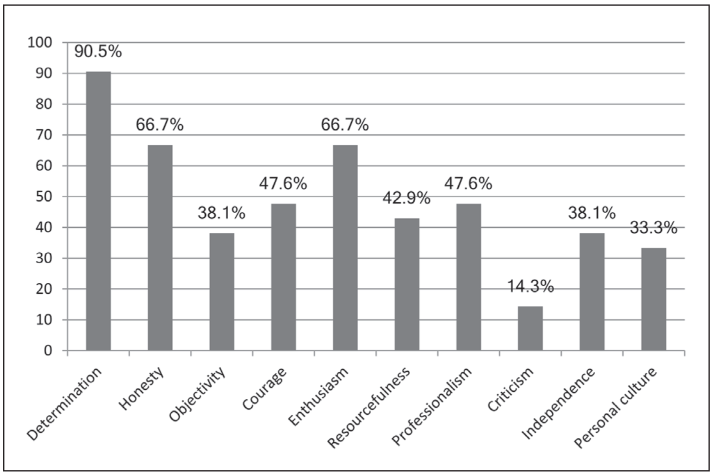

Figure 2: The most important traits that manager has to own

Discussion

The main purpose of the study was to determine determine the main and specific knowledge, skills and traits of managers in kinesiological recreation.

Our results showed that the most important skills and expertise were the ability for running a firm were ability to organize business (66.7%), expertise (52.4%), inovation abilities (47.6%) and speed of decision making (47.6%), which is in accordance to some other studies *(Sikavica, P., Bahtijarević-Šiber, F. 2004).* As mentioned before in the Introduction section, five most important abilities were determination, with almost 80% of importance, followed by honesty with 65%, doing business (62%) and objectivity (58%). The least preferable knowledge and skills are criticism, courage and honesty, which is partially in accordance to our results. To clarify, low positioning of enthusiasm can be explained by the fact that managers do not have special bonus and incentives to be creative and proactive within the firm.

Next, our results showed that being determinated, having the ability to organize business and speed of decision making were the most important characteristics of the managers, which is in accorg+dance to some previous research (referenca). Among the twelve given skills and abilities, five most important abilities were expertise (64%), the ability to organize business (62%), speed of decision making (48%), the ability to coordinate business (48%) and the ability to predict (47%).

Our study has several limitations. First, due to a cross-sectional design, it is possible that some other knowledge, abilities and skills may influence on successful business running, since the economy (especially in kinesiological recreation) is changing with new technologies and methods. Also, due to a small sample size, we cannot apply our results on the other manager businesses in other parts of Croatia. Third, we did not include managers from other industries, like IT technology, where there may be different distribution of important needed abilities and skills important for successful business. Future studies need to be more focused on larger sample size with more specific sport industry and additional information about the size of business (number of employees).

In conslusion, our findings show that the most important skills and expertise are he ability to organize business, expertise, inovation abilities and speed of decision making. On the other hand, the most important traits of managers are determination, followed by enthusiasm and honesty. Special seminars need to be implemented within the process of specialization, to learn and perfect special and the most important abilities to successfully run business in every industry.

References

1. Andrijašević, M. (2010). Kineziološka rekreacija, Sveučilišni udžbenik, Sveučilište u Zagrebu.
2. Bartoluci, M., Škorić, S. (2009). Menadžment u sportu. Zagreb: Odjel za izobrazbu trenera Društvenog veleučilišta u Zagrebu i Kineziološki fakultet.
3. Malik, F. (2012) Führen Leisten Leben. Wirksames Management für eine neue Zeit. Deutsche Verlagsanstalt,
4. Sikavica, P., Bahtijarević-Šiber, F. (2004). Menadžment – Teorija menadžmenta i veliko enpirijsko istraživanje, Zagreb, Masmedija.

“QUIET EYE” TRAINING IN AMATEUR GOLFERS: REVIEW

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Abstract

Although playing golf is associated with improved both physical health and mental well-being, complexity of performing technical elements of the game is one of key factors causing recreational players to drop out. One of the methods that has been proven effective for enhancing motor learning and performance is called “Quiet Eye” (QE) training. The purpose of this paper is to provide review of research that has examined effects of QE training and instructions on gaze behaviour (QE duration) and performance in amateur golfers. A systematic literature search was conducted using the following bibliographic databases: EBSCO, SCOPUS, and Web of Science Core Collection resulting in 249 findings among which 16 published journal articles met the inclusion criteria. All studies included in review showed improvement in QE duration and/or performance after QE training or instructions. Furthermore, QE training improved performance in high-pressure conditions. Finally, practical guidelines for QE training of amateur golfers are suggested.

Introduction

It has been proven that playing golf is associated with improved both physical health and mental well-being (Murray et al., 2017). Since golf is played by 55 million people worldwide (Farrally et al., 2003), it has huge public health potential. Although approximately 3.5 million people join the game every year, due to an equal number of people who quit playing, there was no significant growth of the golf participation over the past years (Farrally et al., 2003; National Golf Fundation, 2015). One of the possible reasons for dropping out is difficulty to master a golf swing, a key element of golf play. It was estimated that reaching reasonable handicap of 10 – 15 requires 5 to 10 thousand practice hours (Brunton, 2007 as citied in Jäncke, Koeneke, Hoppe, Rominger, & Hänggi, 2009). In order to help people acquire necessary skills, numerous methods of golf teaching were developed. Studies have shown that, among factors which influence motor skill learning, focus of attention plays a very important role (Wulf & Su, 2007). Although, traditionally golf instructions are focused on body movements (internal focus of attention), research on focus of attention has consistently demonstrated greater benefits of external focus of attention (i.e. movement effect) for motor performance and learning (Wulf, 2013).

“Quiet eye” (QE) is defined as “the final fixation or tracking gaze that is located on a specific location or object in the task space within 3° of visual angle (or less) for a minimum of 100 ms’ (Vickers, 2016). In other words, QE is the duration of the final fixation towards a relevant target prior to the execution of the critical phase of movement (Vine & Wilson, 2010). It is considered that QE period can provide external focus of attention and it has been proven to benefit motor performance (Rienhoff, Tirp, Strauß, Baker, & Schorer, 2016). QE is a concept introduced in 1992 by Vickers and has been used in golf studies training efficacy, performance, and anxiety reduction (Vine et al., 2012). Numerous research studies of QE in golf setting have been conducted in past 25 years. Therefore, the purpose of this paper is to provide review of research that has examined effects of QE training and instructions on gaze behaviour (QE duration) and performance in amateur golfers.

Methods

A systematic literature search was conducted using the following bibliographic databases: EBSCO (Academic Search Complete, SocINDEX with Full Text, CINAHL with Full Text, ERIC, Health Source: Nursing/Academic Edition, MasterFILE Premier, MEDLINE, SocINDEX with Full Text, SportDiscus with Full Text), SCOPUS, and Web od Science Core Collection (Conference Proceedings Citation Index, Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, Index Chemicus, Current Chemical Reactions, Book Citation Index). The database search was carried out on 13 April 2017 using the following syntax: golf and “Quiet Eye”. Only the studies meeting the following criteria were included in the review: presence of pre and post measurement of QE duration, presence of intervention description (QE training or instructions) or changed environment with aim to influence QE behaviour, study sample encompassed amateur golfers or beginners with no golf experience.

Results and Discussion

The database search produced a total of 249 findings, among which 16 met the inclusion criteria (Table 1).

Table 1: The number of articles published up to April 2017 identified through electronic searches of EBSCO, SCOPUS, and Web of Science†*

Indexing database	No. of findings
EBSCO*	116
SCOPUS	114
WEB OF SCIENCE (WOS)†	19
TOTAL	249
No. of articles selected for review	16

*Academic Search Complete, SocINDEX with Full Text, CINAHL with Full Text, ERIC, Health Source: Nursing/Academic Edition, MasterFILE Premier, MEDLINE, SocINDEX with Full Text, SportDiscus with Full Text

†Conference Proceedings Citation Index, Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, Index Chemicus, Current Chemical Reactions, Book Citation Index

The summarized results of QE in golf studies are presented in Table 2. The sample size in presented studies ranged from 1 to 127 participants. Nine studies were conducted on novice golf players or university students with minimal or no golf experience and 7 on amateur golf players (handicap ranged between 1 and 41). Most of the studies dealt with putting performance (15 out of 16) and several general conclusions can be drawn based on their findings: a) longer "Quiet eye" period was related with more successful putting performance; b) the longer gaze time for specific area (in front, behind or at the hole), the more chance for ball landing in that area; c) QE training produced significant improvements in putting performance (radial error and number of holed putts), increase in QE duration (more effective gaze control), and improvement in kinematics; d) QE training helped in dealing with pressure; e) illusions and mental training can improve QE duration and putting performance. Only one study (Bishop, Addington, & D'Innocenzo, 2017) researched relation between gaze behaviour and full swing consistency and concluded that visually guided learning protocol can improve consistency of gaze behaviour and performance (accuracy and consistency of golf strokes).

Table 2: Summary results of studies on "Quiet Eye" (QE) in golf

Study	Sample	Procedure	Results and conclusion
(Binsch, Oudejans, Bakker, & Savelsbergh, 2009)	27 undergraduate students (14 women) with no golf experience	Golf putts performed under 3 types of instructions where to land the ball (on the hole, avoid too long putts and avoid too short putts)	The longer gaze time for specific area (in front, behind or at the hole), the more chance for ball landing in that area. Negative instruction can affect gaze behaviour and aiming action leading to over-compensation or ironic effect.
(Bishop et al., 2017)	One male student, experienced golfer (handicap 4)	Verbal feedback after execution of each full swing with the goal of maintaining gaze consistency (visually guided learning protocol)	Visual guidance protocol improved accuracy and consistency of gaze behaviour, which in consequence resulted in more accurate and consistent shots.
(Fulton, Ertz, Rohler, Fontana, & Mack, 2014)	8 division-I collegiate golfers	50 golf putts performed in a low and 50 golf putts performed in a high-pressure condition	Longer "Quiet eye" period was related with more successful putting performance. Elongated "Quiet eye" period hypothesized to represent coping mechanism to distraction.
(Klostermann, Kredel, & Hossner, 2014)	12 expert golfers (handicap M=6) and 12 near-expert golfers (handicap M=25.6)	16 putts performed with under two different focus-of-attention conditions: movement-related focus and effect-related focus	Better performance recorded under effect-related conditions; expert golfer had longer QE duration compared to near-experts; longer QE duration is beneficial for experts' performance; long QE duration is important for movement preparation and execution.
(Causer, Hayes, Hooper, & Bennett, 2017)	21 undergraduate students (14 female) with no golf experience	80 golf putts performed to two distances (1.83 m and 3.35 m) in full vision condition and occluded vision	Higher radial error (distance of the ball from the hole at finish) and longer QE in occluded than in full vision condition.

(Frank, Land, & Schack, 2016)	45 university students (27 female) with no golf experience assigned to one of 3 groups: Combined mental and physical practice, Physical practice, and No practice	3 days training of golf putting (repeatedly executing the putts or together executing and imagining putts)	Both experimental groups increased their putting performance. Group that combined mental and physical training revealed longer QE duration than control group (it was not the case for group with physical practice only).
(Moore, Vine, Cooke, Ring, & Wilson, 2012)	40 undergraduate students with no golf experience assigned to one of 2 groups: QE training or Technical training	420 puts (baseline, training, retention, and pressure putts) performed during 7 days (5 sessions)	Compared to Technical training group, the QE group showed higher improvement in putting performance (radial error and number of holed putts), higher increase in QE duration (more effective gaze control), lower clubhead acceleration, greater heart rate deceleration, and reduced muscle activity.
(Moore, Vine, Freeman, & Wilson, 2013)	30 undergraduate students with no golf experience assigned to one of 2 groups: QE training or Technical training	420 puts (baseline, training, retention, and pressure putts) performed during 7 days (5 sessions)	Compared to Technical training (during the pressure test), the QE group showed longer QE duration, greater perceived coping resources, and perceived pressure more as challenge than as a treat.
(Moore, Vine, Wilson, & Freeman, 2012)	127 undergraduate students (63 female) with no golf experience randomly assigned to one of 2 experimental groups: Challenge and Treat group	6 putts performed to 3.28 m distance	Compared to Treat group, Challenge group showed higher accuracy (lower mean radial error), reported more favourable emotions, significantly longer QE duration, more consistent putting kinematics and less muscle activity.
(Moore, Wilson, Vine, Coussens, & Freeman, 2013)	60 experienced golfers (4 female) (handicap M=10.2) randomly assigned to one of 2 experimental groups: Challenge and Treat group	6 putts performed to 3.28 m distance	Compared to Treat group, Challenge group experienced significantly less anxiety, had more facilitative interpretations of anxiety, reported less conscious processing, and displayed longer QE durations.
(Panchuk, Farrow, & Meyer, 2014)	29 amateur golfers (handicap range 1-41) randomly assigned to one of 4 groups: Control, Hole-focus, Ball marker, and “Putting box of science” group	10 putts performed to 1.83 m distance (after 30 practice putts under group-specific instruction)	The QE duration did not change in Control and “Putting box of science” group, decreased in Hole-focused group and increased in Ball marker group.
(Vine, Lee, Walters-Symons, & Wilson, 2017)	27 golfers with average handicap 5.8	6 putts performed in each of three, counterbalanced, occlusion conditions: no occlusion, early occlusion, and late occlusion	Compared to control (no occlusion), only late visual occlusion had a significant detrimental effect on performance and kinematics measures. Early visual occlusion did not significantly undermine neither performance nor kinematics indicating that visual information during movement execution is critical in golf putting.
(Vine, Moore, Cooke, Ring, & Wilson, 2013)	45 undergraduate students with no golf experience randomly assigned to one of 3 experimental groups: QE, Analogy training, and Explicit-learning group	40 baseline and 320 acquisition putts performed during 7 days (5 sessions)	Compared to Analogy group, the QE showed lower radial error at Retention. The QE group showed lower radial error than both other groups at Pressure test. The QE group showed longer QE duration than both other groups at both Retention and Pressure test. Compared to Explicit group, the QE-group and the Analogy group reported fewer explicit rules and less conscious processing.
(Vine, Moore, & Wilson, 2011)	22 elite male golfers (handicap M=2.7) randomly assigned to Experimental (QE-training group) and Control group	20 putts performed in retention task and 15 in pressure test; putting statistics recorded on 10 rounds of golf before and after intervention; Training included video feedback of gaze behaviour (both groups) with additional instructions for maintaining QE period (Experimental group only)	Significantly lower average performance (left ball closer to the hole) error determined in Experimental than in Control group on retention test. Experimental group showed better performance (holed more putts and left the ball closer to the hole) and longer QE duration than Control group in the pressure test. The Experimental group made significantly fewer putts per round than the Control group (26.7 vs. 29.9).
(Vine & Wilson, 2010)	14 undergraduate male students with little or no golf experience randomly assigned to Experimental (QE-training group) and Control group	320 acquisition and 120 test putts performed in retention and pressure test	Compared to Control group, Experimental group maintained more effective attentional control and performed significantly better in the pressure test.
(Wood, Vine, & Wilson, 2013)	40 novice golfers (10 females) with minimal formal golf experience	Ebbinghaus illusion putting task was performed at 1.75 m	Illusions can affect duration of QE, perceptually bigger holes promote longer QE duration and putting performance.

There are at least three possible mechanisms through which QE influences golf performance: a) the longer QE duration the more information about targets is gathered which help in executing successful stroke; b) steady focus on the ball can help reduce different kind of visual distractions; c) QE may provide "external focus of attention" which can prevent golfer from focusing on internal or external distracters or negative thoughts (Vine et al., 2011).

In conclusion, all studies included in review showed improvement in QE duration and/or performance after QE training or instructions. Furthermore, QE training improved performance in high-pressure conditions. Since QE training can affect motor learning in amateur golfers with different playing experience (beginner to elite golfers), it is highly recommended training method for all recreational golf players. Instructions for effective QE training, based on review results, for golf amateurs are presented below:

1. QE training combined with negative instructions should be avoided (e.g. do not leave ball short to the hole). Promotional focus is recommended (e.g. hole the ball).
2. Physical training should be combined with mental training (i.e. imagining strokes).
3. QE training should have priority compared to technical training in beginners.
4. When putting, amateur golfers should use marker on the balls.
5. QE training combined with challenge-focused instruction should be promoted (e.g. instructions focused on participants perceiving the task as a challenge to be met and overcome, thinking of themselves as capable of meeting that challenge, and emphasized that previous participants had performed well on the task).
6. QE training combined with threat-focused instruction should be avoided (e.g. instructions focused on the task's high degree of difficulty and emphasized that previous participants had difficulty performing the task).
7. Video feedback of gaze behaviour should be part of QE training.
8. Illusions which influence perception of the holes size in a way that hole is perceived to be bigger should be used in QE training.

Literature

1. Binsch, O., Oudejans, R. R. D., Bakker, F. C., & Savelsbergh, G. J. P. (2009). Unwanted effects in aiming actions: The relationship between gaze behavior and performance in a golf putting task. *Psychology of Sport and Exercise, 10*(6), 628-635. doi: 10.1016/j.psychsport.2009.05.005
2. Bishop, D. T., Addington, N., & D'Innocenzo, G. (2017). Using visual guidance to retrain an experienced golfer's gaze: A case study. *European Journal of Sport Science, 17*(2), 160-167. doi: 10.1080/17461391.2016.1216169
3. Brunton, Henry. (2007). The Development of Expertise for Elite Competitive Golfers and the Related Probability of Advancing to the PGA Tour–Key Information for Athletes, Parents, Coaches, Golf Professionals and Administrators. Retrieved from PGA of Canada website: http://cpga.com/UserFiles/CPGAMastersPaper-FINALEDITED-REVISED%20NOV(1).pdf
4. Causer, J., Hayes, S. J., Hooper, J. M., & Bennett, S. J. (2017). Quiet eye facilitates sensorimotor preprograming and online control of precision aiming in golf putting. *Cognitive Processing, 18*(1), 47-54. doi: 10.1007/s10339-016-0783-4
5. Farrally, M. R., Cochran, A. J., Crews, D. J., Hurdzan, M. J., Price, R. J., Snow, J. T., & Thomas, P. R. (2003). Golf science research at the beginning of the twenty-first century. *Journal of Sports Sciences, 21*(9), 753.
6. Frank, C., Land, W. M., & Schack, T. (2016). Perceptual-cognitive changes during motor learning: The influence of mental and physical practice on mental representation, gaze behavior, and performance of a complex action. *Frontiers in Psychology, 6*(JAN). doi: 10.3389/fpsyg.2015.01981
7. Fulton, Timothy, Ertz, Josiah, Rohler, Abraham, Fontana, Fabio, & Mack, Mickey. (2014). The Effects of a Visual Distraction on Quiet Eye Duration and Putting Performance of Collegiate Golfers. *International Journal of Golf Science, 3*(1), 26-34.
8. National Golf Fundation. (2015). 2015 Golf Participation in the U.S. – A Slight Dip Tempered by Strong Positive Indicators. from http://ngfdashboard.clubnewsmaker.org/Newsletter/1ll1udoge19?a=5&p=2389923&t=410871
9. Jäncke, Lutz, Koeneke, Susan, Hoppe, Ariana, Rominger, Christina, & Hänggi, Jürgen. (2009). The Architecture of the Golfer's Brain. *PLoS ONE, 4*(3), e4785. doi: 10.1371/journal.pone.0004785
10. Klostermann, André, Kredel, Ralf, & Hossner, Ernst-Joachim. (2014). On the Interaction of Attentional Focus and Gaze: The Quiet Eye Inhibits Focus-Related Performance Decrements. *Journal of Sport & Exercise Psychology, 36*(4), 392-400.
11. Moore, L. J., Vine, S. J., Cooke, A., Ring, C., & Wilson, M. R. (2012). Quiet eye training expedites motor learning and aids performance under heightened anxiety: The roles of response programming and external attention. *Psychophysiology, 49*(7), 1005-1015. doi: 10.1111/j.1469-8986.2012.01379.x
12. Moore, L. J., Vine, S. J., Freeman, P., & Wilson, M. R. (2013). Quiet eye training promotes challenge appraisals and aids performance under elevated anxiety. *International Journal of Sport and Exercise Psychology, 11*(2), 169-183. doi: 10.1080/1612197X.2013.773688
13. Moore, L. J., Vine, S. J., Wilson, M. R., & Freeman, P. (2012). The effect of challenge and threat states on performance: An examination of potential mechanisms. *Psychophysiology, 49*(10), 1417-1425. doi: 10.1111/j.1469-8986.2012.01449.x
14. Moore, L. J., Wilson, M. R., Vine, S. J., Coussens, A. H., & Freeman, P. (2013). Champ or chump?: Challenge and threat states during pressurized competition. *Journal of Sport and Exercise Psychology, 35*(6), 551-562.

15. Murray, A D, Daines, L, Archibald, D, Hawkes, R A, Schiphorst, C, Kelly, P, . . . Mutrie, N. (2017). The relationships between golf and health: a scoping review. *British Journal of Sports Medicine, 51*(1), 12-19. doi: 10.1136/bjsports-2016-096625
16. Panchuk, D., Farrow, D., & Meyer, T. (2014). How can novel task constraints be used to induce acute changes in gaze behaviour? *Journal of Sports Sciences, 32*(12), 1196-1201. doi: 10.1080/02640414.2013.876089
17. Rienhoff, R., Tirp, J., Strauß, B., Baker, J., & Schorer, J. (2016). The 'Quiet Eye' and Motor Performance: A Systematic Review Based on Newell's Constraints-Led Model. *Sports Medicine, 46*(4), 589-603. doi: 10.1007/s40279-015-0442-4
18. Vickers, J. N. (2016). Origins and current issues in Quiet Eye research. *Current Issues in Sport Science, 1*, 11. doi: 10.15203/CISS_2016.101
19. Vine, S. J., Lee, D. H., Walters-Symons, R., & Wilson, M. R. (2017). An occlusion paradigm to assess the importance of the timing of the quiet eye fixation. *European Journal of Sport Science, 17*(1), 85-92. doi: 10.1080/17461391.2015.1073363
20. Vine, S. J., Moore, L. J., Cooke, A., Ring, C., & Wilson, M. R. (2013). Quiet eye training: A means to implicit motor learning. *International Journal of Sport Psychology, 44*(4), 367-386. doi: 10.7352/Ijsp2013.44.367
21. Vine, S. J., Moore, L. J., & Wilson, M. R. (2011). Quiet eye training facilitates competitive putting performance in elite golfers. *Frontiers in Psychology, 2*. doi: ARTN 10.3389/fpsyg.2011.00008
22. Vine, S. J., & Wilson, M. R. (2010). Quiet Eye Training: Effects on Learning and Performance Under Pressure. *Journal of Applied Sport Psychology, 22*(4), 361-376. doi: Pii 92946296110.1080/10413200.2010.495106
23. Wood, G., Vine, S. J., & Wilson, M. R. (2013). The impact of visual illusions on perception, action planning, and motor performance. *Attention Perception & Psychophysics, 75*(5), 830-834. doi: 10.3758/s13414-013-0489-y
24. Wulf, G. (2013). Attentional focus and motor learning: a review of 15 years. *International Review of Sport and Exercise Psychology, 6*(1), 77-104. doi: 10.1080/1750984X.2012.723728
25. Wulf, G., & Su, J. (2007). An external focus of attention enhances golf shot accuracy in beginners and experts. *Res Q Exerc Sport, 78*(4), 384-389. doi: 10.1080/02701367.2007.10599436

A SIX-MONTH PROGRAM OF COMBINED TRAINING ENHANCES AEROBIC CAPACITY IN MIDDLE-AGED WOMEN

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Purpose: The purpose of this study was to identify whether there are and what are the effects of a six-month program of combined training on aerobic capacity of middle-aged women who are physically active.

Methods: The overall sample consisted of women (n=47) divided in two groups, the experimental group (n=32) women of average age of 33,87±3,18, and the control group (n=15) average age of 40,33±3,04. In the experimental group, participants of the study trained five times a week, an average of 180 minutes a week, doing different groups of fitness programs, while the control group did not exercise. All measurements and tests were done at the very beginning and after six months, using the Cosmed for PFT Suite spirometer (Cosmed, Italy) and exercise test on the treadmill bar (T 1700), for obtaining the data on aerobic capacity indicators.

Results: The obtained results, based on statistical analysis MANCOVA and ANCOVA, indicate that there are statistically significant effects on all aerobic capacity indicators, at the level of p=0.01 in middle-aged women who exercised regularly, compared to the control group.

Conclusions: Upon conducting the experimental treatment of six months, the conclusion is that regular exercising, at moderate level, combining different types of trainings, contributes to the improvement of the aerobic capacities in middle-aged women.

Key words: *ageing, aerobic capacity, moderate physical activity*

NATIONAL PROGRAM “LIVING HEALTHY”: REGULAR PHYSICAL ACTIVITY IN SERVICE OF HEALTH PROMOTION

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Purpose: The aim of the National Program “Living Healthy” is to raise awareness and educate the population about risky behaviors for the development of chronic diseases and other negative effects on health, how to protect health and affect the determinants of health to improve the quality of life by preserving health and functional abilities. Acting on the individual, community and environmental level, project activities influence all important determinants of health: biological, social, psychological and environmental.

Methods: National Program “Living Healthy” consists of five components: Health Education, Health and Physical Activity, Health and Nutrition, Health and the Workplace and Health and the Environment. Each of these components in its own specific way encourages regular physical activity and is designed for the entire population of Croatia.

Results and conclusions: As part of its regular activities, Croatian Institute of Public Health conducts public health interventions for increasing the awareness of all people living in Croatia about the importance of regular physical activity.

The programs and activities of the National Program “Living Healthy” are focused on improving the health of the entire population through the implementation at the local community level by informing, educating and sensitizing citizens of all ages about the positive aspects of healthy lifestyles. To ensure the quality of the institutional framework and sustainability of project activities, implementation of experts’ capacity strengthening will be carried out. The aim of this overview is to show the activities related to promotion of physical activity within the National Program “Living Healthy”.

References

1. WHO/EUROPE(2016). HBSC 2016 study (2013/2014 survey): *Growing up unequal: gender and socioeconomic diferences in young people’s health and well-being.* Retrieved October 15, 2016 from: http://www.euro.who.int/en/hbsc-report-2016
2. WHO/EUROPE(2004). *Global Strategy on Diet, Physical Activity and Health*. Retrieved October 11, 2016 from: http://www.who.int/dietphysicalactivity/factsheet_young_people/en/
3. Loucaides, CA, Jago, R, Charalambous, I (2009). Promoting physical activity during school break times: piloting a simple, low cost intervention. *Preventive Medicine*, 48(4), 332-334.

THE EFFECTS OF DIFFERENT EXERCISE—BASED INTERVENTIONS ON FUNCTIONAL FITNESS IN OLDER ADULTS

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Abstract

Purpose: Aging is a multifactorial process associated with several not-irreversible functional and cognitive alternations of human body and determined by genetic and environmental factors. As lifespan and aged population are increasing (Klenk et al., 2007), emerging problem should represent identification of optimal and timely pharmacological, surgical, dietary, exercise and cognitive interventions that can mitigate ageing-related changes on number of levels (Rowe and Kahn, 1997). The aim of this study was to compare effects of three physical activity interventions (PAI) (with additional cognitive exercises (PA-CI)/diet supplementation (PA-DSI) – here and after PAI) on functional fitness of older adults.

Methods: In total, 40 independent living older adults (mean age 70 y; 75% females) were randomly assigned to physical exercise group (N=9; PAI), concurrent physical and cognitive exercise group (N=10; PA-CI), physical exercise with additional diet supplementation group (N=11; PA-DSI), and control group (N=10; CG). Three-month physical exercise was the same between all three intervention groups consisting 3 weekly 60-minute sessions. Pre and post evaluations were performed with Senior fitness test, upgraded with Four square step test and grip strength test.

Results: When intervention groups were pooled, we found moderate to low improvements in Chair stand up, Timed up and go, Four square step and 6-min walk tests (all $P < .001$). However, those improvements were intervention-specific with highest improvements found in PAI for the Four square step test ($P = .004$) and 6-min walk test ($P = .004$); in PA-CI for the Timed up and go test ($P < .001$); and in PA-DSI for body mass ($P = .012$), Chair stand up test ($P < .001$).

Conclusions: Although the sample size was low, our study provides further evidence of different interventional exercise-based programs that can benefit the population of independent-living older adults.

References

1. Klenk J, Rapp K, Büchele G, Keil U, Weiland SK. Increasing life expectancy in Germany: quantitative contributions from changes in age-and disease-specific mortality. Eur J Pub Health. 2007;17(6):587-92.
2. Rowe JW, Kahn RL. Successful aging. Gerontologist. 1997;37(4):433-40.

DANCE CONTRIBUTION TO IMPROVING PHYSICAL ACTIVITY AND HEALTH

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Abstract

Physical activity programs are one of the tools that can be used to prevent noncommunicable diseases. Dance could be also a type of physical activity that may appeal even to people who are not otherwise active and may be a form of activity that is more acceptable than others.

Purpose: The purpose of this paper is to collate information on dance interventions leading to Improving Physical Activity and Health across all age categories.

Methods: We used the portal for electronic information sources to identify articles published within the last 16 years.

Results. Dance interventions contribute to increase physical activity of youth and also contributes to the development of creative capacity, constructiveness, self-esteem and self-confidence etc. The two main goals of dance in the category of adult individuals is energy expenditure, which should correspond with the recommendations for physical activity and stress reduction. Dance interventions for the elderly are effective both as prevention of falls and as an instrument to maintain or improve cognitive functions.

Discussion: Including dance into the offer of physical activities broadens the range of options where everyone can find an activity to match their needs.

Conclusion: Dancing has the potential to be an attractive physical activity that can be adjusted to fit a target population's age, physical limitations, and culture.

***Key words**: inactivity, dance interventions, health benefits, youth, adults, elderly*

Introduction

This manuscript addresses the fundamental issues and assumptions pertaining to physical activity and inactivity, covering such topics as health outcomes in a public health context. Tobacco use, physical inactivity, unhealthy diet and alcohol abuse all increase the risk of noncommunicable diseases (NCDs) such as cardiovascular diseases, cancer and diabetes. These behaviours lead to four key metabolic/physiological changes that increase the risk of NCDs: raised blood pressure, overweight/obesity, hyperglycaemia (high blood glucose levels) and hyperlipidemia (high levels of fat in the blood). According to the World Health Organization (WHO) physical inactivity is the 4th most common risk factor for mortality in the world and causes 6% of deaths. (World Health Organization, 2016).

Physical activity programs are one of the tools that can be used to prevent NCDs, however, traditional physical activity programs such as running, walking, and playing competitive sports are not popular with all people. Non-competitive dance, however, may be a more suitable option for those people who perceive traditional exercise negatively, e.g. girls who do not like vigorous types of activities or prefer non-competitive forms of physical activity. In addition, dance provides other benefits as well including an outlet for emotional expression, stress reduction, and creativity.

Methods

In our search for sources we used the portal for electronic information sources discovery.muni. We searched for information dated between 2000 – 2016. We excluded studies dealing with professional dancers and dance interventions which include dance exergaming.

Results

Dance interventions to increase physical activity of Youth

Certain amount of the above recommended physical activity can be in the form of dance lessons. The considerable significance of dance in youth is confirmed by an extensive research of 7500 pupils and students from the USA (where there is currently an epidemic of obesity), aged on average 15.4 years. We can see that dance is a favourite of physical activity among young people especially girls (the third most popular physical activity). Dance may be one of primary means by which to increase physical activity rates in young people (Mavridis, Filippou, Rokka, Bousiou, & Mavridis, 2004). In addition, according to recent research dancing provides a wide range of health benefits. Use of dance contributes to the development of creative capacity, musicality and motor abilities, also of initiative, imagination, originality, constructiveness, self-esteem and self-confidence (Cicović-Sarajlić, Pavlović, & Popović, 2013). Special attention is paid to the issue of self-concept, perception of body and anxiety in children and youth. A certain positive impact of dance on these components of identity has been observed (Burkhardt & Brennan, 2012).

The 9 studies was included to our characteristics related to our topics. Characteristics of the included studies and results are presented inTable 1.

Table 1: General characteristics and results of including studies - Youth

Autor	Date	Type of dance	Methods	Results
Jago et al.	2012	Hip hop, street dance	Accelerometers	Inconclusive weekday MVPV
Maria A. Lopez Castillo, San Diego, et al.	2015	Ballet, Partnered Dance, Community Jazz/Hip-Hop, Private Jazz/Hip-Hop, LatinFlamenco, Latin-Salsa Ballet/Folklorico, Tap	Accelerometers	The structure of dance lessons can impact youths' physical activity.
Gillian Burgess, Sarah Groganb, Les Burwitz	2005	aerobic dance	The Body Attitudes Questionnaire (BAQ), The Children and Youth Physical Self-Perception Profile (CY-PSPP) , The Leisure Time Physical Activity Questionnaire (LTPAQ),	Positive effects on body image and self-worth during the aerobic dance intervention, but these effects were not sustained after the aerobic intervention
Olvera, Scherer et al.	2010	Rumba, Salsa, Hip – hop, Cheerleading, modern line dancing	Accelerometers	Increased MVPA
Robinson et al.	2010	African dance, Hip-hop, Step	Accelerometers	Conclusive PA outcomes
Kim, Kim	2007	Hip-hop, Dance aerobic	Questionnaire	Higher positive well-being
Mavradis et al.	2004	dance aerobic	Assessment - cardiorespiratory, strength, flexibility	Improved all health-related abilities – cardiorespiratory, strength, endurance, flexibility
Silvestri	2004	dance aerobic	Assessment - heart rate, blood pressures	Non-significant but improvements in resting and recovery heart rate
Visck-Stalec et al.	2007	Jazz dance, Folk dance and aerobics	Assemssment - weight, adipose tissue, aerobic fitness, motor skills, coordination	Reduction owerweight and adipose tissue, greater improvement in aerobic capacity, strength and flexibility

Dance interventions to increase physical activity of adults

There is extensive recent literature on various types of dance as a form of physical activity beneficial to physical, mental and social health and well-being of an individual. The analysis included both people in good health and people suffering from diseases (Sivvas, Batsiou, Vasoglou, & Filippou, 2015).

The two main goals of dance in the category of adult individuals is energy expenditure, which should correspond with the recommendations for physical activity and stress reduction.

The studies available suggest that there have been a greater number of dance interventions aimed at women and women also comprised majority in dance interventions (Sivvas et al., 2015). This fact presumably reflects the rate of popularity of dance as a type of physical activity in both genders. Also, every age groups has a special preference of a dancing style, this preference is then the reason why they choose the particular dance intervention.

Selected studies confirm the effectiveness of dance interventions (Table 2)

Table 2: General characteristics and results of including studies - Adults

Autor	Date	Type of dance	Methods	Results
Cugusi et al.	2015	Sardinian folk dance ballu sardu	Accelerometers	Exercise intensity (EI) and energy expenditure (EE) fulfill the recommendations ACSM
Lankford et al.	2014	Recreational ballroom dance	Gas exchange was recorded using a portable metabolic system	The intensity of exercise as matching the criteria established by ACSM
Domene, Pablo et al.	2015	Latin dance and non-partnered Latin-themed aerobic dance	Accelerometer with accompanying heart rate monitor	Efficacious in terms of community-based physical activity and psychosocial health promotion

Dance interventions to increase physical activity of the elderly

One of the major issues in the 21st century is maintaining the quality of life of the aging population. There is no doubt that health problems are associated with ageing. Common health complications in the elderly are falls, which are around the world considered to be a threat to public health. One of the major causes of falls is impaired ability to quickly adapt to a changing environment. Falls are the main aetiology factor leading to death caused by an accident of people over 65 (Reguli & Svobodová, 2011). Dance interventions for the elderly are effective both as prevention of falls (Sherrington et al., 2011) and as an instrument to maintain or improve cognitive functions (Verghese et al., 2003). Impairment of cognitive functions resulting in depression, MCI (mild cognitive impairment), Alzheimer´s disease and dementia are some of diagnoses increasing dramatically. It is estimated that by 2030 the number of patients suffering with dementia will have risen by 70% (Raboch, 2010). Dance as a means of improving cardiorespiratory parameters is effective, nevertheless there are studies which confirm that it is just as effective as any other type of exercise (Rodrigues-Krause, Farinha, Krause, & Reischak-Oliveira, 2016).

Table 3: General characteristics and results of including studies - elderly

Autor	Date	Type of dance	Methods	Results
Kosmat, Vranic	2015	Slow waltz	Satisfaction with Life Scale, General Self-Efficacy Scale, Wisconsin Card, Modified Auditory Verbal Learning Test	Positive effect on cognitive function
Kimura, Ken; Hozumi, Noriko	2012	Aerobic dance	Task-switching reaction time test	Executive cognitive network was facilitated
Maria Clarissa Ora Del Moral, Jacqueline C. Dominguez, Boots P. Natividad	2016	Ballroom dancing	Neuropsychological tests - MoCA-P, MMSE-P, ADAS-Cog, GDS, NPI, DAD, PSMS, IADL	Significant improvement - executive control, overall cognitive function and general wellbeing
Ken Kimura, Noriko Hozumi	2010	Free style – choreography	task switching reaction time test	Long choreography might affect the executive control process
Da Silva Borges, Eliane Gomes, De Souza Vale, et al.	2014	Ballroom dancing	Stabilometric and posturometric platform	Improved balance and reduced the number of falls
Sofianidis, Hatzitaki, Douka, Grouios	2009	Traditional Greek dance	COP, trunk kinematics, Sharpened-Romberg test, 1-leg (OL) stance, WS	Improving static and dynamic balance control
Merom, Mathieu, Cerin, et al.	2016	Folk or ballroom dancing	SF-12, The Physiological Performance Assessment	Social dancing was not effective in reducing the number of falls, but improved gait speed by 0.07 m/s
Sibel Eyigor, , Hale Karapolat, Berrin Durmaz, et al.	2007	Turkish folkloric dances	20-m walk test, 6-min walk test, stair climbing, chair rise time, Berg balance scale (BBS), the Medical Outcomes Study (MOS) 36-item short form health survey (SF-36), and geriatric depression scale (GDS) questionnaires	Improvements in physical performance, balance and QoL in elderly females
Serra, Alonso, Peterson, et al.	2016	Samba	Physical activity questionnaire, isokinetic muscle strength testing for the knee extensors and flexors, postural balance assessment	No differences in the isokinetic peak torque corrected by body weight, total work and flexor/extensor ratio; postural sway with the eyes closed was increased

Discussion

Results suggest that dance can improve cardiovascular parameters and can contribute to preventing or reducing obesity (Adiputra, Alex, Sutjana, Tirtayasa, & Manuaba, 1996; Bennell et al., 2000; Janssen & LeBlanc, 2010).

There is also limited evidence implying that dance intervention may improve self-concept and body image and reduce anxiety (Burgess, Grogan, & Burwitz, 2006; Cuypers et al., 2012).

A crucial question that remains unanswered is motivation for physical activity. Including dance into the offer of physical activities broadens the range of options where everyone can find an activity to match their needs.

As the history of dance is so long, many dance styles have been examined regarding their health benefits, the intensity of loading, energy expenditure as well as mental aspects. Currently new styles are springing up, providing new challenges to revise the effects of dance.

Conclusion

The global epidemic of inactivity and diseases caused by inactivity leads to the introduction of various measures. Policies to address insufficient physical activity are operational in 56% of WHO Member States and WHO Member States have agreed to reduce insufficient physical activity by 10% by 2025 (World Health Organization, 2016).

The above review of literature covering various aspects of dance as physical activity for improving physical, mental and social health indicates a wide range of effects. In children and youth dance generally fulfils the function of physical activity and also contributes to the development of creative capacity, musicality, also of initiative, imagination, originality, constructiveness, self-esteem and self-confidence. In adults significantly more women than men participate in dance intervention even though dance contributes to increasing physical activity and resulting prevention of NCDs and stress reduction. Dance in the elderly primarily fulfils the function of fall prevention and maintaining or improving cognitive functions.

Dancing has the potential to be an attractive physical activity that can be adjusted to fit a target population's age, physical limitations, and culture. Despite the scientific evidence on health benefits of dance it still has to be taken into consideration that physical activity alone cannot guarantee the overall health of an individual, it is merely one of the significant factors contributing to a healthy lifestyle and enhancing physical and mental health.

References

1. Adiputra, N., Alex, P., Sutjana, D. P., Tirtayasa, K., & Manuaba, A. (1996). Balinese dance exercises improve the maximum aerobic capacity. *Journal of Human Ergology*, *25*(1), 25-29.
2. Bennell, K., Khan, K., Matthews, B., Cook, E., Holzer, K., McKay, H., & Wark, J. (2000). Activity-Associated Differences in Bone Mineral Are Evident before Puberty: A Cross-Sectional Study of 130 Female Novice Dancers and Controls. *Pediatric Exercise Science*, *12*(4), 371-381. https://doi.org/10.1123/pes.12.4.371
3. Burgess, G., Grogan, S., & Burwitz, L. (2006). Effects of a 6 - week aerobic dance intervention on body image and physical self-perceptions in adolescent girls. *Body Image*, *3*(1), 57-66. https://doi.org/10.1016/j.bodyim.2005.10.005
4. Burkhardt, J., & Brennan, C. (2012). The effects of recreational dance interventions on the health and well-being of children and young people: A systematic review. *Arts & Health*, *4*(2), 148-161. https://doi.org/10.1080/17533015.2012.665810
5. Cugusi, L., Massidda, M., Matta, D., Garau, E., Di Cesare, R., Deidda, M., … Mercuro, G. (2015). A New Type of Physical Activity from an Ancient Tradition: The Sardinian Folk Dance "Ballu Sardu". *Journal of Dance Medicine & Science: Official Publication of the International Association for Dance Medicine & Science*, *19*(3), 118-123. https://doi.org/10.12678/1089-313X.19.3.118
6. Cicović-Sarajlić, D., Pavlović, B., & Popović, B. (2013). Dancing as an Expression of Children's Creativty in Music Culture Teaching and Physical Education. *Activities in Physical Education & Sport*, *3*(1), 77-78.
7. da Silva Borges, E. G., de Souza Vale, R. G., Cader, S. A., Leal, S., Miguel, F., Pernambuco, C. S., & Dantas, E. H. M. (2014). Postural balance and falls in elderly nursing home residents enrolled in a ballroom dancing program. *Archives of Gerontology and Geriatrics*, *59*, 312-316. https://doi.org/10.1016/j.archger.2014.03.013
8. Dempsey, J. C., Sorensen, T. K., Williams, M. A., Lee, I.-M., Miller, R. S., Dashow, E. E., & Luthy, D. A. (2004). Prospective Study of Gestational Diabetes Mellitus Risk in Relation to Maternal Recreational Physical Activity before and during Pregnancy. *American Journal of Epidemiology*, *159*(7), 663-670. https://doi.org/10.1093/aje/kwh091
9. Domene, P. A. (2015). Efficacy of Latin dance as a health-enhancing leisure activity for adults.
10. Eyigor, S., Karapolat, H., Durmaz, B., Ibisoglu, U., & Cakir, S. (2009). A randomized controlled trial of Turkish folklore dance on the physical performance, balance, depression and quality of life in older women. *Archives of Gerontology and Geriatrics*, *48*(1), 84-88. https://doi.org/10.1016/j.archger.2007.10.008
11. Filippou, F. (1993). La danse traditionnelle comme phénomène social dans la région d'Aridea. Ecole des Hautes Etudes en Sciences Sociales, section Anthropologie Sociale- Ethnologie, Paris.
12. Flores, R. (1995). Dance for health: improving fitness in African American and Hispanic adolescents. *Public Health Reports*, *110*(2), 189-193.
13. Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 40.
14. Jago, R., Sebire, S.J., Cooper, A.R., Haase, A.M., Powell, J., Davis, L., McNeill, & Montgomery, A.A. (2012). Bristol Girls Dance Project feasibility trial: Outcome and process evaluation results. The International Journal of Behavioral Nutrition and Physical Activity, 9, 83.
15. Kim, S., Kim, J. (2007). Mood after various brief exercise and sport modes: Aerobics, Hip Hop dancing, ice skating and body conditioning. *Perceptual and Motor Skills, 104*, 1265-1270.

16. Kimura, K., & Hozumi, N. (2010). Effect of Aerobic Dance Exercise on Cognitive Executive Function in Elderly People. *Medicine and Science in Sports and Exercise*, *42*(5), 597-597.
17. Kosmat, H., & Vranic, A. (2017). The Efficacy of a Dance Intervention as Cognitive Training for the Old-Old. *Journal of Aging & Physical Activity*, *25*(1), 32-40.
18. Lankford, D. E.; Bennion, T. W.; King, J.; Hessing, N.; Lee, L; and Heil, D. P. (2014) "The Energy Expenditure of Recreational Ballroom Dance", *International Journal of Exercise Science*: Vol. 7 : Iss. 3.
19. Lopez Castillo, M.A., Carlson, J.A., Cain, K.L., Bonilla, E.A., Chuang, E., Elder, J.P., & Sallis, J.F. (2015). Dance class structure affects youth physical activity and sedentary behavior: A study of seven dance types. Research Quarterly for Exercise and Sport, 86, 225-232. doi:10.1080/0 2701367.2015.1014084
20. Mavridis, G., Filippou, F., Rokka, S., Bousiou, S., & Mavridis, K. (2004). The effect of a health-related aerobic dance program on elementary school children. *Journal of Human Movement Studies*, *47*(4), 337-349.
21. Merom, D., Mathieu, E., Cerin, E., Morton, R. L., Simpson, J. M., Rissel, C., … Cumming, R. G. (2016). Social Dancing and Incidence of Falls in Older Adults: A Cluster Randomised Controlled Trial. *PLoS Medicine*, *13*(8), 1.
22. Olvera, N., Scherer, R., McLeod, J., Graham, M., Knox, B., Hall, K., . . . Bloom, J. (2010). BOUNCE: An exploratory healthy lifestyle summer intervention for girls. American Journal of Health Behavior, 34, 144-155.
23. Ora Del Moral, M. C., Dominguez, J. C., Boots, P. (2016). An observational study on the cognitive effects of ballroom dancing among filipino elderly with MCI.
24. Raboch, J. (2010) Kognitivní funkce, stárnutí a stravovací návyky. http://www.cspsychiatr.cz/dwnld/CSP_2010_2_81_86.pdf
25. Reguli, Z., Svobodová, L. (2011). Česká verze diagnostiky strachu z pádů u seniorů - FES-I (Falls Efficacy Scale International). Studia sportiva, Brno: FSpS MU 5(2), 5-12. ISSN 1802-7679.
26. Robinson, T. N., Killen, J. D., Kraemer, H. C., Wilson, D. M., Matheson, D. M., Haskell, W. L., … Varady, A. (2003). Dance and reducing television viewing to prevent weight gain in African-American girls: the Stanford GEMS pilot study. *Ethnicity & Disease*, *13*(1 Suppl 1), S65-77.
27. Rodrigues-Krause, J., Farinha, J. B., Krause, M., & Reischak-Oliveira, A. (2016). Effects of dance interventions on cardiovascular risk with ageing: Systematic review and meta-analysis. *Complementary Therapies in Medicine*, *29*, 16-28.
28. Serra, M. M. (1), Alonso, A. C. (1, 3), Mochizuki, L. (1), Greve, J. M. D. (1), Garcez-Leme, L. E. (1), & Peterson, M. (2). (2016). Balance and muscle strength in elderly women who dance samba. *PLoS ONE*, *11*(12). https://doi.org/10.1371/journal.pone.0166105
29. Sherrington, C., Tiedemann, A., Fairhall, N., Close, J. C. T., & Lord, S. R. (2011). Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. *New South Wales Public Health Bulletin*, *22*(3-4), 78-83.
30. Silvestri, L. (2004). Effects of aerobic dance and progressive relaxation on improving physical fitness of high school girls. *Journal of Human Studies, 47,* 337-349.
31. Sivvas, G., Batsiou, S., Vasoglou, Z., & Filippou, D. A. (2015). Dance contribution in health promotion. *Journal of Physical Education and Sport; Pitesti*, *15*(3), 484-489.
32. Sofianidis, G., Hatzitaki, V., Douka, S., Grouios, G. (2009). Effect of a 10-Week Traditional Dance Program on Static and Dynamic Balance Control in Elderly Adults. *Journal of Aging and Physical Activity. 17(2),* 167-180, https://doi.org/http://dx.doi.org/10.7752/jpes.2015.03073
33. Verghese, J., Lipton, R. B., Katz, M. J., Hall, C. B., Derby, C. A., Kuslansky, G., … Buschke, H. (2003). Leisure activities and the risk of dementia in the elderly. *The New England Journal of Medicine*, *348*(25), 2508-2516. https://doi.org/10.1056/NEJMoa022252
34. Viscki-Stalec, N., Stalec, J, Katic, R., Podvorac, D., & Katovic, D. (2007). The impact of dance-aerobics training on the morpho-motor status in female high-schoolers. *Collegium Antropologicum,* 31, 259-266
35. West, J., Otte, C., Geher, K., Johnson, J., & Mohr, D. C. (2004). Effects of Hatha yoga and African dance on perceived stress, affect, and salivary cortisol. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, *28*(2), 114-118. https://doi.org/10.1207/s15324796abm2802_6
36. World Health Organization (2016). Physical Activity. http://www.who.int/mediacentre/factsheets/fs385/en/

DIFFERENCES OF STATIC STRENGTH ENDURANCE OF THE LATERAL SIDES OF THE CORE AMONG WOMEN PARTICIPATING IN DIFFERENT GROUP RECREATIONAL PROGRAMS

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Abstract

The aim of this paper is to determine the differences between static strength endurance of the lateral sides of the core using the side bridge test among women participating in different group recreational programs. The study was conducted on a total of 60 healthy women with the mean age of 37 +/- 10 years. They were divided into four groups, according to the type of recreational program they have attended at least two times a week for at least 3 months continuously: (1) Zumba group (ZG); (2) Pilates group (PG); (3) Resistance training group (RG); (4) Yoga group (YG). The side bridge test was conducted on both sides: right side bridge (RSB) and left side bridge (LSB). Apart from the time results for each side individually, the results of both sides have been summarized and ratios were calculated as indicators of strength endurance balance that represent a risk for the low back disorders. The total results as well as the results of PG and RG groups are approximately the same as the normative times established in the previous studies. The results of the ZG group are considerably below the standards and the results of the YG group are considerably above. With respect to the RSB/LSB ratios, the results of ZG and PG groups show a disbalance while the results of RG and YG groups indicate a balance between the lateral sides of the core. These results lead to a conclusion that different forms of group recreational programs have a different effect on the development of the static strength endurance of the lateral sides of the core in women, and depend on the typical movements and types of muscular contractions that can be found in specific programs. Time results of the side bridge test have no influence on the endurance ratio of the lateral sides of the core. Their balance is influenced by a symmetrical use of targeted exercises for a specified period for both lateral sides equally.

Key words: *strength endurance, lateral sides of the core, side bridge test, women, group recreation*

Introduction

The core is part of a trunk consisting of lumbar spine, abdominal wall muscles, back extensors and quadratus lumborum. From the anatomical and functional perspective, the core may also include multi-joint muscles: latissimus dorsi, psoas and gluteal region muscles (McGill, 2010). The core may also be observed as a cylinder that is closed by diaphragm on the upper side and pelvic muscles at the lower side (Bliss et al., 2005). The role of the core is to ensure spinal and pelvic stability and help generate and transfer energy from large to the smaller body parts by providing the proximal stability for distal mobility (Kibler et al., 2016). Therefore, the core undoubtedly has the essential role in injury prevention.

Core stability has no clear definition but it may be defined as the ability to control the position and movement of the trunk for optimal production, transfer and control of the forces towards and away from the extremities during the performance of functional activities. Core stability critical components are muscular capacity and neuromuscular control (Silfies et al., 2015). Endurance is essential for the maintenance of muscle activity stabilization patterns and in that respect, has proved to be more important than strength. Lack of strength endurance, or more specifically, the endurance disbalance of the core muscles, is observed in persons with a history of lower back problems (McGill, 2007). Individual dimensions of core endurance are difficult to isolate considering the functional synergy between the muscles involved. The most frequently studied and referenced time tests of the isometric strength endurance of the core are Biering-Sorensen test for the extensors and flexion endurance test and side bridge test suggested by McGill. Out of those, the most frequently conducted tests are the ones in the sagittal plane (core flexors and extensors). Considering the noticeable lack in literature, we have decided to study the endurance in the frontal plane using the side bridge test. When compared to the tests in the sagittal plane, during the side bridge test, the lowest load is transferred to the spine considering the prolonged isometric contraction and we consider it more suitable for the assessment of persons who participate in recreational exercise programs.

The aim of this paper is to determine differences between static strength endurance of the lateral sides of the core using the side bridge test among women participating in different and most frequent group recreational programs: Zumba fitness, Pilates, Group resistance training and Yoga. We expect that Yoga and Pilates will show the highest time scores respectively. As for the ratio of right and the left lateral sides of the core, we assumed that they would be balanced in all forms of group recreational programs, apart from the Zumba fitness. No studies were found in the literature that would compare differences in the influences of several different recreational programs on the strength endurance of the core.

Methods

A total of 60 women voluntarily participated in the study, with the mean age of 37 +/- 10 years. According to the type of recreational activity attended, four groups were formed: (1) Zumba group (ZG); (2) Pilates group (PG); (3) Resistance training group (RG); (4) Yoga group (YG). Study inclusion criteria were dominant use of particular type of program at least 2 times a week for at least 3 months; the person needed to be right-handed and during the past 6 months must not have had any disorders related to the musculoskeletal system. Recreational programs attended by the participants were defined as following: (1) Zumba - combination of basic movement structures and dance moves that are combined into coordination-rhythmical units, i.e. choreographies; (2) Pilates - series of exercises that are performed in slow and controlled manner, with the emphasis on the development of balance, flexibility and muscle strength and endurance of the trunk, and are performed on a mat and specially designed Pilates equipment; (3) Group resistance training – combination of strength exercises that are performed with bodyweight or external resistance in the form of weights and elastic bands using different type of muscle contractions; (4)Yoga - traditional hinduistic system comprising of breathing exercises, meditation and assuming of certain poses (asanas) with the purpose of restoring balance of the body, mind and the spirit. Measurement were conducted in four different specialized studios/centres where original forms of the specific programs were conducted, under the supervision of certified instructors.

Strength endurance of the lateral sides of the core was assessed using the side bridge test which was performed bilaterally, first on the right side and then on the left side - right side bridge (RSB) and left side bridge (LSB).

The subjects were assessed following a warm up in the duration of 10 minutes, typical for the program they are attending. It was particularly emphasized that the warm up must not include isometric contractions of the trunk in any planes. The examiner demonstrated the side bridge test. The measurement mat had a mark – a 5 cm wide tape and the participants assumed the lateral lying position (first on the right side) with the support on the forearm in a way that the elbow (positioned in line with the shoulder), hip and extended lower leg were aligned with the tape mark. Upper leg was positioned on the floor in front of the lower leg and the free upper arm was positioned over the chest with the hand holding the opposite shoulder. When signalled by the examiner, supporting herself with the elbow and feet, the participant raises her hips assuming the body position that resembled a straight line. The time of the held position was measured using a stopwatch and stopped when the body of the participant lost the shape of a straight line and the hips were lowered to the floor. The results were recorded in seconds, using two decimal spaces. Following the right side, the test was repeated for the left side. Both sides were measured in the single attempt due to high reliability of the test (Waldhelm et al., 2012). All measurements were performed by a single examiner.

For analysis, mean values with standard deviation were calculated. Normal distribution of the variables was confirmed using the Kolmogorov-Smirnov test. Differences between the groups were analysed using univariate analysis of variance, and within the group using the Tukey's post-hoc test. Significance level was set for $p < 0.05$. Statistical analysis of the data was performed using Statistica 12 program package (StatSoft, Inc., Tulsa, OK, USA).

Results

All participants have successfully completed the test. The results are shown in Table No. 1. Time results sorted from highest to lowest in RSB were: YG, PG, RG, ZG. Sequence from highest to lowest in LSB and RSB+LSB in groups was as follows: YG, RG, PG, ZG. There are statistically significant differences between all groups for RSB, except between PG and RG. There are statistically significant differences between all groups for LSB, except between ZG and PG as well as PG and RG. According to McGill and associates (McGill et al., 2003) RSB/ LSB ratio between 0.95 and 1.05 indicates a balanced endurance of the lateral sides of the core while a ratio outside that range indicates disbalance that may represent a risk factor for the development of low back disorders. Within that scope, the results for ZG (0.84) and PG (1.15) represent a disbalance of the lateral sides of the core. Results of RG (1.01) and YG (1.02) are within the recommended range and indicate balanced strength endurance of the lateral sides of core.

Table 1: Basic descriptive statistics of the study participants

Study variables	Total (N=60)	Zumba (N=15)	Pilates (N=15)	Resistance training (N=15)	Yoga (N=15)
	AM±SD	AM±SD	AM±SD	AM±SD	AM±SD
Age (years)	37.12±9.83	38.20±6.29	41.40±7.32	33.80±12.66	35.07±10.79
RSB (sec)	73.62±35.46	36.97±19.28[a,b,c]	75.67±34.00[a,e]	73.08±19.02[b,f]	108.75±25.33[c,e,f]
LSB (sec)	72.18±35.44	43.98±27.20[b,c]	65.91±26.39[e]	72.59±20.57[b,f]	106.24±36.00[c,e,f]
Sum RSB + LSB (sec)	145.80±68.67	80.95±44.67[a,b,c]	141.58±59.15[a,e]	145.67±36.04[b,f]	214.99±58.61[c,e,f]
Ratio RSB/ LSB	1.02	0.84	1.15	1.01	1.02

[a]-differences between zumba and pilates group;
[b]-differences between zumba and resistance training group;
[c]-differences between zumba and yoga group;
[d]-differences between pilates and resistance training group;
[e]-differences between pilates and yoga group;
[f]-differences between resistance training and yoga group;
$p<0.05$ (two sided)

Discussion

Norm for the mean value of time endurance for young healthy women performing the side bridge test is 75 seconds for RBT and 78 seconds for LBT (McGill et al., 2003). The total results as well as the results of PG and RG groups in this study are approximately corresponding to the stated norm. The results of the ZG group are considerably below the norm and the results of the YG group are considerably above. The reason for below average results of the ZG group could be due to the fact that the movement patterns in Zumba fitness do not contain targeted exercises for the endurance of the core generally nor its lateral sides. On the same line, the above average results of the YG group are a direct consequence of the prolonged isometric contractions, typical for the Yoga program, including the fact that that the test itself is one of the modified Yoga poses that are practiced in every session.

We interpret that the lack of significant differences between the PG and RG groups for both lateral sides of the core is due to similar movement structures of Pilates and resistance training, in both static and dynamic exercise regimes, with or without external resistance. Although Pilates exercises are performed in slower and controlled manner, and those in Group resistance training more dynamic, both programs use exercises for the development of static endurance of the lateral sides of the core.

Particularly interesting are the results of RSB/ LSB ratio that, according to the study by McGill and associates (McGill et al., 2003) the result of 0.96 is a norm for healthy young women. In this study the total ratio is 1.02 and the difference is probably due to the fact that this study was performed on healthy adult women of all ages. According to the formula $0.95 \leq$ RSB/ LSB ≤ 1.05, the results of RG and YG groups as well as the total result, have RSB/LSB ratios that indicate a balanced endurance of lateral sides of the core. However, despite the satisfactory time results of the PG group that are higher than those of the RG group for RSB and RSB+LSB sum, the RSB/LSB ratio results show a disbalance of lateral sides that represents a risk factor for the development of low back disorders. The possible explanation might be that during Pilates sessions there are not structured music or stopwatch with which the instructors could control the time that would ensure equal intervals of static muscle contractions of both sides of the core. We find similar explanation for the somewhat better RSB/LSB ratio in RG group when compared to YG group – during Yoga sessions instructors do not use any means (structured music, stopwatch) that would ensure same time intervals of static contractions of both lateral sides of core, but are subjective estimated.

This study is not without limitations. Norms listed were obtained on young healthy women (McGill et al., 2003) while this study included adult women of all age groups. Also, the full interpretation of influences of different recreational programs on the endurance of the core would require sagittal plane tests, and ratio of the lateral side of the core and extension should be calculated (McGill, 2007).

Conclusion

Results of this study lead to a conclusion that different forms of group recreational programs have different effect on the development of the static strength endurance of the lateral sides of the core in healthy women, and are dependent on the movement structures and the type of muscular contractions that can be found in specific programs. Time results when performing the side bridge test have no influence on the endurance ratio of the right and left sides of the core, which is a risk indicator for the development of low back disorders. Balance of the static strength endurance of the lateral sides of the core is influenced by the timely precise symmetrical use of targeted exercises for both lateral sides equally.

References

1. Bliss, L.S., Teeple P. (2005). Core Stability: The centerpiece of any training program. Current Sports Medicine Reports, 4:179-183.
2. Kibler, W.B., Press, J., Sciascia, A. (2006). The role of core stability in athletic function. Sports Medicine, 36(3):189-198.
3. McGill, S. (2007). Low back disorders: evidence-based prevention and rehabilitation. Human Kinetics, 2nd edition.
4. McGill, S. (2010). Core training: Evidence translating to better performance and injury prevention. Strength and Conditioning Journal, 32(3):33-46.
5. McGill, S., Grenier, S., Bluhm, M., Preuss, R., Brown, S., Russell, C. (2003). Previous history of LBP with work loss is related to lingering deficits in biomechanical, physiological, personal, psychosocial and motor control characteristics. Ergonomics, 46(7), 731-746.
6. Silfies, S.P., Ebaugh, D., Pontillo, M., Butowicz, C.M. (2015). Critical review of the impact of core stability on upper extremity athletic injury and performance. Brazillian Journal of Physical Therapy, 19(5):360-368.
7. Waldhelm, A., Li, L. (2012). Endurance tests are the most reliable core stability related measurements. Journal of Sport and Health Science, 1(2), 121-128.

GARDENING AS THE OPTIONAL PHYSICAL ACTI VITY FOR SENIORS

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Abstract

Purpose

Physical activity (PA) insufficiency has been an up-to-date topic for individuals regardless their age. PA is particularly important to the old population group. That is the reason why we aim our study at seniors.

Complementary PA for seniors is usually implemented as a part of various intervention programs. The question arising is if the intervention program could be a substitute for a natural working activity; and subsequently, if a working activity can bring sufficient and diverse PA for seniors.

Our study wants to prove that gardening, and specifically viticulture (care of vineyard, cultivation of vineyard), can be used as an alternative PA for seniors.

Methods

Our research has been designed as a case study; based on one-year observation. The subject of the study was a 64-year old man living in the South-Moravian region (CZE). The observation was carried out in an observation-suitable period (spring - autumn 2016).

Basic statistic methods were further used for the quantitative analysis. The energy expenditure of working activities was set due to work of Ainsworth et al. (1993) and Novotný (2003).

Results

Within the period of one year the subject of the study had visited the vineyard 48 times. The mean visit duration was longer than 3 hours and the mean energy expenditure was of 435 kJ (160 kcal) per visit. Within this year the subject of the study had implemented almost 20 different types of operations consisting of various abilities: endurance, strength-endurance, flexibility and balance. Some of the operations required fine-motor-skill involvement.

Conclusions

Firstly, our study shows that a suitably selected working activity can completely substitute intervention programs for seniors. Secondly, a positive motivational aspect of gardening has been observed - viticulture that could be connected to meaningful usage of motion.

However, at the same time, it is necessary to mention that the feeling of "need" to complete some working operations can also have it drawbacks. The work overload; and unilateral activity may bring imbalance and other health complications.

Key words: *Physical Activity, Hypokinesia, Elderly, Sedentary Lifestyle*

Introduction

An adequate physical activity belongs among basic building stones of healthy lifestyle and it is an all-society highlighted matter. Human movement insufficiency – hypokinesia is considered to be one of the biggest problems in this field (Hendl and Dobrý 2011).

The trend of hypokinesia is sufficiently mapped locally in the Czech society (Frömel, Chmelík, Nykodým, & Et, 2007; Máček & Máčková, 2013; Matoulek, Svačina, & Lajka, 2014), (Bebcakova et al., 2015), (Zháněl, 2014), as well as globally at the all-European (Gerovasili et al., 2015), (Kahlmeier et al., 2015), and world levels (Abdullah and Wolbring 2013), (Howitt et al., 2016). In fact, it regards all age groups, from the youngest ones (Tremblay et al., 2016) to the oldest ones (Hagströmer et al., 2015). Primarily, health impact on organism of an individual with a sedentary job and lifestyle is mentioned (Bernaards, Hildebrandt, and Hendriksen 2016). Secondarily, a wider aspect of the negative impact of hypokinesia needs to be seen, e.g. at the economic level, associated with reduced productivity, employability, costs of health care etc.

For the aforementioned reasons, numerous activities aimed at coping with hypokinesia and minimizing its consequences are under way in the Czech Repulic. At the medical level, we usually address consequences associated with diseases and worsened health condition of individuals with sedentary lifestyle. Various intervention and preventive programmes are successfully prepared for individuals whose health condition allows so. However, they are often expensive and demanding for material.

Therefore, we asked ourselves whether a suitable form of physical activity (PA) can also be found in common working activities or working activities that were usual in the past. And if so, what are the main quantitative and qualitative factors of the selected PA with regard to energy expenditure, time consumption, health risk etc.?

Our study focused on the age group of seniors (age 60 +). In this age group, we can find, in addition to natural physiological changes associated with ontogeny, a lot of other risk factors. In the Czech Republic, this age is usually connected with retirement (leaving a job), which is usually connected with a change in the exercise regimen of an individual. At the social level, individuals are often gradually segregated, which may manifest in a reduced need to leave home. The occurrence of health problems and limitation is also usual.

Some of these aspects and positive impact of gardening has described Roberson and Kudlacek (2015)**.** They recommend gardening as the Czech phenomenon for elderly to meet the lifelong demands for a healthy life.

In our study specific variant of gardening - viticulture was selected as PA. Term viticulture represents activity that is connected with cultivation of vineyard and vine production. South Moravia, as a southern part of the Czech Republic, is a region historically associated with viticulture. Vineyards take the area of 174.5 km^2, and in addition to large wine farms, there are numerous small private producers whose vineyards do not have more than 500 plants. These vineyards are characteristic of a manual work without using mechanisation. We also consider the working activity in a small vineyard as an interesting alternative to PA of seniors. In addition to PA itself, it also often brings suitable connection on a social level because an individual is naturally socialized at the level of cultural elements associated with viticulture.

Methods

The case was study based on a one-year observation of the respondent, supplemented with his individual working activity records. The monitored person was a 64 year old man from the Znojmo region (CZE), living in the settlement with the population not exceeding 500 people. The man was selected based on the principle of availability and he was not informed about the objectives of the study. During 2016 his working activity was monitored at the vineyard with the area of 769 m^2, where he managed 420 grape vine plants. The vineyard was situated 3.3 km from the respondent's residence and he used his car or bicycle for transportation.

PA was evaluated on the basis of personal observation of working activities and the determination of their energy expenditure according to (Ainsworth et al., 1993) and (Novotný, 2003). The estimate of energy expenditure of a working activity was carried out by two experts independently, and consequently confronted. In the context of the taxonomy of abilities according to Měkota (Měkota and Novosad, 2005), the activities were further divided to groups according to their character: endurance, strength-endurance, dexterity, flexibility and balance and involvement of fine motor skills.

At the same time, a potential health risk was evaluated in relation to long-term performance of the physical activity associated, e.g. with one-sided overload.

Activities described in Table 1 were alternatively performed during the season.

Table 1: List of activities

activity	MET	E expenditure [kJ/hour]	health risk	type of activity	Activity realization						
					March	April	May	June	July	August	September
cutting of branches	3.5	1125	2	2;4	x						
transport of branches	4	1287	0	2;3;4	x			x	x		
removal of protectors	3.5	1125	0	4	x						
treatment after cutting	3	963	0	4;5	x						
binding	3.5	1125	0	2;5	x						
spraying the vineyard	4.5	1444.5	2	1;3;4		x	x	x	x	x	
lawn moving	4	1287	0	1		x	x	x	x	x	
digging	4	1287	1	1;4		x	x	x	x	x	
digging away	5.5	1768.5	1	1;4			x				
breaking out of branches	3.5	1125	0	2;3;5			x	x	x	x	
weeding	7	2250	2	1;4			x				
watering	4.5	1444.5	2	1;4				x			x

threading of branches	3.5	1125	0	4;5				x			
hacking of branches	4.5	1444.5	2	1;3;4					x	x	
tearing off leaves	3	963	0	2;3;5					x	x	x
guarding	3	963	0	2						x	x
grape harvest - cutting	3.5	1125	2	2;3;4;5							x
manuring	4	1287	0	2;3							x

Legend: HEALTH RISK: 0 – minimum risk; 1 - high risk, imbalance; 2 - moderate, possible risk after log overload, TYPE OF ACTIVITY: 1 - strength-endurance; 2 - endurance; 3 - dexterity; 4 - flexibility and balance; 5 - fine motor skills

Results

All the results are generated regarding to basal metabolism of the respondent - 8,712 kJ (2,082 kcal).

During the 2016 season the senior visited the vineyard to work there 48 times in total. His visits were spread over the period of March – September. June was the month with the highest number of visits (11). In total, the senior worked for 149.5 hours in the vineyard and on average, he spent there more than three working hours per visit. The shortest visits did not exceed 1 hour, on the other hand, the longest time the respondent spent at the vineyard continuously was 12 hours. On average, the respondent performed work with energy expenditure of 4,435.4 kJ per visit. The respondent performed work with energy expenditure of 21,289.5 kJ in total per season.

June was the month with the highest number of visits and the most energy demanding works were performed. An average energy expenditure of the senior was more than 8,000 kJ in June, which is almost a double in comparison with the other months.

A car was used as a prevailing vehicle for travelling to the vineyard (41x), the other travels were by bicycle (7x). When riding the bicycle the respondent consumed 630 kJ per visit. Transport by bicycle resulted in the energy expenditure of 4,410 kJ in total.

Table 2: Vineyard visits during 2016

	No. of visits	Visit duration TOTAL [hours]	Visit duration MEAN [hours]	Energy expenditure TOTAL [kJ]	Energy expenditure MEAN [kJ/visit]
January					
February					
March	5	16.5	3.3	20,963.2	4,192.6
April	7	32	4.6	32,397.8	4,628.3
May	4	18	4.5	33,033	8,258.3
June	11	31.5	2.9	43,469.3	3,951.8
July	9	15	1.7	21,235.5	2,359.5
August	7	18.5	2.6	27,315.8	3,902.3
September	5	28	5.6	34,485	6,897.0
October					
November					
December					

During the season the senior performed 18 types of various working activities. Most activities he performed can be defined as strength-endurance. The activities were usually performed on unstable ground and therefore balance ability was also engaged. Fine motor skills were only required for five types of activities.

During the whole season there were three periods where the accumulation of work with higher health risk at long-term overload was noted. It was the spring cutting of the vineyard in March, the period of digging and digging away at the turn of April and May. The last one was the period of digging and sawing (cutting away) at the turn of August and September. There were activities with a potential health risk in other periods as well but their duration was never too long.

Discussion

Our study tries to introduce a different view of physical activity of seniors. We realize that viticulture is a specific activity with its regional limitation. At the same time, with this study we want to indicate that no special intervention programmes need to be created for seniors in many cases. Targeted motivation to a suitable working activity, which, in addition to satisfaction with the performed activity, ensures meeting standards for recommended PA of a senior, is often sufficient.

Our case shows that without the respondent being purposely participating in a movement intervention, he conducted almost 150 hours of PA during seven months of 2016. With regard to the fact that all the working activities can be classified in the interval >3MET, it is an activity identified as moderate to vigorous - MVPA (Loprinzi, 2015). In most weeks the senior met (exceeded) the recommendations of WHO (WHO | Global Recommendations on Physical Activity for Health n.d.) on minimum PA.

As described above, the activities associated with viticulture also represented the possibility of senior's socialisation in a social group which is culturally connected with the region. Secondarily, this strengthened his motivation to continue the started work.

During the study we also encountered some limitations to PA. Taking care of a vineyard is a seasonal activity. This causes a problem of searching another supplementary physical activity for the period of October – March. A potential problem may also be overloading of the organism after long lasting activities. Respondent´s excess motivation to finish work manifested negatively in this regard (e.g. due to expected worsening of weather conditions). Together with unilateral load of some activities, this may result in a higher health risk.

With regard to successful implementation of the pilot research, we consider extending the surveyed cohort and verification of data on energy demand of work data by means of Oxycon mobile device.

Conclusions

The study presents research focused on physical activity of seniors implemented by means of working activities at a vineyard. The respondent was a 64 year old senior from the Znojmo region (CZE) and the research was done during 2016.

For the period of March – September the senior visited the vineyard to work there 48 times. During these visits he spent more than 3 hours there and performed a working activity with energy expenditure 4,435,5 kJ. By doing so he usually met the recommendations of WHO for the PA standards. A problematic factor of the PA related to viticulture is the seasonal implementation of working activities and possible unilateral load of the organism in accumulation of specific working activities.

References

1. Abdullah, B., & Wolbring, G. (2013). Analysis of newspaper coverage of active aging through the lens of the 2002 World Health Organization Active Ageing Report: A Policy Framework and the 2010 Toronto Charter for Physical Activity: A Global Call for Action. *International Journal Of Environmental Research And Public Health*, *10*(12), 6799-6819. https://doi.org/10.3390/ijerph10126799
2. Ainsworth, B. E., Haskell, W. L., Leon, A. S., Jacobs, D. R., Montoye, H. J., Sallis, J. F., & Paffenbarger, R. S. (1993). Compendium of Physical Activities. *Medicine & Science in Sports & Exercise*, *25*(1), 71.
3. Bebcakova, V., Vadasova, B., Kacur, P., Junger, J., Borzikova, I., Zvonar, M., & Gimunova, M. (2015). Distribution of health-related physical fitness in Slovak population. *Springerplus*, *4*, 691-691. https://doi.org/10.1186/s40064-015-1479-4
4. Bernaards, C. M., Hildebrandt, V. H., & Hendriksen, I. J. M. (2016). Correlates of sedentary time in different age groups: results from a large cross sectional Dutch survey. *BMC Public Health*, *16*, 1-12. https://doi.org/10.1186/s12889-016-3769-3
5. Frömel, K., Chmelík, F., Nykodým, J., & Et, A. (2007). Pohybová aktivita české mládeže: koreláty intenzivní pohybové aktivity. *Česká kinantropologie*. Retrieved from https://is.muni.cz/publication/765765
6. Gerovasili, V., Agaku, I. T., Vardavas, C. I., & Filippidis, F. T. (2015). Levels of physical activity among adults 18–64 years old in 28 European countries. *Preventive Medicine*, *81*, 87-91. https://doi.org/10.1016/j.ypmed.2015.08.005
7. Hagströmer, M., Kwak, L., Oja, P., & Sjöström, M. (2015). Original research: A 6 year longitudinal study of accelerometer-measured physical activity and sedentary time in Swedish adults. *Journal of Science and Medicine in Sport*, *18*, 553-557. https://doi.org/10.1016/j.jsams.2014.07.012
8. Hendl, J., & Dobrý, L. (2011). *Zdravotní benefity pohybových aktivit : monitorování, intervence, evaluace*. Praha : Karolinum, 2011.
9. Howitt, C., Brage, S., Hambleton, I. R., Westgate, K., Samuels, T. A., Rose, A. M. C., & Unwin, N. (2016). A cross-sectional study of physical activity and sedentary behaviours in a Caribbean population: combining objective and questionnaire data to guide future interventions. *BMC Public Health*, *16*, 1-12. https://doi.org/10.1186/s12889-016-3689-2
10. Kahlmeier, S., Wijnhoven, T. M. A., Alpiger, P., Schweizer, C., Breda, J., & Martin, B. W. (2015). National physical activity recommendations: systematic overview and analysis of the situation in European countries. *BMC Public Health*, *15*(1), 1-14. https://doi.org/10.1186/s12889-015-1412-3
11. Loprinzi, P. D. (2015). Frequency of moderate-to-vigorous physical activity (MVPA) is a greater predictor of systemic inflammation than total weekly volume of MVPA: Implications for physical activity promotion. *Physiology & Behavior*, *141*, 46-50. https://doi.org/10.1016/j.physbeh.2015.01.002
12. Máček, M., & Máčková, J. (2013). Pohybová aktivita a dětská obezita. *Medicina Sportiva Bohemica et Slovaca*, *22*(2), 96-102.

13. Matoulek, M., Svačina, Š., & Lajka, J. (2014). Pohybová aktivita a obezita v ČR 2000-2013. *Physical Activity and Obesity in Czech Republic in 2000-2013.*, *23*(1), 8-9.
14. Měkota, K., & Novosad, J. (2005). *Motorické schopnosti*. Olomouc : Univerzita Palackého v Olomouci, 2005.
15. Novotný, J. (2003). *Kapitoly sportovní medicíny. [elektronický zdroj]*. Brno : Paido, 2003.
16. Roberson, Donald, and Michal Kudlacek (2015). The Garden Colony: Restorative Ecology. Ecopsychology 7(1): 12.19.
17. Tremblay, M. S., Barnes, J. D., González, S. A., Katzmarzyk, P. T., Onywera, V. O., Reilly, J. J., & Tomkinson, G. R. (2016). Global Matrix 2.0: Report Card Grades on the Physical Activity of Children and Youth Comparing 38 Countries. *Journal of Physical Activity & Health*, *13*, S343.
18. WHO | Global recommendations on physical activity for health. (n.d.). Retrieved February 1, 2017, from http://www.who.int/dietphysicalactivity/factsheet_recommendations/en/
19. Zháněl, J. (2014). *Aplikace výzkumných metod v kinantropologii*. Brno : Masarykova univerzita, 2014.

CORRELATION BETWEEN PARENTS' AND PRESCHOOL CHILDREN'S PHYSICAL ACTIVITY IN CAPITAL OF CROATIA

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Abstract

The aim of this study was to determine correlation between parents physical activity and physical activity of their preschool children in the capital of Croatia. Parents physical activity was measured with "Single item physical activity measure" and preschool childrens physical activity with "Netherlands physical activity questionnaire". Both were filled out by parents. Study included 398 mothers and fathers and 398 of their preschool children aged 3-7 years. Results show low correlation between child's and parent physical activity, but medium correlation between mother's and father's physical activity.

Key words: *environment, child, movement*

Introduction

According to the World Health Organization (2016) physical inactivity has become one of the ten most mortality risk factors. Some of the devastating facts are that every fourth person in the world is not enough physically active, 80% of adolescents are not enough physically active (WHO, 2016) and 42 million worldwide preschool children, younger than 5, are overweight (WHO, 2011).

There is decreasing number of physically active people and children with aging (Strauss et al., 2001; Telebar, 2013; Milanović et al., 2012). Furthermore, children aged 10 to 16 in New Jersey spend 75,5% of the day inactive and only 1,4% of the day in vigorous activity (Strauss et al., 2001). Only 54% of studies in systematic review (Tuckers, 2008) shown that children aged 2 to 6 years were meeting physical activity recommendation from the National Association of Sport and Physical Education.

Human body is made to move. Physical activity is essential biological stimulus which is needed to keep functions and structures of organs and organ systems (Vuori, 2004). Physical inactivity inflicts damage on human health because it decreases functions of our muscles which is important for improvement and keeping humans health good (Mraković, 1995). Furthermore, deficiency of physical activity and sedentary way of life may cause development a number of diseases of the modern era.

In regard to previous studies, there is a need to initiate actions on a global and local level to promote physical activity and change people's view and attitude toward physical activity. The best way to make difference is to start with changes in early childhood with preschool children. There is more likely for children to stay active in adolescence and adulthood if they create a habit of physical activity in early age. Studies have shown that physical activity plays an important role in the fight against childrens obesity (Moore et al., 2003; Riddoch et al., 2009) and that children with higher levels of physical activity during childhood will have less body fat by the time of early adolescence (Moore et al., 2003). Study of Horvat and Sindik (2012) of preschoolers and their parents, shown that parent's interests and care about their children's quality of life has a big impact in creating habits in preschool children. Preschool children learn by watching and imitating adults. The proof for this is found in studies which show us that the children were 5,8 times more likely to be active if both of their parents are active (Moore et al., 1991) and if parents enjoyed physical activity (Irwin et al., 2005). Likewise, higher parental TV viewing is related with increased risk of higher TV viewing for their children (Jago et al., 2010). The aim of this study was to determine correlation between parent's physical activity and physical activity of their preschool children in capital of Croatia.

Methods

Participants, materials and procedure

The study included 398 male and female preschool children aged 3 to 7 and their parents. The preschool children attended three kindergartens in the capital of Croatia and were tested from March to May 2016. Parents physical activity was measured with "Single item physical activity measure" (Milton et al., 2010) and preschool children's physical activity with "Netherlands physical activity questionnaire" (Bielemann et al., 2011). Both were filled out by parents. "Single item physical activity measure" showed a good validity in Hamilton's study (Hamilton et al., 2012) where it has found a strong correlation between single-item and pedometer steps (0.81) and 7-day physical activity recall (0.51). Previous studies also showed that "Single item physical activity measure" is a good way for assessing people's physical activity levels (Milton et al., 2010). The "Netherlands physical activity questionnaire" consists of 8 questions about children's physical activity and their habits. First seven questions are about physical activity of a child, ant the eight one is about their inactivity. The final result for overall physical activity is obtained by summing results in first 7 questions.

Spearman correlation coefficient (rho) was used to determine correlation between measures of physical activity of parents and children. Significance was set at $p<0.05$.

Results

Correlation between parent's and child's physical activity measures is presented in Table 1.

Table 1: Spearmans correlation in all variables used in this study.

Variable	NPAQ	Ques. 1	Ques. 2	Ques. 3	Ques. 4	Ques. 5	Ques. 6	Ques. 7	SI mom	SI dad
NPAQ										
Ques. 1	0,5422									
Ques. 2	0,6638	0,2111								
Ques. 3	0,5812	0,2229	0,3218							
Ques. 4	0,6169	0,2922	0,3289	0,4085						
Ques. 5	0,3432	0,0131	0,1591	-0,1298	-0,0659					
Ques. 6	0,5795	0,3080	0,3360	0,2243	0,2259	0,0836				
Ques. 7	0,6035	0,2629	0,3264	0,3573	0,2980	0,0825	0,2737			
SI mom	**0,1080**	0,0756	0,0469	0,0491	0,0456	0,0369	0,0636	0,1196		
SI dad	**0,0933**	0,0110	0,0669	0,0538	0,0203	0,0455	0,1014	0,0704	**0,5029**	

Significant correlations are marked in bold. NPAQ – final result in "Netherlands physical activity questionnaire"; Ques.1-Ques.7 – results in every single question from "Netherlands physical activity questionnaire"; SI mom – result in "Single item physical activity" for mothers; SI dad – result in "Single item physical activity" for fathers).

Spearmans correlation show significant but low correlation between parents physical activity and physical activity of their preschool children aged 3-7 in the capital of Croatia. Furthermore, study shows significant medium correlation (r_s = 0,50) between mother's and father's level of physical activity.

Discussion and conclusions

Hamilton's study (Hamilton et al., 2012) found that parents, on average, were engaging in at least 30 minutes of a moderate-intensity physical activity on 3 days of the week. In this study values are 2.53 days of the week for mothers and 2.84 days of the week for fathers engaged in moderate intensity physical activity during the week. Values are similar for fathers, but poorer for Croatian mothers of preschool children. Correlation results from our study suggest that in family with physically active father, mother is also physically active. We would expect positive results to child's behavior, that is, physical activity level as well. The mean of NPAQ scores for the preschool children in the capital of Croatia measured in this study was 24.98, while the score for Brazilian children was 25.5 (Bielemann et al., 2011), which shows poorer results of children in Croatia. Creating habits in children is influenced by a number of factors. One of them is parent's influence which is important in creating opinions, habits and motivation to do something. Parent's influence is also important in children's participation in physical activity. It seems like parental support and beliefs about their child's competence are important factors on which depends will their children participate and how much will they participate in physical activity (Gustafson, Rhodes, 2006; Davison et al., 2003; Bois et al., 2004). Some of the previous studies show us that children were more likely to be active if their parents were active and enjoyed physical activity (Moore et al., 1991; Irwin et al., 2005). This was not found in our study. In the capital of Croatia there is no significant correlation between parents physical activity and physical activity of their preschool children aged 3-7yrs. It seems like physical activity of preschool children in the capital of Croatia does not depend on physical activity of their parents as shown in few other studies. Unfortunately, the research literature related to parental correlates of activity behavior in preschool children is limited (Hinkley et al., 2008). To design effective family-based interventions to promote PA in preschool children, a clear understanding of how parents influence their children's PA behavior is required (Loprinzi et al., 2010). Several possible mechanisms are identified in previous studies for the effect of parents' activity levels on children's activity (Moore et al., 1991). The first hypothesized mechanism for the enhancement of physical activity levels within families is that parents (and siblings) serve as role models for activity. This presumption was not confirmed in our study: it seems that it takes more in parent behavior than role modeling to affect child physical activity level. It is also possible that parents may enhance their children's level of activity by just supporting their participation in activities like purchasing sports equipment for them, providing transportation to parks and other activity-related facilities and providing reinforcement for physical participation (Moore et al., 1991; Loprinzi, 2010). A second hypothesized mechanism is that the strong association between parents' activity levels and the child's in previous research may simply reflect the tendency toward sharing activities. Based on that, we can assume that children in capital of Croatia are not active with their parents, but somewhere else like in kindergarten of caregiving institutions. Parents who perceived their children to be more competent and capable of actively playing were more likely to provide the instrumental and emotional support required for young children to be physically active (Loprinzi, 2010). Furthermore, the childcare center was identified as a strong determinant of physical activity in the children (Finn et al., 2002), as well as the time spent playing outside (Hinkley et al., 2008). Future studies that simultaneously investigate multiple variables across multiple domains would be useful to add new insight into correlates and influences on preschool children's physical activity.

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References

1. Bielemann, R. M., Reichert, F. F., Paniz, V. MV., Gigante, D. P. (2011). Validation of the Netherlands physical activity questionnaire in Brazilian children. *International Journal of Behavioral Nutrition and Physical Activity*. http://www.ijbnpa.org/content/8/1/45.
2. Bois, J. E., Sarrazin, P. G., Brustad, R. J., Trouilloud, D. O., Cury, F. (2004). Elementary school children's perceived competence and physical activity involvement: the influence of parents' role modelling behaviors and perceptions of their child's competence. *Psychology of Sport and Exercise* 6(4): 381-397.
3. Davison, K. K., Cutting, T. M., Birch, L. L. (2003). Parents' Activity-Related Parenting Practices Predict Girls' Physical Activity. *Medicine and Science in Sports and Exercise,* 35(9): 1589-1595.
4. Finn, K., Johannsen, N., Specker, B. (2002). Factors associated with physical activity in preschool children. *The Journal of Pediatrics* 140 (1): 81-85.
5. Gustafson, S. L., Rhodes, R. E. (2006). Parental Correlations of Physical Activity in Children and Early Adolescents. *Sports Medicine* 36(1): 79-97.
6. Hamilton, K., White, K. M., Cuddihy, T. (2012). Using a single-item physical activity measure to describe and validate parents' physical activity patterns. *Research Quarterly for Exercise and Sport*, 83(2): 340-345.
7. Hinkley, T., Crawford, D., Salmon, J., Okely, A.D., Hesketh, K. (2008). Preschool children and physical activity: a review of correlates. *American Journal of Preventive Medicine* 34(5):435-441.
8. Horvat, V., Sindik, J. (2012). Povezanost i spolne razlike u pojedinim čimbenicima života predškolske djece. Zbornik radova Međimurskog veleučilišta u Čakovcu, lipanj 2012.
9. Irwin, J. D., He, M., Sangster Bouck, L. M., Tucker, P., Pollett, G. L. (2005). Preschoolers' Physical Activity Behaviours - Parents' Perspectives. *Canadian Journal of Public Health*, 96(4): 299-303.
10. Jago, R., Fox, K. R., Page, A. S., Brockman, R., Thompson, J. L. (2010). Parent and child physical activity and sedentary time: Do active parents foster active children? *BMC Public Health* 10: 194.
11. Loprinzi, P.D. Trost, S.G. (2010). Parental influences on physical activity behavior in preschool children. *Preventive Medicine* 50: 129-133
12. Milanović, Z., Pantelić, S., Sporiš, G., Krakan, I., Mudronja, L. (2012) Razlike u nivou tjelesne aktivnosti kod muškaraca i žena preko 60 godina starosti, 21. ljetna škola kineziologa Republike Hrvatske. Hrvatski Kineziološki Savez.
13. Milton, K., Bull, F. C., Bauman, A. (2010). Reliability and validity testing of a single-item physical activity measure. *British Journal of Sports Medicine* 45(3): 203-208.
14. Moore, L. L., Gao, D., Bradlee, M. L., Cupples, L. A., Sundarajan-Ramamurti, A., Proctor, M. H., Hood, M. Y., Singer, M. R., Ellison, R. C. (2003). Does early physical activity predict body fat change throughout childhood? *Preventive Medicine* 37(1): 10-17.
15. Moore, L. L., Lombardi, D. A., White, M. J., Campbell, J. L., Oliveria, S. A., Ellison, R.C. (1991). Influence of parents' physical activity levels on activity levels of young children. *The Journal of Pediatrics* 118(2): 215-219.
16. Mraković, M. (1995). Programirana tjelesna aktivnost u funkciji zdravlja. U: *Zbornik radova 4. ljetne škole pedagoga fizičke kulture, Rovinj,* 15-17.
17. Riddoch, C. J., Leary, S. D., Ness, A. R., Blair, S. N., Deere, K., Mattocks, C., Griffiths, A., Smith, G. D., Tilling, K. (2009). Prospective associations between objective measures of physical activity and fat mass in 12-14 year old children: the Avon Longitudinal Study of Parents and Children (ALSPAC). *British Medical Journal* 339:b4544.
18. Strauss, R. S., Rodzilsky, D., Burack, G., Colin, M. (2001). Psychosocial Correlates of Physical Activity in Healthy Children. *Archives of Pediatric and Adolescent Medicine* 155(8): 897-902.

19. Telebar, B. (2013). Angažiranost učenika u izvannastavnim i izvanškolskim sportsko-rekreativnim aktivnostima, 22. ljetna škola kineziologa Republike Hrvatske. Hrvatski Kineziološki Savez.
20. Tucker, P. (2008). The physical activity levels of preschool-aged children: A systematic review. *Early Childhood Research Quarterly* 23(4):547-558.
21. Vuori, I. (2004). Physical inactivity is a cause and physical activity is a remedy for major public health problems. *Kinesiology* 36 (2):123-153.
22. World Health Organization (2016). Physical activity (accessed 8th October 2016). http://www.who.int/mediacentre/factsheets/fs385/en/
23. World Health Organization (2011). Obesity and Overweight: Fact Sheet No. 3. World Health Organization, Geneva, Switzerland.

HEALTH STATUS AND QUALITY OF LIFE ASSESMENT AMONG CORPORATE EMPLOYEES, THE BENEFICIARIES OF KINESIOLOGY RECREATION PROGRAMS WITHIN THE WORKPLACE

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Abstract

The sample included 36 female employees of an institution of higher education in Kuwait, beneficiaries of kinesiology recreation program within the workplace, in which they participated three times a week for 60 minutes. A survey on their perception of health and quality of life was conducted. A non-invasive analysis of body composition, the Tanita BC-418 MA and a standardized international survey on the health and quality of life (HRQoL) – the RAND 36 (Hays, 1994), which included a total of eight health concepts, were used to gather the data on the respondents. A statistically significant correlation was obtained between the variable *FAT%* (body fat percentage) and the variable of *health change*, while the results of regression analysis did not show a statistically significant relationship between 8 predictor variables and the criterion variable of the *health change.*

Key words: *college teachers, health-related quality of life, kinesiology recreation, health status, workplace*

Introduction

A healthy lifestyle contributes to the quality of life and is significantly associated with the presence of physical activity in daily life. Its benefits have long been well known and documented in the literature. In the 21st century, health promotion in the workplace is a priority for the employer and the workers themselves in order to preserve the quality of life. The workplace has a direct impact on the well-being of employees. Consequently, it affects the health of their families and society in general. The promotion of healthy lifestyles includes welfare of employees and efforts to improve the work conditions, work habits and well-being of people at work. The concept of wellness in the workplace is not in general practical use, despite good evidence that has shown that the introduction of this kind of programs reduces absenteeism and health care costs. Besides, it increases productivity and overall job satisfaction (Parks & Steelman, 2008; Berry, Mirabito, & Baun, 2010; Falkenberg, 1987). Diseases caused by our modern society and lifestyle such as autoimmune diseases, type 2 diabetes, cardiovascular diseases, cancer, etc., are closely related to the modern way of life dominated by sitting and stress. In order to alleviate the negative impact of stress as one of the key problems of modern workplace, or to stop it from arising in the first place and, also in order to prevent diseases, a program called *Worksite Wellness* was developed within the higher education institution in which the research was conducted, aiming to actively involve female employees in kinesiology and recreational programs within their ordinary course of work. Also, the aim of the program was to reduce the negative effects of employment on women's health. In the first six months of the project which was supported by the marketing campaign, the *Worksite Wellness Program* actively involved 128 women, of whom 45 agreed to participate in this study. The respondents in this study were college teachers who were assigned at least 45 hours per week, which is higher than the European average (Cabrita & Galli da Bino, 2012). The teachers spend most of the time in a standing position, which increases the effort and the occurrence of fatigue in the workplace. They spend slightly less time in a seated position, thus increasing the risk of developing health problems such as varicose veins, circulatory disorders, low back pain, swelling of the lower extremities, and, also, increasing a chance of developing specific problems in pregnancy (National Union of Teachers, 2016). Hypokinesia has far-reaching implications that go beyond just health; it relates to certain socio-economic effects such as total medical costs, a burden for the economy; decline in production caused by sick leave and occupational injuries (Katzmarzyk & Janssen, 2004; Martinson et al., 2005). The purpose of this study was to estimate the health and quality of life of women who were the beneficiaries of employee kinesiology recreation programs that were implemented at the worksite.

Research Methods

Data collection

The health status of a total of 36 female employees of a higher education institution in Kuwait who were the beneficiaries of kinesiology recreation programs, which were implemented within the institution, was assessed in this cross sectional study. The female employees were expected to participate in at least 60 minutes of moderate to vigorous physical activity three times a week. Due to the specific socio-cultural environment the sample included 36 respondents. Recreation programs were available to all participants at the worksite within the campus. The female employees could engage in such programs before work, during work, and after-hours, free of charge. Individual and group recreational programs, in which the respondents were involved, were designed and adapted by a kinesiologist. Participation in the survey was voluntary, and each woman had the right to withdraw from the research study. The female participants were informed of the purpose and objective of the research study, and have given informed consent to participate.

Sample of subjects

The sample used in the present study consisted of 36 women. The original sample included 45 female respondents. After the questionnaire had been reviewed, 9 respondents were discarded for further analysis on the grounds of incompleteness of the questionnaire. The ages of women responding to the survey were ranging from 23 to 45 (AS=31.69). The respondents work at a higher education institution in Kuwait and have been classified within the institution as lecturers.

Sample of variables

A non-invasive analysis of body composition was used as a data collecting instrument. After the body composition analysis had been made, the participants filled out a standardized questionnaire about health and quality of life - the RAND 36 (Hays, 1994). It is comprised of 36 items that assess eight health concepts. Body composition analysis of subjects was performed using the Tanita BC-418MA system with 8 electrodes. The following data were provided: body mass index (BMI), fat free mass (FFM), fat mass and percentage of body fat (FAT%). This assay was conducted in a controlled environment; always at the same time, at least 2 hours after a meal and drinking large amounts of fluids and the bladder needed to be empty (Fosbøl & Zerahn, 2015). A standardized survey instrument - the RAND-36 was used for self-assessment of health-related quality of life (HRQoL) in eight variables, as follows: (1) physical functioning, (2) limitation due to physical problems, (3) the limitation due to emotional problems, (4) the level of energy/fatigue (5) emotional well-being, (6) social functioning, (7) bodily pain, and general health (8). The survey included one independent variable (9) which measured the subjective perception of a change in health status. The RAND-36 is a multi-use survey for self-assessment of health which does not rely on a specific population, as well as disease or age of the respondents. The result is expressed as a standardized value ranging from 0 (the lowest or worst possible level of functioning) to 100 (highest or best possible level of functioning) for each measured dimension. Low scores reflect a poor perception of health and functional limitations or loss of functioning. High scores indicate the absence of functional limitations and reflect a good perception of health. The data were collected from February to July 2016.

Data processing methods

An advanced analytics software package - Statistica 12.0 (StatSoft, Inc., Tulsa, OK, USA) was used to process the data. Basic parameters of variables were calculated within descriptive statistics; the arithmetic mean (AM) was calculated of a central tendency data set. Dispersion measures included the standard deviation (SD), the minimum value of the results (MIN), maximum value results (MAX) and the variance (s2). Skewness, kurtosis and the correlation coefficient (r) were also calculated. A multiple regression analysis of 36 cases was performed.

Results and Discussion

As shown in Table 1, the mean value of the variable FAT% (body fat percentage) amounted to 30.77, which is a very good result if the mean age of the subjects is taken into account (M = 31.69). According to Gallagher et al. (2000), such a result matches the "healthy range", although a negative skewness of the results was observed in the variables FFM (fat-free mass) and FAT% (body fat percentage).

Table 1: Basic statistical parameters and normality of result distribution of body composition analysis performed by Bioelectrical Impedance Analysis (BIA)

	n	Mean	Min	Max	s²	SD	Skewness	Kurtosis
AGE	36	31.69	23.00	45.00	27.18	5.21	0.80	0.41
BMI	36	23.93	18.80	31.10	11.99	3.46	0.52	-0.74
FFM	36	43.93	32.50	50.90	19.37	4.40	-0.70	-0.03
FAT MASS	36	20.52	9.80	36.80	42.84	6.54	0.58	0.29
FAT%	36	30.77	16.80	44.10	44.21	6.64	-0.04	-0.60

Legend: n- number of entities, Mean-arithmetic mean, Min-minimum value, Max-maximum value, s2-measure of variations in results, the SD-standard deviation, Skewness coefficient as the lack of symmetry in the variable, kurtosis- the coefficient of kurtosis as a measure for the degree of 'tailedness' in the variable.

Table2: The basic statistical parameters and normality of distribution results of 8 variables to assess the health and quality of life (RAND-36).

	n	Mean	F	Min	Max	s²	SD	Skewness	Kurtosis
PHYSICAL FUNCTIONING	36	78.33	11	10.00	100.00	608.57	24.66	-1.11	0.39
ROLE LIMITATIONS DUE TO PHYSICAL HEALTH	36	77.08	19	0.00	100.00	906.25	30.10	-1.10	-0.01
ROLE LIMITATIONS DUE TO EMOTIONAL PROBLEMS	36	64.35	17	0.00	100.00	1526.23	39.06	-0.52	-1.28
ENERGY / FATIGUE	36	51.52	5	0.00	95.00	546.88	23.38	-0.34	-0.58
EMOTIONAL WELL-BEING	36	67.77	4	20.00	100.00	383.94	19.59	-0.45	-0.46
SOCIAL FUNCTIONING	36	70.13	9	25.00	100.00	493.55	22.21	-0.53	-0.56
PAIN	36	70.90	8	12.50	100.00	691.12	26.28	-0.68	-0.54
GENERAL HEALTH	36	68.61	6	35.00	95.00	282.30	16.80	-0.18	-0.76
HEALTH CHANGE	36	61.11	13	0.00	100.00	873.01	29.54	0.03	-1.08

Legend: n- number of entities, Mean-arithmetic mean, F-frequency, Min-minimum value, Max-maximum value, s2-measure of variations in results, the SD-standard deviation, Skewness coefficient as the lack of symmetry in the variable, Kurtosis- the coefficient of Kurtosis as a measure for the degree of 'tailedness' in the variable.

The lowest value was achieved for *energy/fatigue* variable (M = 51.52), followed by the *health change* variable (M = 61.11) and *the limitation due to emotional problems* variable (M = 64.35), which supports the abovementioned theory about the difficulties related to the alignment of business and private obligations, and the lack of free time. Such results are not surprising given the age and sex of respondents. The highest value was obtained for the *physical functioning* variable (M = 78.33), which can be explained by the fact that all respondents were a population that is engaged in physical activity three times a week for 60 minutes, hence were sampled on the basis of this criterion.

Table 3: An overview of the results of correlation analysis between percentage of body fat (FAT%) and the subjective perception of a change in health status.

	Mean	SD	FAT%	HEALTH CHANGE
FAT%	30.77	6.64	1.00	-0.51
HEALTH CHANGE	61.11	29.54	-0.51	1.00

Legend: Mean-arithmetic mean, SD-standard deviation, FAT%-percentage of body mass (p =0.05)

From the Correlation Analysis table, it can be seen (with an error of 5%) that the obtained correlation was negative, that is, the higher the reached value in the first variable (% FAT), the lower the reached value in the second variable (subjective assessment of health). The stated value is somewhat obvious and expected since the results of numerous studies suggest that percentage of body fat is strongly associated with poor quality of life scores (Fontaine & Barofsky, 2001, Han, Tijhuis, Lean, & Seidell, 1998; Lean, Han, & Seidell, 1998).

Table 4: Summary of the multiple regression analysis: 8 independent (predictor) variables and one dependent (criterion) variable - subjective assessment of health. R = 69686050; R2 = 33320405; F (8.27) = 3.1862; p<01121; Std.Error of estimate: 24.127

Variables	BETA	Std.Err.of Beta	B	Std.Err.	t (27)	p-value
Intercept			-25.105	20.226	-1.241	0.225
PHYSICAL FUNCTIONING	0.046	0.180	0.055	0.216	0.255	0.800
ROLE LIMITATIONS DUE TO PHYSICAL HEALTH	0.186	0.206	0.182	0.202	0.903	0.374
ROLE LIMITATIONS DUE TO EMOTIONAL PROBLEMS	-0.081	0.181	-0.061	0.137	-0.448	0.657
ENERGY / FATIGUE	0.175	0.201	0.222	0.254	0.872	0.390
EMOTIONAL WELL-BEING	-0.117	0.225	-0.176	0.340	-0.519	0.607
SOCIAL FUNCTIONING	0.262	0.313	0.349	0.417	0.837	0.409
PAIN	-0.106	0.335	-0.119	0.376	-0.318	0.752
GENERAL HEALTH	0.466	0.229	0.820	0.402	2.036	0.051

Legend: R - multiple correlation; R^2- determination coefficient of multiple correlation; F (8.27) - the value to test for the significance of all the variables in the model; p - level of significance of multiple correlation coefficients, standard error of estimate; Beta - standardized regression coefficient; Std. Err. of Beta - standard error of standardized regression coefficients; B - standardized regression coefficients; Std. Err. of B - standard error of non-standardized regression coefficients; t (27) - the value of df = n-m-1 = 27 degrees of freedom used for testing the significance of regression coefficients; p - level of significance of regression coefficients)

As shown in Table 4, after the multiple regression analysis had been performed, there were no statistically significant correlations between the predictor variables and the criterion variable (subjective assessment of health). Based on the standardized regression coefficients and their level of significance, it can be concluded that none of the eight independent variables had any statistically significant effects on health which was subjectively assessed by respondents.

Conclusions

The concept of quality of life broadly encompasses how an individual measures the ‘goodness’ of multiple aspects of their life. To be more specific, Health Related Quality of Life (HRQoL) is concerned specifically with health aspects while also accounting for general QoL components. College teachers involved in this study experienced overall good level of HRQoL, even though their mental QOL were impaired more seriously than physical QOL. By analyzing the composition of the body, it was found that respondents were within the range that is considered good health. The lowest scores were obtained in the following three variables: the level of *energy/fatigue*, *health change* and *limitation due to emotional problems*, which can be explained by high intensity workload. The obtained data may indicate the need to go beyond bio-medical concepts in this specific workplace program and try to expand its mandate and include other dimensions of wellness, since former variables have lowest scores. Additional programs like stress management classes, nutrition services, weight-loss and smoking cessation programs might better serve employees in this specific environment in coping with work–life balance, etc., although for further implications is advisable to conduct prospective study. Furthermore, results of meta-analysis on the health effects of stress on teachers (Guglielmi & Tatrow, 1998), concluded that workplace stress was directly associated with poorer health of employees. Similar results have been observed in the study by Chuan Liu, Shu Wang, Xue Shen, Mengyao Li & Wang Lie (2015) which was conducted among Chinese college teachers. The results of the study have shown that mental health of teaching staff was more seriously undermined than physical health, which has also been confirmed by other studies dealing with the same subject matter (Galeon, 2016; Gokhale, 2015; Aidoo, Essuman, Aidoo, Yawson, & Yawson, 2015). Biernat (2015) pointed to the fact that the risk of physical inactivity in individuals with high levels of education quadruples and puts them at risk of developing a number of adverse health conditions. However, high RAND-36 scores are indicative of better QoL, when divided in summary of Physical Components (PCS=73,73) and summary of Mental Components (MCS=63,44) it is indicative that health-related quality of life of our respondents was at high level, even though there is a slight difference between physical and mental functioning. Scale maximum (SM) is 100 (the maximum value for each variable) and in general population of developed countries the value ranges from 60-80% of SM. Our findings are within the normative range, which assumes that our respondents have a high estimated subjective quality of life.

Also, it should be emphasized that the present study bears some limitations: (1) a small sample size for a cross sectional study due to cultural characteristics (2) cross-sectional study was used as sampling method in this study and this method does not determine the cause and effect of relationship. Furthermore, the present study does not take into account the health status and QoL of the employees before the initiation of the study.

Health has a major impact on daily functioning and ability to work, and the results obtained in this study have pointed to the importance of improving the emotional and social dimensions of wellness that affect the health of employees, and, indirectly, the QoL. Wellness today represents a complex concept and consequently a multidisciplinary approach should be taken to help employees reach an optimal level of health and well-being. A strategically integrated workplace wellness program which is relevant to employees' needs and interests can (and must) produce substantial benefits for employers and their employees.

References

1. Aidoo, H., Essuman, A., Aidoo, P., Yawson, A. O., & Yawson, A. E. (2015). Health of the corporate worker: health risk assessment among staff of a corporate organization in Ghana. *Journal of Occupational Medicine & Toxicology*, *10*(1), 1–6. https://doi.org/10.1186/s12995-015-0072-7
2. Berry, L. L., Mirabito, A. M., & Baun, W. B. (2010, December 1). What's the Hard Return on Employee Wellness Programs? Retrieved September 16, 2016, from https://hbr.org/2010/12/whats-the-hard-return-on-employee-wellness-programs
3. Biernat, E. (2015). Factors increasing the risk of inactivity among administrative, technical, and manual workers in Warszawa public institutions. *International Journal of Occupational Medicine & Environmental Health*, *28*(2), 283–294. https://doi.org/10.13075/ijomeh.1896.00194
4. Chuan Liu, Shu Wang, Xue Shen, Mengyao Li, & Lie Wang. (2015). The association between organizational behavior factors and health-related quality of life among college teachers: a cross-sectional study. *Health & Quality of Life Outcomes*, *13*(1), 1–12. https://doi.org/10.1186/s12955-015-0287-4
5. Cabrita, J., & Galli da Bino, C. (2012). Developments in collectively agreed working time 2012. Eurofond. Retrieved from https://www.eurofound.europa.eu/observatories/eurwork/comparative-information/developments-in-collectively-agreed-working-time-2012
6. Fontaine, K. R., & Barofsky, I. (2001). Obesity and health-related quality of life. *Obesity Reviews*, *2*(3), 173–182. https://doi.org/10.1046/j.1467-789x.2001.00032.x
7. Fosbøl, M. Ø., & Zerahn, B. (2015). Contemporary methods of body composition measurement. *Clinical Physiology & Functional Imaging*, *35*(2), 81–97. https://doi.org/10.1111/cpf.12152
8. Galeon, G. A. (2016). Correlates of the health statuses of the faculty at midlife. *Journal of Mid-Life Health*, *7*(1), 15–21. https://doi.org/10.4103/0976-7800.179168
9. Gallagher, D., Heymsfield, S. B., Heo, M., Jebb, S. A., Murgatroyd, P. R., & Sakamoto, Y. (2000). Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index. *The American Journal of Clinical Nutrition*, *72*(3), 694–701.
10. Gokhale, M. (2015). Work-Related Quality of Life and Work Engagement of College Teachers. *Annamalai International Journal of Business Studies & Research*, 60.
11. Guglielmi, R. S., & Tatrow, K. (1998). Occupational Stress, Burnout, and Health in Teachers: A Methodological and Theoretical Analysis. *Review of Educational Research*, *68*(1), 61–99. https://doi.org/10.3102/00346543068001061
12. Han, T. S., Tijhuis, M. A., Lean, M. E., & Seidell, J. C. (1998). Quality of life in relation to overweight and body fat distribution. *American Journal of Public Health*, *88*(12), 1814–1820.
13. Hays, R. (1994). The Medical Outcomes Study (MOS) Measures of Patient Adherence. Retrieved September 8, 2016, from http://www.rand.org/health/surveys/MOS.adherence.measures.pdf.
14. Katzmarzyk, P. T., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian Journal of Applied Physiology*, *29*(1), 90–115.
15. Lean, M., Han, T., & Seidell, J. (1998). Impairment of health and quality of life in people with large waist circumference. *The Lancet*, *351*(9106), 853–856. https://doi.org/10.1016/S0140-6736(97)10004-6
16. Lee, I.-M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Katzmarzyk, P. T. (2012). Impact of Physical Inactivity on the World's Major Non-Communicable Diseases. *Lancet*, *380*(9838), 219–229. https://doi.org/10.1016/S0140-6736(12)61031-9
17. Martinson, B. C., Crain, A. L., Pronk, N. P., Whitebird, R. R., Fine, L. J., & others. (2005). Health care charges associated with physical inactivity, overweight, and obesity. Retrieved from https://www.researchgate.net/profile/Robin_Whitebird/publication/7597938_Health_care_charges_associated_with_physical_inactivity_overweight_and_obesity/links/09e41509285af12ec3000000.pdf
18. National Union of Teachers. (n.d.). Classroom ergonomics. Retrieved September 7, 2016, from https://www.teachers.org.uk/help-and-advice/health-and-safety/c/classroom-ergonomics
19. Parks, K. M., & Steelman, L. A. (2008). Organizational wellness programs: A meta-analysis. *Journal of Occupational Health Psychology*, *13*(1), 58–68. https://doi.org/10.1037/1076-8998.13.1.58

DIFFERENCE IN WATER LOSS BETWEEN INDIVIDUALS OF DIFFERENT PHYSICAL CONSTITUTION AND BODY MASS DURING PROLONGED PHYSICAL EXERTION

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Abstract

The aim of this research is to establish the difference, on a sample of 20 male participants, in water consumption in persons with different body constitution and body mass. The test consists of walking on a treadmill for three hours. The walking speed is 5 km per hour with 6% incline. Body constitution is established by measuring of skin folds according to Jackson and Pollock; the body height, body weight and body fat percentage are measured before the testing. After the testing urine mass, body mass after taking the urine mass and water loss per kilogram of body mass are measured. With supposition that water loss develops linearly in all the participants, the results show that persons with higher body fat percentage lose 1.2 more water during extensive physical activity that persons with lower body fat percentage. These results are to be taken with caution as the research is conducted with a small group of participants.

Key words: *morphological characteristics,body fat, walking, water loss*

Introduction

Water represents one of the basic human needs for survival. Life is unimaginable without water that spawned the primordial life forms. The important thing in maintaining of homeostasis is that the water levels in a body are kept within certain boundaries. Water makes 50% to 70% of our bodies making 61% an average value. Total content of water in a body of an average male weighing 70 kg is around 40 litres, which is about 57% of his entire weight (Bethea, & Powell,2005). Even the 2% water loss can cause a decrease in motor skills. Gopinathan at al. (1988) have in their research proven that dehydration has considerable effect on cognitive functions, therefore the weight loss due to 2% dehydration seriously debilitates mental functions. Water loss is particularly apparent during strenuous physical activity in hot environment. The perspiration during moderate physical strain measures one litre per hour (Cheung, McLellan & Tenaglisa, 2000), while a maximum perspiration measured during an Olympic marathon is 3,7 litres per hour (Armstron, Hubbard, Szlyk, et al., 1985). If the water loss is not replenished on time dehydration takes place. Dehydration is defined as dynamic water loss from a body due to perspiration, without liquid being restored or when liquid is not replaced fast enough (Bethea, & Powell, 2005). Dehydration results in hypohydration. Hypohydration is a state of a body when the entire water level is lower than normal. It occurs during physical activity, manual work or exposure to high temperatures. Hypohydration has negative effect on performance of training sessions and competition activities, and consequently on sport results themselves. Hypohydration also has negative effect on cognitive functions, thermoregulation maintenance and performance of extensive aerobic activities. The feeling of thirst marks the beginning of dehydration, while intensive thirst warns that body is seriously dehydrated. In order to avoid dehydration it is necessary to drink water before the thirst occurs. Daily intake of liquids is 2,3 litres in average (Costil, 1972). Water controls a considerable number of metabolic processes. It helps with digestion and absorption of food, it helps with discharge of waste from body, it regulates body heat through perspiration, ensures suppleness, firmness and elasticity of joints and makes about 92% of blood content, the most important transport system of nutrients in an organism.

Especially large water loss occurs during prolonged physical stress of hot days outdoors. To avoid dehydration of persons exposed to such stress would be useful to know precisely what amount of water will be required during prolonged physical exertion. For practical use it is best to plan the necessary amount of water relative weight of people who participate in physical stress outdoors. In addition there is a presumption that a person with a higher fat content, due to better insulation body fat tissue have difficulty in thermoregulation, especially during prolonged physical exertion in hot weather. This is why such people probably lose more water through sweating. Data on the existence and size of these differences could be useful in the practice of work and training outdoors. These data may be useful for professional soldiers in the performance of their tasks exposed to prolonged physical stress and increased loss of water, top and recreational athletes, scouts, and all the people who were caught in a situation of survival in nature during which can not provide a sufficient amount of water. The first objective of this research is to establish entire amount of water consumption per kilogram of body mass during extensive physical strain. The second aim is establishing the difference in water consumption between individuals of different physical constitution and body mass during extensive physical activity.

Methods

The sample consists of 20 males of averagely aged 23.5 ± 1.56. Their average weight is 86.65±12.92 kilograms, and average height is 182.1±.34 centimetres. All the participants voluntarily accepted to be tested and were in advance familiar with aim and objective of the research.

Table 1: Total sum of the three skin folds

	BRSF	USF	BASF	X
1.	10,0	8,8	10,1	28,9
2.	4,9	5,2	7,0	17,1
3.	12,2	12,2	16,1	40,5
4.	9,0	7,3	16,3	32,6
5.	11,4	7,3	12,4	31,1
6.	13,2	7,3	14,7	35,2
7.	28,6	21,1	26,1	75,8
8.	13,3	14,2	14,5	42,0
9.	24,4	27,2	26,1	77,7
10.	9,9	10,7	13,1	33,7
11.	6,1	4,9	11,8	22,8
12.	21,0	20,1	11,2	52,3
13.	12,4	9,2	13,6	35,2
14.	14,0	13,5	16,5	44,0
15.	9,0	4,2	12,2	25,4
16.	6,1	9,8	10,7	26,6
17.	14,0	13,5	9,5	37,0
18.	9,4	13,3	13,2	35,9
19.	4,7	11,2	4,7	20,6
20.	4,8	8,2	8,1	21,1

A day before the tests all participants had their diet regulated. Optimal testing conditions were controlled by environment heat in the diagnostic centre, which was 25.3±0.42°C. Participants body constitution was measured by method of measuring of three skin folds [X] according to Jckson Pollock (1978). These folds are breast skin fold [BRSF], upperarm skin fold [USF], back skin fold [BASF] and they are presented in Table 1. The results are entered into regression equation for evaluating body density. The body density result is further inserted into formula for calculating body fat Sirija (Siri, 1956).

Table 2: Body constitution (X – total sum of three skin folds (mm); X2 – age of participants; D – body density (kg/ m^{3});%BF – percentage of body fat)

	X	X2	D	%BF
1.	28,9	26	1,072820905	11,40
2.	17,1	24	1,085811005	5,88
3.	40,5	24	1,062511625	15,88
4.	32,6	22	1,07019218	12,53
5.	31,1	24	1,071147405	12,12
6.	35,2	25	1,06701722	13,91
7.	75,8	24	1,03876002	26,53
8.	42,0	24	1,0612235	16,44

9.	77,7	24	1,037870345	26,94
10.	33,7	20	1,069637545	12,77
11.	22,8	24	1,07958062	8,51
12.	52,3	23	1,053290845	19,96
13.	35,2	24	1,06726122	13,80
14.	44,0	24	1,0595445	17,18
15.	25,4	26	1,07636938	9,88
16.	26,6	21	1,07635758	9,88
17.	37,0	21	1,0663455	14,20
18.	35,9	22	1,067104205	13,87
19.	20,6	23	1,08218698	7,41
20.	31,1	25	1,070903405	12,23

Variable sample consists of anthropometric dimensions: body height, body weight before the testing, body mass after the testing, body mass after subtraction of urine mass and three skin folds – breast skin fold, upper arm skin fold and back skin fold. Other variables are percentage of body fat, urine mass and water loss per kilogram of body mass. The variable of water loss per kilogram of body mass calculation is based on measuring of body weight before and after the testing and according to total urine loss.

Table 3: Total water loss per kilogram of body mass (BM1 – participant body mass before the testing (kg); BM2 – participant body mass after the testing (kg); BM3 – participant body mass after subtraction of urine mass (kg); UM – urine mass (g); Water loss/ kg BM – water loss per kilogram of body mass)

	BM1	BM2	BM3	UM	Water loss/ kgBM
1.	70,6	69,2	68,9	300	0,02408
2.	64,0	62,8	62,5	231	0,02344
3.	82,9	81,3	80,9	399	0,02413
4.	90,2	88,2	87,9	317	0,02550
5.	72,9	71,8	71,6	162	0,01783
6.	85,6	84,2	83,9	263	0,01986
7.	101,4	99,1	98,9	125	0,02465
8.	104,3	102,1	101,8	361	0,02397
9.	114,6	111,9	111,7	94	0,02531
10.	82,8	81,3	81,2	90	0,01932
11.	72,6	71,0	70,8	222	0,02479
12.	102,3	100,2	100,1	81	0,02151
13.	89,6	87,8	87,4	306	0,02455
14.	88,5	86,7	86,5	131	0,02260
15.	92,0	90,3	90,0	281	0,02174
16.	83,7	82,5	82,1	443	0,01912
17.	97,5	95,5	95,3	106	0,02256
18.	73,6	72,4	72,2	101	0,01902
19.	92,0	90,2	90,0	220	0,02174
20.	71,9	70,2	69,7	108	0,03060

A day before the tests all participants had their diet regulated. Optimal testing conditions were controlled by environment heat in the diagnostic centre. The measuring was executed on a one-time basis with every participant. Before the testing, body height, body weight and skin folds were measured, as all the general data on each participant were taken. The test consisted of cyclical aerobic activity, ie. walking on treadmill for 3 hours with an aim of establishing the difference in water consumption among participants of different body constitution. Walking speed was 5 km per hour with 6% incline. After the testing was finished body weight was measured before taking the urine mass, then urine mass was measured and body weight again after measuring the urine mass. The results of this research are processed with MS Office pack Excel 2010. Statistics methods for reliability data analysis are used that are the following: the number of samples of two population and hypothesis of environment with unknown dispersion.

The results and discussion

Measuring of the percentage of body fat produced results according to which six participants has body fat percentage smaller than 12%, seven participants has body fat percentage bigger than 14%, and seven participants has body fat percentage between 12 and 14%. During the statistical data analysis the participants with body fat percentage less than 12% and bigger than 14% were taken into consideration.

Table 4: Water loss per kilogram of body mass depends on body fat percentage

% BODY FAT<12% Participants X	Water loss/ kg TM	% BODY FAT>14% Participants Y	Water loss/ kg TM
11,40	0,02408	19,96	0,02151
5,88	0,02344	15,88	0,02413
8,51	0,02479	26,53	0,02465
9,88	0,02174	16,44	0,02397
9,88	0,01912	26,94	0,02531
7,41	0,02174	17,18	0,02256
		14,20	0,02256

There are two hypotheses. The first hypothesis H_0 claims that water loss is equal in participants with different body constitution and the alternative hypothesis H_1 claims that men with bigger body fat percentage lose more water during extensive physical strain. The measurement is executed on 13 male participants aged between 20 and 26. They are divided into two groups based on body fat percentage, Group X consists of participanst with smaller body fat percentage while gropu Y consists of participants with higher body fat percentage. Detailed analysis is shown in Table 4. The arithmetic mean of total water loss per kilogram of body mass is calculated for both groups of participants. The results are as follows i 023527. If it is supposed that samples $X_I, \ldots, X_n$i$Y_I, \ldots, Y_m$ are independent with normal division with equal dispersion result of which is not known the evaluation of standard deviation is calculated which results in: = i . Based on known standard deviation evaluations a common standard deviation evaluation is calculated result of which is as follows: All the calculations are inserted into the formula:

$$T = \frac{\overline{X} - \overline{Y}}{S_Z} \cdot \sqrt{\frac{n \cdot m}{n + m}}$$

Which results with T= . Based on Table of quantiles Student of this division the critical quantile for level of reliability is established, together with 11 degrees of liberty which comes to:

$$T_{11,0.95} = 1{,}7959$$

These quantiles are compared in order to reject the zero hypothesis and accept the hypothesis claiming that participants with bigger body mass percentage lose more water during extensive physical strain. Critical and calculated quantiles are compared and the results are following:

$$-1{,}095730974 < 1{,}7959 \textit{ odnosno } T < T_{11,0.95}$$

Hypothesis H_0 is rejected and the hypothesis H_1 is accepted according to which it can be stated with 95% probability that males with higher body fat percentage lose more water during extensive physical strain. In order to get the proportion of water consumption per kilogram of body mass that is higher in participants with higher body fat percentage the confidence intervals are calculated in both groups. With supposition that the water loss proceed linearly in both groups of participants, further statistical analysis shows that participants with higher body fat percentage lose 1.2 more water during extensive physical strain that participants with lower body fat percentage. This statistics is calculated with a small number of participants so the results are to be taken with caution.

Conclusion

The results of this research show the amount of water consumption during extensive physical strain in persons of different body constitution. Water loss per kilogram of body mass is 1.2 times higher in persons with higher body fat percentage. According to these findings, it is important to take care of water consumption during exercising extensive physical activities with heterogeneous groups and to encourage more water consumption in persons with higher body fat percentage.

References

1. Armstrong, L. E., Hubbard, R. W., Szlyk, P. C., et al. (1985). Voluntary dehydration and electrolyte losses during prolonged exercise in the heat. *Aviation, Space and Environmental Medicine,* 56, 765-770.
2. Cheung, S. S., McLellan, T. M., & Tenaglia, S. (2000). The thermophysiology of uncompensable heat stress, physiological manipulation and individual characteristics. *Sport Med,* 29, 329-359.
3. Costil, D. L. (1972). Water and electrolytes. In: Morgan, W. P., edited, Ergogenic Aids, and Macular performance. *Newyork: Academic Press*, 293-320.
4. D. Bethea and S. Powell, "Dehydration review", Health and Safety Laboratory, Buxton, Derbyshire SK17 9JN, UK. Rep. HSL/2005/29, 2005.
5. Gopinathan, P. M., Pichan, G., & Sharma, V. M. (1988). Role of dehydration in heat stress - induced variations in mental performance. *Archives of Environmental health*, 43 (1), 15-17.
6. Jackson, A. S., & Pollock, M. L. (1978). Generalized equations for predicting body density of men.*British Journal of Nutrition*, 40, 497-504.
7. Siri, W. E. (1956). The gross composition of the body. *Newyork: Academic Press*, 239-280.

Kinesiology of Top-level Sport

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KIDS WILL BE KIDS: CAN WE REDUCE INJURY RISK IN YOUTH SPORT?

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Abstract

Early specialisation is characterised by formal participation in a single sport at the exclusion of others. Limited data are available to support this approach in the development of young athletes, and few go on to attain elite status later in life. Of growing concern is the associated increased risk of injury and suggestions that single sport specialisation is a risk factor independent of age, growth, biological maturation and training volumes. It is well recognised that injury incidence increases throughout maturation and peaks around peak height velocity. It is also well recognised that females are 2-8 times more likely to suffer a non-contact injury compared to males once hours of athlete exposure are taken into account. The risk factors associated with non-contact injuries are multifaceted and include both modifiable and non-modifiable factors. There has been recent debate as to the influence that fatigue might play in injury occurrence due to incidence occurring later in match play, what fatigue is most likely to be present. Additionally few studies in children have explored the effects of an accumulation of high training hours, which are probably less of a relevant marker for success, and the impact of such a significant increase in training volume for young athletes who are experiencing a range of growth and maturational processes is currently unknown. What is poorly described throughout maturation are the risk factors associated with injury incidence making both screening and training prescription difficult. There are a number of screening techniques proposed to identify high risk youth athletes and these will be critically addressed in this keynote lecture. One of the biggest issues with all available screening techniques is that none have a fatigue element associated with them, increasing the risk of identifying false negatives. Modifiable factors include muscle strength, balance and co-ordination, landing mechanics and general movement competency. There is a growing evidence base to suggest that training interventions are available to reduce injury incidence in youth athletes, however limited data exists into the effectiveness of these programmes across a range of ages, maturational status and sports. This keynote will explore the effectiveness of injury prevention interventions and explore possible barrier to the successful implementation of such programmes.

RESEARCHES INTO STUDENTS BASKETBALL DEVELOPMENT HISTORY AND STATUS QUO IN CHINA

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1. Basketball is the most popular, most popular sporting event in Chinese universities. CUBA is the abbreviation of China Universities Basketball Association. It is divided into two groups, one for the elite group, the other for the sun group. The college students' league (the elite group) has been in development for two decades, and the college student league (sunshine group) has only three years, 34 provinces and cities in China, 2595 regional universities (2016 data), Which participated in the CUBA (elite group) basketball league school has more than 700, accounting for about 35% of all colleges and universities.
2. China University Students League (elite group) have changed a lot during the 21 years, including game system, entry conditions of student athletes and competition rules. these measures has promoted the germination period, the development period to the present prosperity period, and China University Students League (elite group) is the second largest college student basketball organization in addition to the United States NCAA Basketball League in the world.
3. The way of college students' sports funds is mainly composed of three parts: school self-financing, corporate sponsorship and special fund allocation. Most of the funding sources are maintained through the allocation of funds for school sports, and sports team funds by the school sports department operation and the team's own efforts to get the sponsorship is very small. For the time being, CUBA college student team income comparison NCAA college student team's income source is relatively simple, the amount of income is also very small.
4. In the Chinese student sports competition project, the college basketball league is the largest number of school teams, the most games, the audience, the majority of students favorite game, but in the World University Games basketball game, the game ranking has been 10 after wandering, indicating that our team's athletic level is still in a relatively backward position, and there is still a big gap between the training level of the coaches, the training ideas, the means of training methods and so on, and it need to continue to improve the level of training and competition in the world of college students to get a better game ranking.

MOVEMENT PATTERNS IN FENCING DEPENDING ON STIMULI TYPES – CASE STUDY

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Abstract

Introduction

The sorts of perception determinate the success achievement in fencing competitiveness and efficiency. The major role of the coach is to focus attention around improving reaction time referring to visual and tactile stimuli. In the real duel environment both of the perception types mentioned above tend to complete each other.

Materials and methods

The female epeeist representing Polish junior team has been invited to participate to the research procedure performing the three trials responding to two types of stimulation which were initiated by the coach who played the role of the tutor. The fencer performed lunge in response to the master fencer's step forward as a visual stimulus. Additional stimulus measured was a tactile type, when the master fencer was losing contact between blades which was a tactile signal to perform lunge by the research participant. The goal of the investigation was to consider a dynamic structure of fencing lunge through the establishment of muscle activation order: *rectus femoris and biceps femoris* in a forwarding leg, *musculus gastrocnemius* in back leg, *biceps brachii, triceps brachii* and *brachioradialis* in a weapon maintaining arm. Moreover, we measured medium value of bioelectric muscle tension (EMG).

Results

In reaction to tactile stimulus, the change in the order of stimulation of triceps and the gastrocnemius lateral head is observed when the muscle activation during simple attack with lunge begins. Triceps is activated as the first one. The activation of remaining muscles is unchanged. Comparing both types of stimulation neuro-muscular response to tactile stimuli generate considerably higher record of EMG signal.

Discussion and Conclusion

The concept mentioned above confirms that the preparation period while fencers anticipate visual stimuli decreases the value of EMG signal (Borysiuk Z., Waśkiewicz Z., (2008). The types of reactions are manifested in practice as sensori-motor responses and should be trained by simple and compound exercises according to motor learning and performance scheme introduced in Czajkowski (2011).

Key words: *EMG signal, fencing lunge, tactile and visual stimuli*

References

1. Borysiuk Z., Waśkiewicz Z., (2008) Information Processes, Stimulation and Perceptual Training in Fencing. "Journal of Human Kinetics" vol. 19: 63-82.
2. Czajkowski Z., (2011). Directing the process of training, taking competition and fencer's personality dimensions as a model. IDO-Movement for Culture. Journal of Martial Arts Anthropology. Vol 11, No. 4: 48-56.

DIFFERENCES IN ATTACK SITUATIONAL ACTIVITY INDICATORS BETWEEN TEAMS IN CROATIAN HANDBALL WOMAN LEAGUE

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Abstract

In this research the differences in some parameters of situational efficiency between the two best placed teams in the competition of the first Croatian handball league for women were studied. The results of analysis using the Mann-Whitney U-test indicated that between a team HC Lokomotiva Zagreb and HC Podravka Vegeta there are statistically significant differences in the variables of the total number of strokes from the wing position, then the total number derived from their penalty shots and assists. In order to approach the European and world handball trends in women's handball, further research, as well as directing the training process are desirable to direct to the factors set forth superior quality in women's handball.

Key words: *comparison, the efficiency in the attack, women in team sports*

Introduction

Technical and tactical complexity of the handball game in combination with a broad spectrum of high levels of fitness, from handball player's put very high demands for efficiency in the situation/competitive conditions handball game i.e., individual matches, tournaments, championships. Handball game that observe the aspects of performance elements techniques in phases defense and attack partly describes and reveals the structure of the game that followed the two opposing teams during a handball match points to certain advantages/disadvantages by each team and for each player. Systems for monitoring of certain sports events including handball are accompanied by high technology, which applies modern information methods that opens spaces for exact analysis specifically recorded events during the match. Professional and amateur league handball exist in different countries on every continent. The World Cup, the championship of individual continents, international tournaments in the category of women's handball are held regularly. From the Olympic Games in Montreal in 1976 for women handball is in the regular program of the Olympic Games. Previous studies of handball game in terms of identification, registration and evaluation of the standard indicators of competitive performance conducted more frequently analyzes of World and European Championships and the Olympic tournament for men than for women (Prieto Gómez & Sampaio, 2015). Gruić et al., (2005) attempted to determine the impact of situational efficiency parameters back court attackers on the final outcome of the matches of the World Handball Championship in 2003 for women, held in Croatia. Ohnjec et al. (2008) studied the influence of differently structured indicators of situational effectiveness on the outcome of the matches of the World Handball Championship in 2003 for women. Ichimura et al. (2011) are at the 17th World Championship for women held a total of 2010 analyzed 4 team, 1374 shots during the 34 matches. They analyzed the position from which the player's shot on the goal during the handball match and its performance. Hianik, (2013) reached the correlation between matches (win/loss) with situational indicators in the phase of attack and defense, and indicators of performance for goalkeeper's. Yamada et al. (2014) conducted a study to clarify the difference in indicators of handball game with successful and unsuccessful European women's handball team. Vurgun et al. (2014), indicated that the winning teams during a match dominated by the execution of shots on goal, then the implementation of the fastbreaks and the successful efficiency of the same, as well as in a higher number of successful goalkeeper's defense. Ohnjec et al. (2015) found that the successful handball team in the competition and the difference between successful and unsuccessful team are most affected by the application of a large number of the beginnings of attacks that have the potential to fastbreak attacks. Club competitions in individual national championships were also objects of study efficiency in woman handball (Michalsik et al., 2014, Bajgorić et al., 2016). The aim of this study was to determine the differences in some parameters of situational efficiency between the two best placed teams First Croatian National League.

Methods

Sample of respondents

The sample of respondents in this study consisted of 50 games that two best ranked teams (HC Podravka Vegeta, Koprivnica and HC Lokomotiva Zagreb) preformed during the First Croatian National League at 2015/2016 competition season. Four the purpose of this study 25 matches HC Podravka Vegete and the same HC Lokomotive were analyzed. HC Podravka Vegeta National Championship ended as first-placed with 48 points with a ratio of 24 wins and 2 losses and a goal difference of 779 goals scored and 486 received goals. HC Lokomotiva National Championship ended as second-placed with 43 points with a ratio of 22 wins, 3 draw and 3 loses and with a goal difference of 702 goals scored and 517 received goals.

Sample of variables

The total of variables consists of 2 groups: frequency of shootings and realisation percentage (the relation between directed and achieved goals). Within each group there are 5 variables: back court position shootings (9m_S), 6 m line shootings (6m_S), wing position shootings (Wing_S), 7 m shootings (7m_S), shootings from the offense transition (FB_S), efficiency from back court position of 9 m (9m_%), efficiency from 6 m line (6m_%), efficiency from wing positions (Wing_%), efficiency from 7 m (7m_%), efficiency of goals after offense transition (FB_%). Except for the mentioned data, we have also used the data concerning the relative assistance number, (AS) and technical errors (TF) of a team.

Data processing methods

The method of notational analysis was used to collect data. The HRS (Croatian Handball Federation) official game statistics is posted and available at the official website (www.hrs.hr). Within the descriptive statistics, the following central and dispersion parameters of the observed variables were determined: Mean – arithmetic mean, SD – standard deviation, and KS – Kolmogorov-Smirnov test, which examines the goodness of data fit. To determine the differences between the first and second ranked team in First Croatian League in situation-related efficiency variables the Mann-Whitney U-test was used.

Results

Table 1 showed the results of descriptive statistics (means and standard deviations) separately for each of the observed team as well as the values obtained testing normality distribution of observed variables. It also presents the results of the analysis of the difference between the two teams in the situational parameters, whereby based on a Mann-Whitney U test statistically significant difference parameters are specially marked with the significance level of less than <.05.

Table 1: Basic descriptive statistics of the performance variables and Mann Whitney U-test of the difference between first and second ranked teams

	Mean	Mean	SD	SD	Max D	K – S p	z	p
	Lokomotiva	*Podravka*	*Lokomotiva*	*Podravka*				
9M_S	17,64	18.76	4,36	5,59	0.10	>.20	-1,01	0,31
9M %	47.35	46,29	11,16	15.76	0.09	>.20	-0,12	0,91
6M_S	11.12	9,40	4,68	3.82	0.15	>.01	1,25	0,21
6M %	78.56	77,30	10,08	14,08	0,10	>.20	0,34	0,73
WING_S	4,00	7,32	1,98	2,10	0,12	<.10	-4,51	0,00*
WING %	61.24	58,82	32,24	20.53	0,08	>.20	0,64	0,52
7M_S	4.72	3,04	2,30	1,46	0,14	<.05	2,65	0,01*
7M %	70,23	79.80	28,47	26,31	0,20	<.01	-1,32	0,19
FB_S	4.76	4,64	4,89	4,71	0,19	<.01	-1,48	0,14
FB %	81,63	79,80	22,70	13,26	0,16	<.01	0,71	0,48
AS	2.52	8,44	2,71	8,52	0,24	<.01	-2,18	0,03*
TF	9.40	8,00	3,21	3.21	0,10	>.20	1,51	0,13

MEAN – arithmetic mean, SD – standard deviation, MAX D – discrepancies between theoretical and cumulative proportions, K-S test p-significance – Kolmogorov-Smirnov test of data distribution normality, Z – value per which approximates U for large samples, p-value – the amount of errors that make the acceptance of the hypothesis that the difference is statistically significant. 9m_S – frequency of back court position shootings, 9m_% – efficiency from back court position of 9 m, 6m_S – frequency of 6 m line shootings, 6m_% – efficiency from 6 m line, Wing_S – frequency of wing position shootings, Wing_%– efficiency wing position shootings, 7m_S – frequency of 7 m shootings, 7m_%efficiency from 7 m, FB_S – frequency of shootings from the offense transition, FB_% – efficiency of goals after offense transition, AS – assists number, TF - technical errors.

Discussion

HC Lokomotiva Zagreb averaged had 17.64 strokes from 9 meters (9M_S) with a percentage efficiency of 47.35% (9M_%), while RK Podravka 18.76 shots on goal with 9 meters with a percentage efficiency of 46.29%. Almost uniform plays two best placed women's handball club in Croatia, in relation to the game of back court attacker's, confirms characteristics of the game with a dominant frequency of shoot's from with these positions (Yamada et al., 2014, Vurgun et al., 2014), but with less frequency in relative to European national teams (Foretić et al., 2011). In the variable shooting from 6 meters (6M_S) HC Lokomotiva average 11,12 shots on goal with the realization of 78.56%, while RK Podravka with this position sent an average of 9.40 strokes with the implementation of 77,29%. The effectiveness of the implementation of the goal area line coincides with the success of the implementation shots from that position with the winning team at the Olympic Games and European Championships (Taborsky, 2013, Yamada et al., 2014).

The tendency of creating a situation for shooting from the goal area line, largely characterized handball for the female population (Foretić et al., 2011), which is reflected in the game of these observed teams. It is possible that the tactical variants of both teams, or in slightly greater numbers of HC Lokomotiva focused on assistance for pivot player's or on feinting defensive players, and thus creating a situation to shoot from the 6 meters. In variable shooting from the wing position (WING_S) HC Lokomotiva average 4.00 shots, with the efficiency of 61,23% (WING%), and HC Podravka average of 7.32 shots from the wing position with the efficiency of 58,82%. The results indicate that a tactical play of HC Podravka more based on the left and right wing players, which can also be linked with a number of assists (AS-8.44) compared to the RK Lokomotiva (AS-2.5) who are more oriented on the pivot player and feinting 1:1 which is also in direct connectors with a large number derived from their penalty shots. In the variable 7 m shootings (7M_S) HC Lokomotiva Zagreb has average 4.72 with efficiency of 70.23% (7M%), and HC Podravka has an average of 3.04 shots from seven meters with the percentage of realization of 79,80%. Fastbreak has become, for all good teams, one of the main concerns, and also an efficient way of scoring goals (Calin, 2010). Comparison of fastbreaks for two observed teams, shows that it had an almost identical role in the creation of the final results of the team, because the HC Lokomotiva on average had 4.76 (FB_S) attacks on unorganized defense which ended with the success of the realization of 81.63%, and the HC Podravka average had 4.64 with the success of implementation of 79,80%. The performance of assists shows that HC Lokomotiva Zagreb has an average of 2.52 per game (AS), while common in the application of the same were players of HC Podravka 8.44. Technical errors that result in the loss of the ball in over the situation occurred in the game HC Lokomotiva 9.49 (TF) with respect to HC Podravka with an average of 8.00 per game.

Analysis of the difference between the teams HC Lokomotiva Zagreb and HC Podravka Vegeta, Koprivnica in the observed variables show that there are significant differences in the variables of the total number of strokes from the wing position (WING_S - Z = -4.51 with p = 0.00), then the total number derived from their penalty shots (7M_S - W = 2.65 with p = 0.01), and assists (A - Z = 2.18 with p = 0.03). The difference between the analyzed variables in the teams obtained the total number of strokes of the wing position WING_S, coincides with the factors distinguishing team participating World Cup (Ohnjec et al., 2008). It is possible that the concept of the game HC Podravka Vegeta, in accordance with the characteristics of their players on the left and right wing, was oriented just to finals the attack on this positions, while form stability and efficiency of shooting the wing players HC Locomotiva mainly directed their game to finding attack finishing solutions from other attack positions. Next obtained difference was in the variables derived from penalty shots. Average HC Lokomotiva has two more penalty shots per match than HC Podravka. On the one side, defensive activity that involves sanctioning penalty shots (7 meters), and on the other to initiate the game in direct confrontation 1: 1 or search pivot player, largely characterized game of HC Locomotiva, compared to HC Podravka. The lack of effectiveness of these situations, possible marked the final placement at the end of the championship. The quality of game one handball team in the offensive also represent assistance which depends on many factors: weak mobility of opponent`s defense, bad cooperation of defense players, low quality of defense players` taking over, poor timing of attack players exit, etc., but also on the attack player`s ability of deciding to perform this technical-tactical element on time (Bajgorić et al., 2016). The resulting statistically significant difference in this variable can explain that the players of HC Podravka compared to HC Lokomotiva better organized game in the final phase of the attack, which is based mostly on group cooperation, and actively attacking and tying two defensive players and search for players that is in the unobstructed situation for realization of the goal.

Conclusion

Situation in the Croatian women's club and national team handball is far away compared to the most successful European and world handball women teams. The two best Croatian teams that are holders of the quality of women's handball in Croatia in the last 15 years have not recorded significant results in European club competitions which in the last few years largely reflects to the results of the women's national senior selection. It would be desirable the presented real situation at the national level compared with those outside the framework of the country. In this way, it could be possible development trends for Croatian clubs and national teams direct towards the excellent results in women's handball. Guidance for further research should look in analysing and comparing with the holders of European and World women's handball quality at club and international level, how would all participants that create guidelines for the development Croatian women's handball at higher level, had the most precise and more exact factors for making the same.

References

1. Bajgorić,S., Rogulj N., Gudelj Ceković, I. (2016). Differences in attack situational activity indicators between successful and less successful teams in elite women`s handball. *Acta Kinesiologica* 10,2 (21-25).
2. Calin R. (2010).The analysis of the efficiency of using fast breaks in female handball during the World Championship in China, *Sci Movement Health*, 2; 594-599.
3. Foretić, N., Rogulj, N.Srhoj, V., Burger, A., Raković, K. (2011). Differences in situation efficiency parameters between top men and woman handball teams. In Proceedings of EHF Scientific Conference „Science and Analytical Expertise in Handball"(pp. 243-274). Vienna: EHF.
4. Gruić, I., Vuleta, D., Milanović, D. & Ohnjec, K. (2005). Influence of performance parameters of backcourt attackers on final outcomes of matches of the 2003 World Handball Championships for Women in Croatia. In D. Milanović & F. Prot (Eds.), Proceedings book of the 4th International Scientific Conference „Science and profession – challenge for the future", Opatija, 2005 (pp.470-474). Zagreb: Faculty of Kinesiology, University of Zagreb.
5. Hianik, J. (2013). The Relation of Women Team Match Performance Indicators to the Result of the Match in Handball. Proceedings of the *2nd EHF Scientific Conference,* „Women and Handball" Scientific and Practical Approaches, (pp. 219-223). Vienna: EHF.
6. Ichimura, S., Ogasawara, I., Nakata, Y., Inafuku, T., Saito, S., Todoroki, M.,Tamura, S.; Moriguchi, T., & Tanaka M. (2011). Quantification of Shooting Play Position and Shooting Course from Pictorial Handball Match Statistics Report In Proceedings of EHF Scientific Conference „Science and Analytical Expertise in Handball" (pp. 261-267). Vienna: EHF.
7. Michalsik, LB., Madsen, K. Aagaard, P. (2014). Match Performance and Physiological Capacity of Female Elite Team Handball Players. *Int J Sports Med*, 35(07): 595-607.
8. Ohnjec, K., Vuleta, D., Milanović, D. & Gruić, I. (2008). Performance indicators of teams at the 2003 World Handball Championship for woman in Croatia. *Kinesiology,* 40(1), 69-79.
9. Prieto, J., Gómez, M.A. & Sampaio, J. (2015). From a Static to a Dynamic Perspective in Handball Match Analysis: a Systematic Review, *The Open Sports Sciences Journal,* 2015, *8,* 25-34. Available at: http://benthamopen.com/ABSTRACT/TOSSJ-8-25. 17.01.2016.
10. Ohnjec, K., Vuleta, D., Milanović, D. (2015). Differences between the winning and defeated female handball teams in relation to the beggining of attacks. *Sport Science* 8 (1);7-11.
11. Taborsky, F. (2013). The Comparison of Cumulative Indicators of Team Playing Performance between Genders: Olympic Games Handball Tournaments 2008 and 2012. Proceedings of the *2nd EHF Scientific Conference,,* „Women and Handball" Scientific and Practical Approaches", (pp. 13 - 18). Vienna: EHF.
12. Vurgun, H., Işik, T., Şahan, C., Işik, O. (2014). Technical Analysis of 2012 Female Europe Championship and Olympiad Games - Handball Performances. *The online Journal of Recreation and Sport*, 3(1), 41-47.
13. Yamada, E., Aida H., Fujimoto, H., Nakagawa, A. (2014). Comparison of Game Performance among European National Women's Handball Teams. *International Journal of Sport and Health Science* Vol. 12 p. 1-10.

ELITE KAYAK ROWERS' (1000 M) BODY ADAPTATION INDICES DURING COMPETITIVE MESOCYCLE IN ALTITUDE TRAINING

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Abstract

The aim of the work was to carry out investigation on the change in elite kayak rowers' (1000 m) indices of physical and functional capacity and aerobic metabolism during competitive period applying altitude effect.

Organization and methods of the research: Kayak rowers carried out training sessions in altitudes for 17 days during competitive mesocycle, preparing for 2016 Olympic Games (OG). Research was carried out before and after training in altitudes. After four days, the athletes left for Brazil and for fifteen days were preparing for participation in OG. The kayak rowers participated in OG in the 19th and 20th days after the end of altitude training. Having returned from the OG, the studies were carried out once more – it was the 25th day after the end of altitude training and the 4th day after the final event in the Games. Aerobic power was analyzed using gas analyzer.

Research results: In altitudes training (AT) camp the athletes rowed 204.03 km. Indices of anaerobic alactic (AA) special 10 sec working power experienced little changes. Special working power of lactic anaerobic threshold (LAT) used to increase respectively by 6 and 2 W during the camp; after the participation in the Olympic event. Studies of aerobic metabolism in kayak rowers, showed little change of VO_{2max}.

Conclusions: No significant changes of body aerobic metabolism occurred in elite kayak rowers (1000 m) during their preparation for the OG in altitudes 17 days during competitive mesocycle. VO_{2max}, special working power within the limits of critical and lactate at LAT remained unchanged.

Key words: *kayak sport, VO_{2max}, aerobic metabolism*

Introduction

All stages of four-year Olympic cycle in kayak rowers' preparation are important, however, choosing appropriate means and methods of preparation for the last competitive mesocycle is of paramount importance. Literature sources present material on elite kayak rowers' preparation in 200 and 500 m events (Rudzinskas et al., 2001). Analysis of investigations of elite athletes' (1000 m) preparation is provided on characteristic features of separate training means and methods effectiveness (Borges et al., 2015). Investigation of kayak rowers' preparation in altitudes highlighted the fact that the best positive impact of the AT was for 1000 m kayak rowers (Hoppeler et al., 2008). The most significant changes after arrival to altitudes manifest themselves in increase of blood Hb concentration (Robach, Lundby, 2012). There are recommendations prepared for the use of altitudes effect in athletes' preparation, special attention paying to the change of working capacity having returned from altitudes (Issurin, 2010). However, the research data of altitude effect in competitive mesocycle of elite athletes, taking part in the OG in 1000 m, are still missing. The aim of the work was to carry out investigation on the change of elite kayak rowers' (1000 m) indices of physical and functional capacity and aerobic metabolism during competitive period applying altitudes (1800 m) effect.

Organization and methods of the research

Two elite kayak rowers (RN. & AO.) of Lithuania underwent four-year training period, participated in 2016 OG (taking there the fifth place). Investigation of their preparation and body adaptation changes can be considered as a single-case research. Kayak rowers underwent AT (1800 m) for 17 days. Research was performed before leaving to altitudes (testing I) and having returned back (testing II). After 4 days, the athletes left for Brazil and 15 days used to prepare for the event. The athletes participated in competitions in the 19th and 20th days after having returned from altitudes. Having returned from the OG, the 25th day after altitude training, which was the 4th day after the final event in the OG, research (testing III) was continued. The content of the testing program included: measuring of body development; establishment of special anaerobic alactic power in 10 sec maximum work duration, the work performed by special kayak rowing ergometer "Dansprint"; establishment of aerobic capacity, which was measured using gas analyzer "Oxycon Mobile 781023-052-5.2" basing on Thoden (1991) special work methodic. At the limits of critical intensity (CIL) and ventilation threshold, indices of lungs ventilation (LV, l/min), pulse rate (PR, b/min), relative O_2 consumption (ml/kg/min), working capacity (W) were established. In 5 min after the work performed, capillary blood samples were taken and lactate (La) concentration (mmol/l) established. During training in altitudes and Brazil, body adaptation process was evaluated by establishing resting pulse rate in the morning (PR), haemoglobin (Hb) concentration (g/l), hematocrit (Ht, perc.). For establishment of volume and intensity of training sessions, computer system "Garmin Connect Forerunner 910 XT" was applied. Such parameters as boat speed, distance, athletes' PR were recorded, La concentration in capillary blood measured.

The results

During AT camp, athletes used to train 13 days and had 20 training sessions. The distance rowed – 204.03 km, 68.5 km in the first microcycle, 94.78 km – in the second, and 40.75 km – in the third. The first microcycle was mainly devoted to the work of the first intensity zone, which made 81.5 percent of the total work (table 1). In the second microcycle, the training workouts were of more intense character – 3.1 percent of time was allocated to work in the third intensity zone. In the third microcycle, 1.9 percent of time was used for maximum activation of glycolytic and aerobic reactions. After return from AT camp, two training sessions were carried out. The first session embraced work mostly in aerobic development zone, while in the other session repeated work, aiming at stimulation of glycolytic reactions, was performed. During 9 days stay in Brazil during competitive microcycle, carried out 10 training sessions, total rowing distance being 77 km. In the OG, kayak double participated three times during two days in 1000 m distance, taking the fifth place in the finals (result – 3 min 14.748 sec; La=14.6, 15.2 mmol/l).

Table 1: Report of kayak rowers' (1000 m) special work (rowing on water) preparing for 2016 Rio Olympic Games

In altitudes						
		1st zone	2nd zone	3rd zone	4th zone	5th zone
Ist microcycle (7 days)	Hours	07:02:00	01:24:00	00:08:00	0	00:04:05
	Percent	**81.5**	**16.2**	**1.5**	**0**	**0.8**
	Total work: 68.5 km.					
IInd microcycle (7 days)	Hours	09:20:00	01:34:00	00:21:00	00:14:40	0
	Percent	**81.2**	**13.6**	**3.1**	**2.1**	**0**
	Total work: 94.78 km.					
IIIrd microcycle (3 days)	Hours	04:59:00	00:17:30	00:22:30	00:06:40	0
	Percent	**86.5**	**5.1**	**6.5**	**1.9**	**0**
	Total work: 40.75 km.					
TOTAL	Hours	21:21:00	03:15:30	00:51:30	00:21:20	00:04:05
	Percent	**82.4**	**12.6**	**3.3**	**1.4**	**0.3**
	Total work: 204.03 km.					
In Lithuania						
		1st zone	2nd zone	3rd zone	4th zone	5th zone
IVth microcycle (3 days)	Hours	00:55:00	00:09:30	00:02:30	00:08:00	0
	Percent	**73.3**	**12.7**	**3.3**	**10.7**	**0**
	Total work: 18.97 km.					
RIO						
		1st zone	2nd zone	3rd zone	4th zone	5th zone
Vth pre-competitive microcycle (9 days)	Hours	05:00:00	00:25:00	00:05:00	00:12:30	0
	Percent	**87.6**	**7.3**	**1.5**	**3.6**	**0**
	Total work: 34.92 km.					
VIthmicrocycle	Hours	05:55:00	00:19:30	00:17:30	00:09:00	00:01:20
	Percent	**88.2**	**4.9**	**4.4**	**2.2**	**0.3**
	Total work: 42.52 km.					
VIIth competitive microcycle (7 days)	Hours	02:30:00	00:12:00	00:03:15	00:01:30	0
	Percent	**90**	**7.2**	**1.9**	**0.9**	**0**
	Total work: 22.51 km.					
TOTAL (IV-VII weeks)	Hours	14:20:00	01:06:00	00:28:15	00:31:00	00:01:20
	Percent	**87.2**	**6.7**	**2.9**	**3.1**	**0.1**
	Total work: 118.92 km.					

Study of the athletes' body development showed almost the same results of both athletes' muscle mass during the first testing, however, it used to decrease for both athletes during the period of investigation almost by 1 kg. Little change was established in indices of AA special power of 10 sec work (table 2). Special working capacity of LAT during AT camp was of insignificant increase.

Table 2: Data of kayak rowers' LAT and 10 sec duration working capacity testing

Athletes	LAT		10 sec			
	b/min	W	max		av.	
			W	W/kg	W	W/kg
Testing I 2016 June 28						
R. N.	160	190	750	8.5	610	6.9
A. O.	182	205	744	8.7	677	7.93
Testing II 2016 July 29						
R. N.	165	203	860	9.6	619	6.92
A. O.	182	207	717	8.4	641	7.54
Testing III 2016 August 22						
R. N.	167	200	749	8.5	615	6.95
A. O.	179	207	724	8.5	644	7.51

Performed research of kayak rowers' aerobic metabolism showed very little change in the athletes' VO_{2max} indices (table 3). Lung ventilation at CIL after AT used to increase by 2 l/min for the first athlete, and it decreased by 21 l/min for the second. In the third testing, this index used to significantly decrease for the first athlete. At this limit, under altitude conditions, working capacity of both athletes did not change. Within the limit of ventilation anaerobic threshold (VAT), O_2 consumption in ATL even had decreasing tendency; however, testing results achieved after the athletes' participation in the OG showed great increase in the activeness of glycolytic reactions.

Table 3: Data of kayak rowers' aerobic metabolism

No	Athletes	Critical intensity limit				Anaerobic threshold limit				La, mmol/l
		LV, l/min	PR, b/min	$VO_{2,}$ ml/min/kg	W, km/h	LV, l/min	PR, t/min	$VO_{2,}$ ml/min/kg	W	
Testing I 2016 June 28										
1	R. N.	190	177	58.3	340	122	162	43.3	220	12.1
2	A. O.	178	197	62.2	340	128	186	51.2	240	11.2
Testing II 2016 July 29										
1	R. N.	192	186	58.2	340	113	165	39.2	200	9.7
2	A. O.	157	201	49.1	340	133	191	50.5	240	10.1
Testing III 2016 August 22										
1	R. N.	181	189	57.8	340	107	169	41.2	200	14.0
2	A. O.	154	201	61.1	320	118	184	46.5	220	13.1

Results of blood Hb concentration of AO. increased greatly – up to 190 g/l the third day having arrived to altitudes, Ht increasing up to 55 perc. After altitude training camp, these results remained at increased level, though with slight decrease.

Discussion

Investigation of elite kayak rowers' body adaptation before the OG and competitive mesocycle, showed sufficient development of the athletes' muscle mass comparing with previous research data (Nekriošius, 2014). Data of special AA power and aerobic metabolism were also of high level. In altitude training, where the greatest part of the work performed was allocated to the zone of aerobic metabolism maintenance, 12.6 percent of total work was carried out at the metabolism limit of LAT. The research data did not demonstrate significant changes of these indices, except increased values of blood Hb concentration of the second athlete the third day after arriving to altitudes; such phenomenon had been observed by the other authors (Robach, Lundby, 2012). According to Wilber (2007), other indices of cardiovascular system also experience changes under conditions of altitudes, however, our results did not demonstrate changes neither in PR of the investigated athletes. Scientific arguments are provided about increased functional and physical powers of the athletes in 2-4 days after their return from altitudes(Millet, 2010),. Little changes were established in the indices of aerobic metabolism. AT did not make influence on VO_{2max} indices; no altitude effect on elite athletes' aerobic metabolism is pointed out by other authors (Friedmann-Bette, 2008). The results of the investigations performed just after athletes' return from the OG, the fourth day after participation in the events, highlighted the fact of complex processes in athletes' bodyPresumably, before participation in the main competitions and during them, elite athlete's body is effected by variety of complex processes. This fact enhances further researches in this field.

Conclusions

1. No significant changes of aerobic metabolism occurred in elite kayak rowers' (1000 m) body during 17 days lasting competitive mesocycle in altitudes. VO_{2max} and special working capacity experienced almost no changes within the CIL and LAT.
2. When in altitudes, blood Hb concentration used to increase in first days, however, the 22nd day after return from the altitudes, increased values of this index were gone.
3. Means and methods applied for kayak rowers' training process were not of sufficient effect on the progress of their mastership improvement. More effective means and methods to improve kayak rowers' aerobic and anaerobic metabolism should be found.

References

1. Borges, O.T., Dascombe, B., Bullock, N., & Coutts, J.A. (2015). Physiological characteristics of Well-Trained Junior Sprint Kayak Athletes. *International Journal of Sports Physiology and Performance*, 2015, 10, 593-599.
2. Friedmann-Bette B. (2008). Classical altitude training. *Scandinavian Journal of Medicine & Science in Sports,* 18(1), 11-20. doi: 10.1111/j.1600-0838.2008.00828.x.
3. Hoppeler H., Klossner S., & Vogt M. (2008). Training in hypoxia and its effects on skeletal muscle tissue. *Scandinavian Journal of Medicine and Science in Sports's,* 18(1), 38-49. Issurin V. Block Periodization. Breakthrough in Sport Training. Ed by Yassis M. Ultimate Ahtlet Concepts Michigan. USA, 2008, 214 p.
4. Issurin N.V. (2010). New horizons for the methodology and physiology of training periodization. Sports Medicine, 4(3), 189-206.
5. Nekriošius, R. (2014). Didelio meistriškumo baidarininkų rengimosi 2013 ir 2014 metų pasaulio čempionatams varžybų mezociklų lyginamoji analizė. *Sporto mokslas*, 4(78), 8-14.
6. Robach P., Lundby C. (2012). Is live high–train low altitude training relevant for elite athletes with already high total hemoglobin mass? *Scandinavian Journal of Medicine & Science in Sports*, 303-305.
7. Thoden J.S. (1991). Testing aerobic power. In: MacDougall J.D, Wenger H.A, Green H.J, editors. Physiological testing of the high-performance athlete. Champaign (IL): Human Kinetics; pp. 107-174.
8. Wilber R.L. (2007). Application of altitude/hypoxic training by elite athletes. *Medicine & and Science in Sports and Exercise,* 39(9), 1610-1624.

EFFECTS OF GAME-RELATED STATISTICAL PARAMETERS ON FINAL OUTCOME IN NATIONAL HOCKEY LEAGUE (NHL)

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Abstract

The aim of this study is to determine which variables affected on final outcome more in situational parameters. We anticipate significant influence of more variables on criteria that shows won and defeated teams. We have taken into consideration scored goals in each period and their difference, minutes of penalty, power play opportunities, face-off percentage, total shots on goal, save percentage, hits, blocks, giveaways and takeaways. These indicators have been standardized by the National Hockey League (NHL). To investigate separate contribution of each game-related statistical parameter on the final outcome of the game, multiple regression analysis was performed. In regression model we can see that variable Save Percentage (SVS%) (β = 0,591242, t=8,07600, p<0,0000) had the main influence on final outcome. Variables P2 (β = 0,4878), P3 (β = 0,3464), P1 (β = 0,2891) and OT (β = 0,2292) can explain variance on this regression model was R^2=0,78. To eliminate influence of scoring variables in second regression model only three variables were statistically significant; SVS% (β = 0,6966, t=6,0264, p< 0,0000), PPG (β = 0,3525, t=3,1925 p< 0,0024) SOG (β=0,2298, t=2,2112, p< 0,03135). Explained variance in second model was R^2=0,46. In conclusion, save percentage contributes the most on the final result. Good teams usually have better defense setup to eliminate shots in front of the net and slot position to help goaltenders to have open shot form distance.

Key words: *Team Sport, Game-Related Parameters, Regression Analysis, Ice hockey*

Introduction

Ice hockey is very intense, intermittent and the fastest team sport that requires a wide variety of motor skills as well as high level of fitness to compete at elite level (Quinney, 2005). Performance indicators, which consist of a selection or combination of action variables, can be used to define performance in invasion games.

Situational parameters became one of the most important and objective factors determining overall efficiency in the game, especially in team sports. Hunter and O'Donoghue (2001) compared successful and unsuccessful rugby teams in 1999 World Cup. Their study found two of eleven variables that are related to winning teams.

In research conducted by Thomas (2006.), he considered the Harvard ice hockey team and made the argument that hockey can be described as a continuous time semi-Markov process. Thomas separated the game of ice hockey into 19 distinct states including: offensive team with the puck in defensive zone, defensive team with the puck in the offensive zone, faceoff at center ice, defensive takeaway, among others.

Moskowitz and Wertheim (2012.) disagree with that statement. They considered multiple sports, including hockey, and tried to determine if teams who were ranked as top defensive teams won championships more often than those who were ranked as top offensive team. In every sport they looked at, there were just as many offensive teams winning as there were defensive teams winning.

Molik et al. (2012) found significant differences between disability groups in the anthropometric measures of training frequency, height, and sledge length but there was no strong evidence to support disability group differences in game efficiency parameters. The results may confirm the lack of need for classification in sledge hockey or may be evidence that a classification system is needed as the lower functioning disabilities are not being represented in the sport.

Nadeau et al. (2008) modified Team Sport Assessment Procedure (TSAP) for ice hockey. It consists of 10 explained constants that three well educated specialists need to mark. These constants made it possible to avoid unreasonable distortions of efficiency index values due to low numbers of ball or puck losses (Gréhaigne et al., 1997; Nadeau et al., 2008).

Nowadays, best efficiency parameters are given by NHL. They go in deep spheres of hockey so that one can get information about time spent on the ice, how many shoots did the player perform in attacking situations, and how many hits, blocks, penalties in defensive situations.

The aim of this study is to determine which variables affected on final outcome more in situational parameters. We anticipate significant influence of more variables on criteria that shows won and defeated teams.

Methods

Subjects. The study was conducted on the sample of the 30 games (60 opponents) playing in the NHL regular 2016/17 season games. Games were selected by Research Randomizer on https://www.randomizer.org/ website. Games with output numbers were considered.

Variables. The variables that represent situational efficiency comprised 18 standard indicators in ice hockey game proven by NHL box score. All results were downloaded from official NHL website (NHL.com, 2017).

Data analysis. For all analyzed parameters, arithmetic mean and standard deviation were calculated To investigate separate contribution of each game-related statistics parameter on the final outcome of the game, multiple regression analysis was performed. Statistical significance was set up at p≤0,05.

Results

In table 1. Descriptive parameters showed that scoring in ice hockey is low. Thomas (2007) and Ryder (2004) suggest that goal scoring in hockey follows a Poisson distribution. Goal scoring in a hockey game is basically a Poisson process. A tie-breaking shoot out would be Binomial, but a hockey game is basically Poisson. Main differences between win and defeated teams are Save Percentage (SVS%) and Scoring in second and third period(P2, P3). Scoring in 2nd and 3rd period is slightly higher than scoring in first period. In other variables there are slight differences but not statistic significant. Winning teams had less penalty minutes which don't give opponent chance for power play. Also, winning teams had lower numbers of Giveaway pucks which resulted in smooth offensive play.

Table 1: Descriptive statistic for independent variables

	KRIT=0(Defeated) KRIT=1 (Win) Descriptive Statistics									
Variable	N DEF	Mean	Min	Max	Std. Dev.	N Win	Mean	Min	Max	Std. Dev.
P1	30	0,60	0,00	3,00	0,77	30	0,90	0,00	4,00	0,96
P2	30	0,53	0,00	2,00	0,68	30	1,53	0,00	4,00	1,25
P3	30	0,73	0,00	2,00	0,78	30	1,43	0,00	5,00	1,33
OT	30	0,00	0,00	0,00	0,00	30	0,10	0,00	1,00	0,31
RES	30	1,87	0,00	5,00	1,25	30	3,97	1,00	6,00	1,59
SOG	30	28,70	20,00	37,00	5,23	30	30,50	19,00	38,00	4,42
SVS	30	26,53	13,00	35,00	4,51	30	26,83	19,00	36,00	4,80
SVS%	30	0,87	0,72	0,97	0,06	30	0,94	0,85	1,00	0,04
FO%	30	0,50	0,36	0,60	0,06	30	0,50	0,40	0,64	0,06
PIM	30	9,63	2,00	20,00	4,52	30	8,37	2,00	17,00	4,09
PPG	30	0,53	0,00	2,00	0,68	30	0,83	0,00	3,00	0,75
PPA	30	2,90	0,00	5,00	1,37	30	3,57	1,00	6,00	1,43
SHG	30	0,03	0,00	1,00	0,18	30	0,03	0,00	1,00	0,18
HITS	30	20,60	9,00	38,00	8,71	30	18,27	6,00	35,00	6,06
BLK	30	14,53	6,00	28,00	5,16	30	14,10	4,00	24,00	4,08
GVA	30	9,13	1,00	16,00	4,51	30	8,23	1,00	23,00	5,42
TKA	30	5,73	1,00	18,00	3,91	30	6,50	1,00	12,00	2,90

P1 – goals scored in 1st period, P2 – goals scored in 2nd period, P3 – goals scored in 3rd period, OT – goals scored in overtime, RES – final result, SOG – Shots on goal, SVS – saves by goalie, SVS% – save percentage, FO% – percentage of win face-offs, PIM – penalty minutes, PPG – power play goals scored, PPA – power play opportunities against, SHG – short hand goals, HITS – number of hits made, BLK – blocked shots, GVA – giveaways, TKA – takeaways

In multiple regression analysis we set up variable Criteria (KRIT) as a dependent variable and the rest of them as independent. As we see in Table 2., in regression model we can see that the main influence on won and lost is variable Save Percentage. Number of saves didn't have influence so much on game outcome, but it's percentage. It is normal to expect that teams must score to win, so goals scored in periods took relevant position. Scoring in 2nd Period took the highest position, which is the critical moment in the game. Of course, if a game goes into overtime, the team need to score if they want to win game. Explain variance on this regression model was R^2=0,77, which was very high for this amount of variables left in Forward stepwise method.

Table 2: Regression Model on criteria win/loose

N=60	Regression Summary for Dependent Variable: KRIT R= ,87704090 R2= ,76920073 Adjusted R2= ,72765687 F(9,50)=18,515 p<,00000 Std.Error of estimate: ,26313			
	b*	Std.Err.of b*	t(50)	p-value
Intercept			-6,89591	0,000000
SVS%	**0,591242**	**0,073210**	**8,07600**	**0,000000**
P2	**0,487820**	**0,076918**	**6,34207**	**0,000000**
P3	**0,346413**	**0,071768**	**4,82683**	**0,000013**
P1	**0,289147**	**0,072378**	**3,99498**	**0,000213**
OT	**0,229157**	**0,073992**	**3,09706**	**0,003202**
SVS	-0,123255	0,078630	-1,56753	0,123299
BLK	-0,148190	0,080906	-1,83164	0,072966
PPG	0,118311	0,076939	1,53772	0,130421
FO%	0,100204	0,073630	1,36092	0,179642

Legend – see table 1.

When we consider results of Regression analysis without scoring in periods, again there is SVS% on first place with β coefficient 0,70. Next Variable that correlated the most with the criteria is PPG with β coefficient 0,35. SOG took place at third position. Explain variance on this regression model is R^2=0,46, which is not so high for this amount of variables left in Forward stepwise method. Variables HITS, FO% and BLK took place in forward stepwise method, but were not statistically significant.

Table 3: Regression model without scoring by Periods

N=60	Regression Summary for Dependent Variable: KRIT R= ,67969211 R2= ,46198136 Adjusted R2= ,40107359 F(6,53)=7,5849 p<,00001 Std.Error of estimate: ,39022			
	b*	Std.Err.of b*	t(53)	p-value
Intercept			**-5,31205**	**0,000002**
SVS%	**0,696554**	**0,115584**	**6,02640**	**0,000000**
PPG	**0,352506**	**0,110415**	**3,19255**	**0,002373**
SOG	**0,229759**	**0,103904**	**2,21126**	**0,031353**
HITS	0,208329	0,118451	1,75878	0,084388
FO%	0,193532	0,110954	1,74425	0,086913
BLK	-0,181538	0,110579	-1,64170	0,106574

Legend - see table 1.

Discussion

The Aim of this study was do determine which situational parameters influenced the most on final outcome of the game in the NHL during season games. Results in table 2. and table 3. show that the Save Percentage had the main influence on final outcome. Also, results from the table 2. and 3. show that 76% and 47% of the variance in final score could be explained trough 8 and 6 remain variables, respectively.

In most of the cases it is thought that scoring is the most relevant for winning games. But results showed that saves were more important. Some coaches and hockey experts says that goalies are 50% of a team, but we considered that goalies takes that much of a team how many save percentage he have achieved during the game. Also, coaches must set defense so opponent doesn't get the puck in slot position that gives him a scoring chance. Further, the defense must clear the way of shots and don't let any traffic in front of the goalie that decrease chances to make a save.

We can anticipate that the scoring goals have large influence on game outcome. That why it took high place in first regression model. Statistical analysis shows that very important part of a game is the second period in which team that score more have greater probability to win the game. P2 had the highest β, which represents plays on tactic showed in first period. P3 is followed, and it represents team's conditioning fitness (level of endurance). Also, winning teams differed in scoring goals in each period. First period represents motivation at the start of a match. If the game goes into overtime, if you want to win, you must score. That is why OT variable took place as significant factor.

Furthermore, when we removed scoring variables from our regression model, as we see in Table 3. SVS% stays on top of with $\beta = 0{,}687$, that is a little bit higher than the result in first regression. In that case statistically significant variables become PPG and SOG with $\beta = 0{,}353$ and $\beta = 0{,}229$, respectively. Top teams score about 33% of their goals in power plays and only 4% of the goals are scored shorthanded (Mensonen & Salo, 2008)

Already, Kinding (1991.) the Swedish coach and hockey researcher stated in his work the objective power play that good power play is equal to a good scoring chance and vice versa. Kinding (1991) stated in his research that 28% of the goals are power play goals. Since power play situations don't occur too often, it is important for the teams to score in this situation and thus have a high power play scoring percentage (Mensonen and Salo, 2008). Today, teams which have near 20% of power play situations scored, were top rated teams.

SOG took third place in our second model. Sometimes in a game is not only important to shoot, it is important how you shot and from which position on the ice. There are some important spots in offensive zones; In front of crease (41.3%), slot (33.5%), point (18.0%), outside of triangle (4,4%) and behind blue line (Mensonen and Salo, 2008). In ice hockey several techniques can be used to score. Shooting the puck is one of the basic skills. In order to score, players need to shoot. The different styles of the shot are dekes or breakaways, wrist shots, backhand shots, slap shots, tips (deflected puck from original path), screens, rebounds and other mixed forms. Shooting in ice hockey is produced by shifting weight from the one leg to the other; this energy is transferred through the middle body into the arms and onto the hockey stick. A firm grip, a strong push into stick and a follow- through help to maximize the power of the shot.

Conclusion

In conclusion, save percentage contributes the most to the final result. Good teams usually have better defense setup to eliminate shots in front of the net and slot position to help goaltenders to have open shot form distance. It is normal that if you want to win you must score that's why scoring variables contributed also to final outcome, especially scoring in second period, which represent tactic battle between two coaches. On the other hand, second regression model showed significant contribution of variables Power Play Goals and Shot on Goal which means you must have better team play that makes more scoring chances to score a goal. Teams that concentrated on defense and try to eliminate shots by blocks or by strong hitting game didn't have as much success. Coaches that want to win must find that kind of team play that eliminates scoring chances and gives opportunities for scoring goals.

References

1. Brieman, L. (1986). *Probability and Stohastic Processes*. Palo Alto CA: The Scientific Press.
2. Gréhaigne, J.-F., Godbout, P., & Bouthier, D. (1997). Performance assessment in team sports. *Journal of Teaching in Physical Education*, *16*, 500-516.
3. Huhhes, M.D & Bartlett, R.M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, *20*(10), 739-54.
4. Hunter, P. & O'Donoghue, P. (2001). A Match Analysis of the 1999 Rugby Union World Cup. In M. F. Hughes, **Book of Abstracts** Fifth World Congress of performance analysis in sports (pp. 95-90). Cardiff: UWIC.
5. Kinding, B. (1991.). *"Objective Power Play" of the 1991 World Championship*. IIHCE Hockey Centre Vierumäki.
6. Mensonen, J. & Salo, O. (2008). Effective Offensive Play. Scoring Analysis of the 2005 World Championship - Bachelor's Thesis. Haaga-Helia University of Applied Sciences.
7. Milanović, D. (1997). Fundamentals of sport trainig. In D. Milanović, *Handbook for sport coaches*. Zagreb: Faculty for phisical education.
8. Molik, B., Morgulec-Adamowicz, N., Kosmol, A., Yilla, A.B., Filipkovska, A., Lewandowski, M., Pijanowska, J., Slyk, K., Zubala, T., Flis, S., Herink, R. (2012). Game Performance in Ice Sledge Hockey: An Exploratory Examination Into Type of Disability and Anthropometric Parameters. *Clinica Journal of Sports Medicine*, *22*(1), 65-69.
9. NHL.com. (2017). Retrieved January 15th, 2017, from www.nhl.com
10. Quinney, H. (2005). Sport on ice. In T. S. Reilly, *Phisiology of Sports* (pp. 275-296). Taylor & Francis.
11. Rabiner, L. (1982). A Probabilistic Distance Measure for Hidden Markov Process. *AT & T Tech. J.* , 391-408.
12. Rabiner, L. (1989). A tutorial of Hidden Markov Model and Selected Application. IEEE. Speech Recognition.
13. Ryder, A. (2004). *Poisson Toolbox: A rewiew of the Poisson Probability Distribution in hockey*. Retrieved from Hockey Analitcs: http://www.hockeyanalytics
14. Thomas, A. C. (2006). The Impact of Puck Possession and Location on Ice Hockey Strategy. *Journal of Quantitative Analysis in Sports*, *2*(1).

DIRECTIONS OF THE MOVEMENT IN ELITE INDOOR FEMALE VOLLEYBALL

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Abstract

The purpose of this study was to evaluate directional diversity of elite indoor volleyball player movement. For evaluation tool was used 3D kinematic analysis of movement, by tracking each of player head during an official elite volleyball match. Post processing of data analysis was performed by TEMA Bio v2.3. (Image Systems Ltd., Sweden) and Matlab (c 1994-2015 The MathWorks, Inc.). Average result for FM was 30 ± 5.5%. For BM it was 17 ± 5.2%, RM reached average of 28 ± 9.4% and LM 24 ± 5.9%. Obtained data can have practical transfer for underlying specific training loads for individual player specializations.

Key words: *external workload, frequency, 3D kinematic analysis, performance*

Introduction

Rapid direction changes, agility, fast decision making, acceleration and many more are crucial for successful indoor volleyball player. If we want to set the demands of the sport game and specify preparation in terms of constantly pushing the boundaries ahead it is crucial to reveal the data about internal loads such as external loads during competitive conditions like match. Physiological or biological limits (or potentials) in performance of human locomotion are nearly depleted by highly scientific approach to train human body (Rabita et al., 2015; Parlebas, 1999; Weynard, 2010). Demands of modern volleyball are getting harder not just because of rising speed of the game and biology limits but also of its combination with highly specific technical performance, which is offering more uncharted limits to develop than biological limits of human body. Dynamic unsuspected movements are rising this difficulty of high technical coordination, reaction and physiological abilities of players. Lehnert et al. (2009) believes that according to the individual player specialization there is great emphasis on differentiation of training units according to the individual player specialization in the modern elite volleyball. High intensity of movement with combination of sharing relatively small space (9 m x 9 m of court; 6 players) puts players to intermittent loads and can easily reach 80% of maximal hearth rate intensity (Lehnert et al., 2009; Schläppi-Lienhard & Hossner, 2015; Wei-ping, 2009). Authors Sturm et al. (2012) and Ericsson (1993) coincide that sufficient, direct and long lasting practice is necessary for successful accomplishment of technical and physiological part of almost all sport activities. If the specificity of practice should be successful, we need to determine the precise demands of external and internal loads that are required during competition conditions. For quantification of distance and speed of the movement, Rawson et. al (2014) have used the Global Positioning System (GPS). A rapid change of direction has significantly degraded the accuracy and absolute reliability of GPS. Many of studies has used kinematic analysis for evaluation of different movement phases, but neither of them has aimed their focus for whole movement during the elite match (Chen et al., 2011,2012; Gomez et al., 2014; Kapidzic et al., 2014; Seminati et al., 2014; Yelverton, 2014; Wang and He, 2009; Wagner et al., 2014). Still closer specification of differences and the actual demands need to be examined. Only then is possible to set the exact dispensing load for the difficult coordination exercises (Bompa & Buzzichelli, 20015; Cardinale et al., 2011; Zatsiorski & Kraemer, 2006).

Methods

Analysed population consisted from elite female indoor volleyball players (n=14; age = 25 ± 6 years; height = 182.3 ± 6.2 cm; weight = 72.1 ± 5.8 kg). For analysis was chosen official CEV Champions League match. For movement evaluation was chosen 3D Kinematic Analysis. The match was recorded by two HD digital camcorders (SONY HDC90E Sony Ltd., frame rate 50 half-frames/s, 1920 x 1080 pixels). 3D Kinematic analysis was performed by software TEMA Bio v2.3. (Image Systems Ltd., Sweden). Calibration file was created within pre-recorded calibration cubes on the playing court and calibration file implemented into TEMA Bio v2.3 software. The average RMS of residual values was 0.033 m for Cam1 and 0.026 for Cam2. Each player was represented by one point, centre of the head. Centre of the head was tracked by TEMA Bio v2.3, due to impossibility to mark players during official match, head was prioritized before hips because of instability of clothing and rotational movements. Standard beginning of the rally was when ball left player hand on the throw for a service and standard end of the rally was when ball touches the ground or any out area. Due to separation of relatively small movements, we set the limit for lowest analysed section to 70 cm and higher. Approximation of rally movement sequences was simplified by linear function within software Matlab (c 1994-2015 The MathWorks, Inc.). Frequency count of each movement section (0.7 m to infinity) was categorized to Forward (FM), Backward (BM), Right (RM) and Left (LM) movement according to the volleyball net (Figure 1). Statistical analysis was performed using IBM® SPSS® v2.1 (Statistical Package for Social Science, Inc., Chicago, IL, 2012).

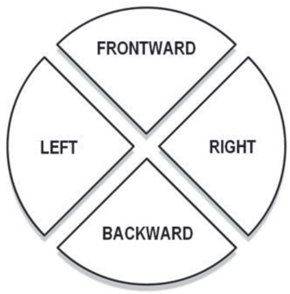

Figure 1: Differentiation of the movement direction by 90° according to the volleyball net

Results

Total amount of 167 rallies, 4 balanced sets (41.8 ± 2.2 rallies) and 4675 distances was analysed. In Table 1 is shown, that player specialization Outside Hitter 1 (OH1) reached the maximal count of 810 sequences. Percentage quantification of FM was highest for positions Opposite (OP), which reached 36% (n = 290) and also for OH1, 2 (35%, n = 287; 36%, n = 278). Player position Setter (SE) reached lowest results within FM between other specializations with 24%. BM retreating movement was representative for OH1 with 22% and OP (22%). Middle Hitters 1 and 2 (MH1 and MH2) reached 11% and 9% within BM. RM direction was most abundant for MH1 with 40% and Setter with 38%. Libero (L) and OH 2 had 18% and 19% at RM. Highest movement to the LM was represented by 32% for Libero and MH2 with 29%. Opposite reached 14.7% with 55.8 m to the RM. MH1 participated in 58.6% of rallies and MH2 60.8%, also Libero participated in 80.3% of all rallies, which can be seen in Table 2. Average result for FM was 30 ± 5.5%. For BM it was 17 ± 5.2%, RM reached average of 28 ± 9.4% and LM 24 ± 5.9%.

Table 1: Distribution of movement directions according to each player specialization; represented by percentage (%) and frequency count (n)

	Total (n)	Forward (n)	Forward (%)	Backward (n)	Backward (%)	Right (n)	Right (%)	Left (n)	Left (%)
Outside 1	810	287	35	182	22	151	19	190	23
Outside 2	771	278	36	139	18	162	21	192	25
Setter	688	163	24	121	18	260	38	144	21
Opposite	803	290	36	174	22	230	29	109	14
Middle 1	483	121	25	55	11	193	40	114	24
Middle 2	469	124	26	41	9	166	35	138	29
Libero	651	194	30	133	20	117	18	207	32
AVG (± StDev)			30 (± 5.5)		17 (± 5.2)		28 (± 9.4)		24 (± 5.9)

Table 2: Participation of player specializations during analysed match; OH1 – Outside Hitter 1, OH 2 – Outside Hitter 2, SE – Setter, OP – Opposite, MH1 – Middle Hitter 1 and MH2 – Middle Hitter 2

Participation	Rallies (n)	OH1,OH2,SE,OP (%)	MH 1 (%)	MH 2 (%)	Libero (%)
Total	167	100	58,6	60,8	80,3

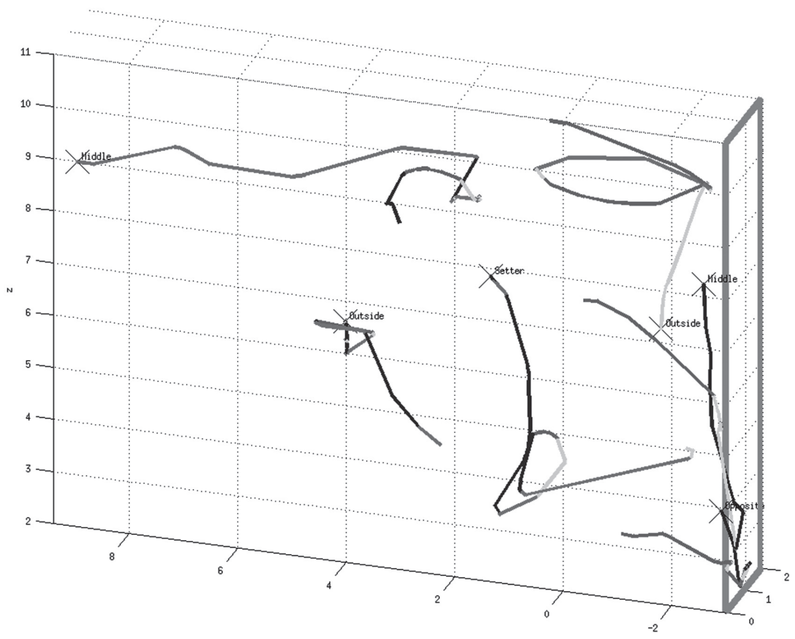

Figure 2: Three-dimensional visualization example of individual movement sequences for each player specialization according to the volleyball net; Matlab (c 1994-2015 The MathWorks, Inc.)

Discussion

The space for performing rapid motions on half of volleyball court is relatively small according to the size of the playing court (9 m x 9 m) and the number of players in a match (6 in total for one half). Percentage quantification of individual frequencies is more representative in this study according to absences in participation in the analysed match. The highest count of sections of FM reached players mainly specialized for attack like OH (36%) and OP (36%) and can be seen in Table 1. Reason probably lies in many repetition of run up sequences for attacking, and retreating movement from the net, represented by BM to get into ready position. OH and OP specialization not only use FM for attack but also for getting close to the net and prepare for defence block, or mostly to zone 6, if they are in back row for the defence. 22% of BM was reached by OH1 and OP. 36% FM versus 22% BM encourages to think about volume and time spent by retreating against to basic linear (straight) movement. Outside Hitters mainly occupy left side of the court in the zone 4, so available transitions are mostly FM and BM with possibility to RM (19% OH1) if needed but also with BM (18% OH2) reached lower results against LM (25% OH2). LM is for Outside Hitters very often used for getting to ready position after rotation changes at the beginning of the rally. Libero also reached 30% to FM, but LM was used mostly by count of 32% and BM represented moderate result of 20%. Liberos` preferred zone for defensive activity is 5, which is in left back corner of the playing field. Rotation changes during the game force the players to get into their regular, “home” zone. 32% of LM for Libero can be explained by repetitive return to home zone 5 after performance in different part of the court. The same principle is applicable for other player specialization, and this study is bringing the insight of volumes, or quantity of individual representative directions. All this transitions require acceleration from deep court and fast deceleration as they reach borders of the net. RM direction was most abundant for Setter (38%; n = 260). During the game, setters occupy right side of the court in zone 1 or 2, where they block or retreat backwards. Most likely they are in acceleration to zone 3 to be able to set the ball for hitters. This requires the transition to the left side from zone 2 or 1 (which includes also movement in front and down by the net to the left), but mostly during longer lasting rallies, after every set they need to retreat back to defensive home zone. Middle Hitters are known for their rapid reaction and subsequent transition along the net for the defence by accelerated run up jump for block. 40% and 35% (MH1,2) of RM and 24% and 29% of LM are mostly representing their preferred work to right and left side, while in contrast to the OH and OP, FM was suppressed to 25% or BM to 9%. Game rules, rotation and player placement is naturally determining possibilities, where player can or cannot move. Nevertheless, the ratio and intensity of this movement can be quantified and in the preparation it is often forgotten to focus on different directions of movement in the same volume as main linear or straight. Software Data volley software is valuable tool for performance analysis studies (Häyrinen et.al, 2007, 2011, 2012; Silva et al., 2016). Recent paper of Silva et al. (2016) analysed the volleyball performance. More precisely, they have identified *“which rotation contributes the most for the final result of the game”.* For the analysis were chosen also elite matches from FIVB and CEV elite competitions including Olympic Games 2012. Through Data Volley (© 2014 Data Project s.r.l., Italy) statistical software suited for volleyball matches was discovered, that mostly rotations P1, P4 and P6 protruded among rest rotations contributing for a level of the performance represented by average achievement of points, but all rotations revealed balanced results according to whole performance during the match. Rotations, in which is setter placed in rotation P1,P5 or P6 can be on one side helpful, because in front zones, there are available three attacking players on the net, which should contribute to a more variables for a heavy and close attack. In modern men volleyball is the difference between attack from front or back row disappearing more and more due to still more precise set abilities and rising physiological condition status represented by a jump height, acceleration, speed and technical accuracy. On the other side, also rotation that include setter in the front row is bringing opportunity to confound opponent team defence on the net and make the attack easier. Game strategy is important against opponent team on one side, but it should be beneficial for the team on their own by preparing the individual player to its individual needs during competition. Analysis of that many elite matches is probably revealing, how balanced preparation for each situation is necessary, at this level, there is not allowed to be not prepared for any situation less than other. We consider it important to clarify the extent to which are the individual directions of movement represented for each specialization. In practical conditions, we often encounter with oppression or lack of knowledge about volumes of exercises that should be evenly divided by actual claims of the competition.

Conclusion

Purpose of this study was to evaluate volumes of directions of movement. To set the demand of sport game, such as volleyball, it is crucial to obtain data about internal load during the match and also external loads for further adjustments of preparation. Data extraction from match experience was crucial for this study and 3D kinematic analysis brought the opportunity to evaluate movement properties more precisely without disruption of the match. Total amount of 167 rallies, 4 balanced sets (41.8 ± 2.2 rallies) and 4675 distances was analysed. Highest average results were evaluated for Forward Movement with 30 ± 5.5% and lowest results reached retreating from the net with 17 ± 5.2%. Through this pilot data, we can see differences between specializations directions, but its significance is needed to be analysed. We differentiated movement according the net to Forward, Backward, Left and Right. These movements have an impact on the quality of individual game activities in a match, which is getting always faster at an elite level, including acceleration at start of the movement, the subsequent deceleration in a small space, vertical reflections and rebounds set by more specified volumes suited for each one of specialization. Quickly, promptly and precisely executed movements are particularly important from the tactical aspect of the performance. Directions of movement are dependent of ether game strategy or momentarily need of the game. In both cases, it needs high preparation in strength training, speed, agility and stability and rapid directional changes. Further analysis of larger group of data should be processed and significance of inter-individual and inter-directional differences is necessary to reveal.

Acknowledgements

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References

1. Bompa, T., & Buzzichelli, C. (2015). Periodization Training for Sports*, 3E*. Human Kinetics.
2. Cardinale, M., Newton, R., & Nosaka, K. (Eds.). (2011). Strength and conditioning: biological principles and practical applications. John Wiley & Sons.
3. Häyrinen, M., Hoivala, T., & Blomqvist, M. (2004). Differences between winning and losing teams in men's European top-level volleyball. In *Proceedings of VI Conference Performance Analysis* (Vol. 168177).
4. Häyrinen, M., & Tampouratzis, K. (2012). Technical and tactical game analysis of elite female beach volleyball. *Jyväskylä, KIHU: Research Institute for Olympic Sports*.
5. Häyrinen, M., Lehto, H., Mikkola, T., Honkanen, P., Lahtinen, P., Paananen, A., & Blomqvist, M. (2011). Time analysis of men's and youth boy's top-level volleyball. *British Journal of Sports Medicine*, *45*(6), 542-542.
6. Rabita, G., Dorel, S., Slawinski, J., Sàez-De-Villarreal, E., Couturier, A., Samozino, P., & Morin, J. B. (2015). Sprint mechanics in world-class athletes: a new insight into the limits of human locomotion. *Scandinavian journal of medicine & science in sports*, *25*(5), 583-594.
7. Parlebas, P. (1999). *Jeux, sports et sociétés: lexique de praxéologie motrice*. Paris: Insep.
8. Schläppi-Lienhard, O., & Hossner, E. J. (2015). Decision making in beach volleyball defense: Crucial factors derived from interviews with top-level experts. *Psychology of Sport and Exercise*, *16*, 60-73.
9. Silva, M., Sattler, T., Lacerda, D., & João, P. V. (2016). Match analysis according to the performance of team rotations in Volleyball. *International Journal of Performance Analysis in Sport*, *16*(3), 1076-1086.
10. Wei-Ping, M. A. (2009). Volleyball Competition's Time Characteristics and Analysis of Its Energy Metabolism [J]. *Journal of Gansu Lianhe University (Natural Science Edition)*, *1*, 028.
11. Weyand, P. G., Sandell, R. F., Prime, D. N., & Bundle, M. W. (2010). The biological limits to running speed are imposed from the ground up. *Journal of applied physiology*, *108*(4), 950-961.
12. Zatsiorsky, V. M., & Kraemer, W. J. (2006). Science and practice of strength training. Human Kinetics.

THE RELATIONSHIP BETWEEN ISOKINETIC STRENGTH IMBALANCES AND KICK SKILLS IN YOUNG ELITE CZECH SOCCER TEAM

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Abstract

Purpose: The aim of this study was to identify the relationship between isokinetic strength asymmetries and velocity and accuracy of the soccer kick.

Methods: In the present study were monitored top-level young soccer players (n=17, age = 17.33 ± 0.61 years, body height = 180.12 ± 9.87 cm, body mass = 75.15 ± 8.75 kg). The role of the subject was to realize instep kick with maximal effort in the middle of the goal from distance 11 meters. We monitored the speed of the kick by Stalker ATS radar equipment and the kick accuracy was evaluated using 2D kinematic analysis. Strength performance was carried out by Humac Cybex Norm isokinetic dynamometer.

Results: The speed of the ball by the kick by dominant limb was significantly correlated with muscle strength of flexors and extensor of knee at all angular velocities (r=0,52 - 0.73, p<0.05). In the case of the non-dominant limb we found out significant relationship between velocity of the kick and muscle strength at low angular frequency (60°/s) and in the case of the knee extensors at the rate of 180°/s. The greater strength asymmetry between preferred and non-preferred legs in kicking, the greater inaccuracy was detected (knee extensors – r=0.79, p<0.05, knee flexors r=0.89, p<0.05)

Conclusion: Strength imbalances may affect motor performance, the high strength asymmetry may negatively influence motor control and could be linked not only with kicking performance but also from a health prevention point of view.

Key words: *instep, lower limb, maladaptation, shot*

Introduction

Velocity and accuracy of the kick are the essential factors successful shot on the goal, as well as by pass on long distances, while global performance is determined by muscle strength of extensors and flexors of knee (Cerrat et al., 2011). Instep soccer kick is considered the strongest soccer kicking technique (Kellis & Katis, 2007), while the maximum speed of the ball is achieved with approach angle 45° (Egan et al., 2007). However, a strong kick does mean it will always be successful because the kick accuracy has a great influence on successful shooting. Kick accuracy and inaccuracy is prejudiced by many factors, ranging from the mistakes of the approach of individual payers to the kick, the characteristic of the location of the support legs in kicking, movements of the kicking limb – swing and the concrete kick to the ball (Kellis et al., 2006; Katis & Kellis, 2010; Scurr et al., 2011; Giagazoglou et al., 2011). By shooting on accuracy underway complicated muscle activation (Dicks & Kingman, 2005), by movement of the lower limbs occurs delicate control of movement and it can also leads to differential activation of muscle during the kick depending on different position of the target (Kelly & Katis, 2007; Scurr et al., 2011). By measuring muscle strength of flexors and extensors of knee is quantified the area of muscle imbalance in two dimensions: bilateral asymmetry of strength and unilateral hamstring muscle strength ratio between groups of hamstrings and quadriceps (H:Q ratio). The strength asymmetry between the lower limbs and relative imbalance between the muscles agonists ad antagonists mentions to a serious problem for soccer payers (Rahnama et al., 2005 Fousek et al., 2010). The reason is when soccer player performs the kick to the ball by dominant leg, non-dominant leg serves as the pillar of the whole body weight (Oshita & Yano, 2010), and any inadequate level of muscular strength of the non-preferred extremities can affect the quality of the kick and subsequent asymmetry of movement may lead to incorrect control of the whole body movement, and it can cause the injury of athlete (Grygorowicz et al., 2010). The aim of this study was to find out relationship between strength asymmetries and the speed and accuracy of the kick in elite youth soccer players.

Methods

Study sample

In the present study were monitored elite soccer players of the youth Czech elite soccer team (n=17, age = 17.33±0.61 years, body height = 180.12±9.87 cm, body mass = 75.15±8.75 kg). The participants have trained soccer in the average 13.7±3.2 years and took part in training sessions six times per a week, plus played one match a week.

Methods of data collecting and processing

Testing velocity and accuracy of kicking took place in field conditions on the field with artificial grass. Before testing the players realized standard warm-up. The role of athlete was to implement with maximum effort the instep kick into middle of the goal from the penalty point. In the middle of the goal was marked the place where the players had purposely to kick. The player made three attempts on both legs. The speed kick we assessed by STALKER ATS radar system (Stalker Radar Inc., USA). The images were taken using a digital camera (Sony Ltd., Japan) MiniDV format with a focal length of 30mm, a pixel size of 16 microns and display field 720x565 pixels. The accuracy of the kick was determined as the absolute distance between the center of a soccer ball and the destination spot in the software equipment TEMA Biomechanics version 3.2 (Image Systems, Sweden). Isokinetic strength parameters we monitored using an isokinetic dynamometer (Cybex Humac Norm ®, USA). We examined the maximum peak torque (PT) knee extensors and flexors on dominant and non-dominant leg in concentric contraction at angular velocities of 60, 180 and 300 °/s. Before testing athlete completed a short warm-up (5 min bicycle, load 120 W at a speed of 90 to 110 revolutions/min).

Statistical analysis

Research data were processed using the basic mathematical - statistical procedures. To express the group result, we used the arithmetic mean and to define differences of endpoints, we used the percentage difference. To describe dependencies between the variables being monitored, we used Pearson correlation coefficient, regression analysis of data and the level of confidence we expressed by the coefficient of determination. We also used the inter and intra individual assessment of player.

Results

The speed of the ball by the kick by dominant limb was significantly correlated with muscle strength of flexors and extensor of knee at all angular velocities. In the case of the non-dominant limb we found out significant relationship between velocity of the kick and muscle strength at low angular frequency (60°/s) (Figure 1) and in the case of the knee extensors at the rate of 180°/s.

Table 1: Strength parameters extensors and flexors of knee

Angular speed	H:Q ratio – PL (%)	H:Q ratio – NL (%)	Bilateral ratio – E (%)	Bilateral ratio – F (%)
60°/s	57,7±9,4	55,8±7,5	7,9±6,5	5,5±4,3
180°/s	60,3±11,5	59,0±9,4	7,7±5,9	8,4±6,9
300°/s	60,5±12,7	60,9±9,3	3,9±3,1	9,9±9,5

Legend – PL – preferred leg, NL – non-preferred leg, E – extensors of knee, F – flexors of knee, H:Q – hamstring to quadriceps ratio

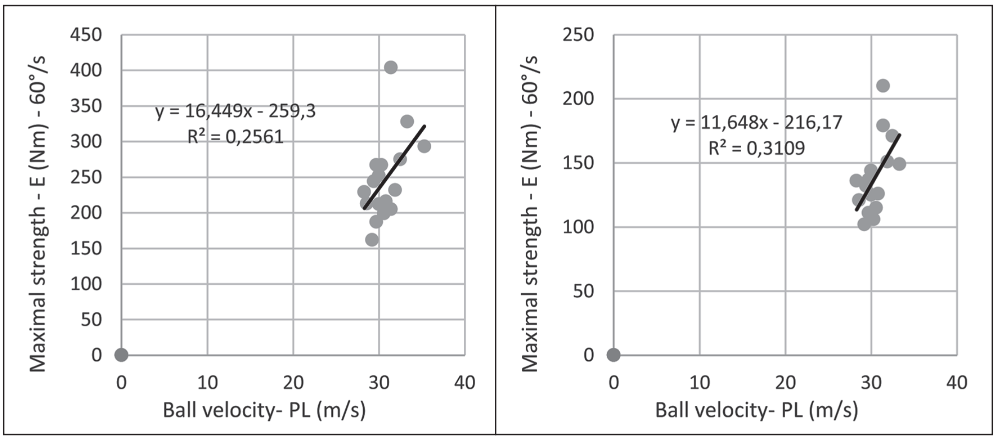

Figure 1: The relationship between ball velocity and maximal strength extensors (E) and flexors of knee (F) on preferred leg (PL)

The correlation between the kick accuracy and unilateral ratio H: Q on dominant leg referred about no statistically significant relationship, but the players with better kick accuracy had not so markedly differences in laterality between kicking and supporting leg by the kick and showed higher muscle strength of flexors and extensors of knee on both limbs (Figure 2). On the other side the players with inaccuracy kick had higher asymmetries in tight muscles.

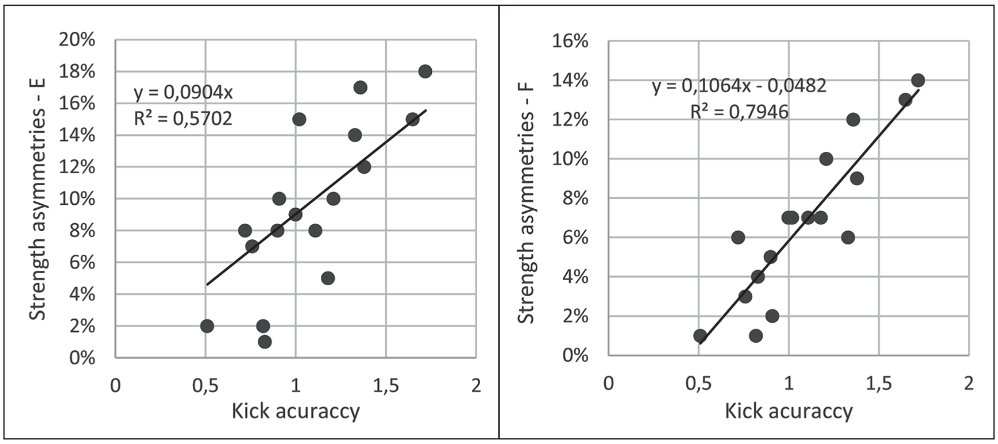

Figure 2: Relationship between strength bilateral asymmetries extensors (E) and flexors (F) of knee and kick accuracy

Discussion

In today´s soccer is successful shooting conditional on the fulfillment of basic requirements, which are accuracy, speed and the element of surprise under pressure in match. Nunome et al. (2006) present in adult elite soccer players significant difference (15,6%) between kick speed the dominant (32.1±1.7 m/s) and non-dominant (27.1±1.2 m/s) leg and lower level athletes reach lower values (Apriantono et al.,2006; Ferraz et al. 2012, Orloff et al., 2008, Kellis et al., 2006). The velocity of the ball by instep kick by preferred limb correlated with muscle strength extensors and flexors of knee at all angular velocities in the range (0.58 - 0.77). A lightly higher correlation (0.61-0.90) report Kelly & Katis (2007) in pubertal soccer players. In the case of the non-dominant leg, we found significant relationship between speed of the ball and the muscle strength of the legs at a low angular velocity (60°/s) and for the knee extensrors at the rate of 180°/s. Extensor and flexors strength of the knee is an important factor in kicking, which directly affects the kicking performance. Cometti et al. (2001) observed that a higher level of isokinetic knee extensor strength between professional and amateur players is not reflected in kick velocity in soccer. Kelly & Katis (2007) deduce that the main objective is to achieve a lot of the maximum speed of the ball, then action antagonists (flexors of the knee joint) in the final stage will be awarded a limiting factor in the performance. Studies clarifying muscle activation during instep kick using electromyography (EMG) showed the importance of the antagonists in connection with the optimal neuromuscular coordination of the muscles involved in activities (Brophy et al., 2007; Cometti et al., 2001; Kelly & Katis, 2004). Muscle activation is complicated by kick on accuracy (Dicks & Kingman, 2005), there is a finer control movement of the leg and there may be differences in muscle activation by kicking on different targets and kick accuracy largely depends on the differential activation of muscles during a kick with the position of the target (Kelly & Katis 2007; Scurr et al., 2011). Despite the fact that we did not find any significant relationship between the kick accuracy and unilateral ratio of the dominant limb, we observed among strength of the lower limbs and the kick accuracy several specifics. Players with better kick accuracy had not so higher significant differences in laterality between the kicking and supporting leg and showed a higher total strength level as flexors as extensors of knee on both legs. On the contrary players with inaccurate kicking had pronounced asymmetry in the muscularity of the lower extremities. This fact tells us that a visible imbalance and asymmetry in inaccurate kicks can cause insufficient muscle strength level on the non-dominant leg, which it becomes support in the kicking and plays a very important role in the stability and any weaker strength level non-dominant limb can affect the quality of the kick (Oshita & Yano, 2010; Grygorowicz et al., 2010).The apparent strength imbalance between the lower extremities and the strength capacity reduced in the supporting leg when kicking, can functionally restrict effective stabilization and the control of skills. The majority of soccer players prefer or are forced to use the dominant leg by soccer kick and other various soccer skills (Fousekis et al., 2010), what can generate strength asymmetries between the both legs, and also the strength imbalance among agonist and antagonist on one leg, as in particular the lower extremities play an important role in the field of sport with asymmetric movement patterns, such as soccer.

Conclusions

The speed of the ball was significantly correlated with preferred limb extensors muscle strength and knee flexors at all angular velocities. The very interesting result is a significant relationship between bilateral strength ratio and the kick accuracy. The greater strength asymmetry between preferred and non-preferred legs in kicking, the greater inaccuracy was detected. Strength imbalances may affect motor performance, the high strength asymmetry may negatively influence motor control and could be linked not only with kicking performance but also from a health prevention point of view. This study was supported by GACR 16-21791S.

References

1. Apriantono, T., Nunome, H., Ikegami, Y., & Sano, S. (2006). The effect of muscle fatigue on instep kicking kinetics and kinematics in association football. [Article]. *Journal of Sports Sciences, 24*(9), 951-960. doi: 10.1080/02640410500386050
2. Brophy, R. H., Backus, S. I., Pansy, B. S., Lyman, S., & Williams, R. J. (2007). Lower extremity muscle activation and alignment during the soccer instep and side-foot kicks. [Article]. *Journal of Orthopaedic & Sports Physical Therapy, 37*(5), 260-268. doi: 10.2519/jospt.2007.2255
3. Cerrah, A. O., Gungor, E. O., Soylu, A. R., Ertan, H., Lees, A., & Bayrak, C. (2011). Muscular activation patterns during the soccer in-step kick. *Isokinetics & Exercise Science, 19*(3), 181-190.
4. Cometti, G., Maffiuletti, N. A., Pousson, M., Chatard, J. C., & Maffulli, N. (2001). Isokinetic strength and anaerobic power of elite, subelite and amateur French soccer players. [Article]. *International Journal of Sports Medicine, 22*(1), 45-51. doi: 10.1055/s-2001-11331
5. Dicks, M., & Kingman, J. (2005). The effect of altered ball approach on kick kinematice ad shot accuracy a soccer case study. *Journal od Sport Sciences,* 23(2), 99-100. doi: 10.1080/02640410512331334413
6. Dörge, H. C., Andersen, T. B., Sørensen, H., & Simonsen, E. B. (2002). Biomechanical differences in soccer kicking with the preferred and the non-preferred leg. *Journal of Sports Sciences, 20*(4), 293-299.
7. Egan, C. D., Verheul, M. H. G., & Savelsbergh, G. J. P. (2007). Effects of Experience on the Coordination of Internally and Externally Timed Soccer Kicks. *Journal of Motor Behavior, 39*(5), 423-432.
8. Ferraz, R., van den Tillaar, R., & Marques, M. C. (2012). The Effect of Fatigue on Kicking Velocity in Soccer Players. *Journal of Human Kinetics, 35*, 97-107.
9. Fousekis, K., Tsepis, E., & Vagenas, G. (2010). Lower Limb Strength in Professional Soccer Players: Profile, Asymmetry, and Training Age. *Journal of Sports Science & Medicine, 9*(3), 364-373.
10. Giagazoglou, P., Katis, A., Kellis, E., & Natsikas, C. (2011). Differences in Soccer Kick Kinematics Between Blind Players and Controls. *Adapted Physical Activity Quarterly, 28*(3), 251-266.
11. Grygorowicz, M., Kubacki, J., Pilis, W., Gieremek, K., & Rzepka, R. (2010). Selected isokinetic tests in knee injury prevention. *Biol Sport, 27*(1), 47-51.
12. Katis, A., & Kellis, E. (2010). Three-dimensional kinematics and ground reaction forces during the instep and outstep soccer kicks in pubertal players. *Journal of Sports Sciences, 28*(11), 1233-1241.
13. Kellis, E., & Katis, A. (2007). Biomechanical characteristics and determinants of instep soccer kick. [Review]. *Journal of Sports Science and Medicine, 6*(2), 154-165.
14. Kellis, E., Katis, A., & Gissis, I. (2004). Knee biomechanics of the support leg in soccer kicks from three angles of approach. *Medicine & Science in Sports & Exercise, 36*(6), 1017-1028.
15. Kellis, E., Katis, A., & Vrabas, I. S. (2006). Effects of an intermittent exercise fatigue protocol on biomechanics of soccer kick performance. *Scandinavian Journal of Medicine & Science in Sports, 16*(5), 334-344.
16. Nunome, H., IkegamI, Y., Kozakai, R., Apriantono, T., & Sano, S. (2006). Segmental dynamics of soccer instep kicking with the preferred and non-preferred leg. *Journal of Sports Sciences, 24*(5), 529-541. doi: 10.1080/02640410500298024
17. Oshita, K., & Yano, S. (2010). Asymmetry of Force Fluctuation During Low Intensity Isometric Contraction in Leg Muscle. *International Journal of Exercise Science, 3*(2), 68-77.
18. Rahnama, N., Lees, A., & Bambaecichi, E. (2005). A comparison of muscle strength and flexibility between the preferred and non-preferred leg in English soccer players. *Ergonomics, 48*(11-14), 1568-1575. doi: 10.1080/00140130500101585
19. Scurr, J. C., Abbott, V., & Ball, N. (2011). Quadriceps EMG muscle activation during accurate soccer instep kicking. *Journal of Sports Sciences, 29*(3), 247-251.

ANALYSIS OF BALL CLEARANCE IN THE FIRST CROATIAN FOOTBALL LEAGUE

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Abstract

The goal of the paper was to confirm the relevance of ball clearance as parameters of situation efficiency in football in regards to the final result of the match and place in the league system of competition. According to the results of the correlation coefficient (r=0,58) and differences between arithmetic means of winning and defeated teams, which is not statistically relevant (p=0,63), a certain negative correlation between variable of the ball clearance and the final score in the table in the league system of competition was determined, whereas there was no statistically significant difference between winning and defeated teams in the analyzed parameter. Analysis of the observed parameter showed that teams with lower quality and lower score had a significantly higher number of ball clearance.

Key words: *situation efficiency, notation analysis, football, ball clearance*

Introduction

It is possible to observe matches, competitions in teams, as well as in individual sport games and martial arts as complex dynamic systems in which two confronted entities (two teams, two pairs or two individuals) try to win. Performance of those two entities, as well as their success is determined by players level of efficiency, characteristics, abilities and knowledge, on which the competing result is based, i.e., on which victory as a final goal is based. When talking about football, such conflict happens in the football match. Systematic observation of a football match reveals many characteristic events in the game which have a tendency of repeating, can easily be recognized and noted. Such events and their results show the degree of situational efficiency of the player and the team, in fact the show the level of their performance.

Event analysis reveals the reason why some team managed to win, i.e. what caused the final result of the match. Ball clearance is an event in a game in the defense phase in which the defense player performs an action in which he cannot take the ball from the attack player, but he temporarily stops development of the attacking action via transition of the power (hitting the ball) to the ball (especially in the space and the zone in front of his own goal). There are three modalities with which it is possible to describe ball clearance in regards to its resultball clearance towards the team–mate (an event in a game in the defense phase in which after implying technique of ball clearance, the ball is controlled by his team–mate), ball clearance towards the opposing player (an event in the defense phase in which after the defense player implies technique of ball clearance, the ball is controlled by one of the opposing attacking players), ball clearance outside the playground (an event in the defense phase in which after implying technique of ball clearance, the ball goes outside the playground) (Bašić et al., 2015). Analyzing the parameters of the ball clearance, it is possible to define the relevance of the mentioned determiner of the situation efficiency on the final score of the match and the league system of competition.

Methodology of the work

Material for the analysis

The research was conducted on 88 matches watched on Max tv of the First Croatian Football League. In order to conduct the research, one half–season in which clubs played 90 matches was analyzed. Due to some technical problems, one match was not recorded, whereas one match finished with result 3:0 without playing due to violation of football rules.

The entities sample

Teams present entities in this research. The First Croatian Football League consists of 10 clubs.

The variables sample

The matches were described with noted determiners of the performance of the ball clearance (Bašić et al., 2015).

Technique of collecting data

The matches were recorded on HDD/DVD as video clips. Using specially designed computer tool named Courteye, the matches were analyzed and prepared for data processing. There were five notators analyzing the matches.

Methods of data processing

Intra-observer variability as a meassure of internal matching of notators was used for defining the reliability of collected data and differences among data collected by the same notator in two different time periods (Hughes i sur., 2002, 2003, 2004). The result was 95% of reliability for ball clearance.

Mann–Whitney's test was used for defining differences between winning and defeated teams, as well as Pearson's coefficient for defining correlation between performance determiners and the final score of the match.

Results

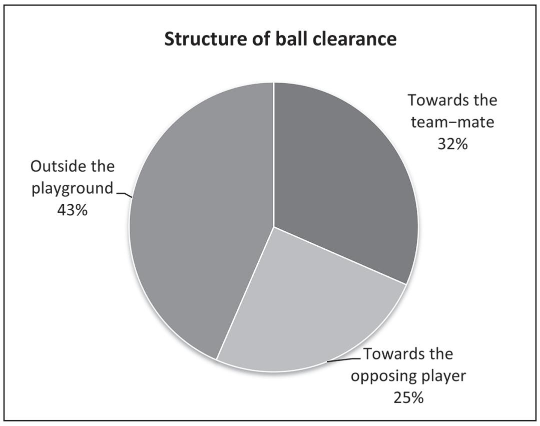
According to analyzed matches, it is possible to note correlation between ball clearance as determiners of situation efficiency with the final score in the league system of competition, as well as to define if there are statistically significant differences between winning and defeated teams in the obsereved parameter.

Table1: The final order of the teams after playing the half–season (TEAM), the final number of played matches (NM), number of wins (WINS), number of draws (DRAWS), number of loses (LOSES), number of points (POINTS),number of points per match (P/MT), and the total number of ball clearance (BC) arithmetic means of ball clearance per match (AM/BC) and coefficient of correlation of ball clearance and the final score (r).

TEAM	NM	WIN	DRAWS	LOSES	POINTS	P/MT	BC	AM/BC
Dinamo	17	13	4	0	43	2,53	**304**	**17,88**
Rijeka	18	12	3	3	39	2,17	**366**	**20,33**
Hajduk	17	8	5	4	29	1,71	**385**	**22,65**
Lokomotiva	18	7	4	7	25	1,39	**486**	**27,00**
Zagreb	18	6	6	6	24	1,33	**504**	**28,00**
Slaven Belupo	17	5	5	7	20	1,18	**382**	**22,47**
Split	17	3	8	6	17	1,00	**497**	**29,24**
Istra 1961	18	3	7	8	16	0,89	**356**	**19,78**
Osijek	18	4	3	11	15	0,83	**480**	**26,67**
Zadar	18	3	3	12	12	0,67	**442**	**24,56**
r= -0,58								

Table 2: Arithmetic means (AM) and standard deviation (SD) of ball clearance of winning (WINS) and defeated (DEF) teams as well as z–value (z) for defining differencies and errors (p) of significance.

	AM	SD	z	p
WIN	**22,12**	10,34	-0,16	**0,63**
DEF	**22,89**	9,88		



Prikaz 1: The Percentage of ball clearance towrds the team–mate, opposing player and ouside the playground

Discussion and conclusion

According to the results (Table 1) of coefficient of correlation (r=0,58) a particular negative connection between variable of ball clearance and the final score could be seen, whereas according to difference between aritmetic means, which is statistically insignificant (p=0,63), (Table 2) between winning (AM=22,12) and defeated teams (AM=22,89), the conclusion would be that the ball clearance as situational determiner of efficiency do not differ winning from defeated teams. The data about the number of ball clearance at defeated as well as at winning teams are matching the results of other similar research (Redwood, Brown, Bussell i Bharay, 2012; Shafizadeh, Taylor and Lago-Penas, 2013).

Nevertheless, according to the coefficient of correlation, it can be seen that more ball clearance throughout longer period of time, i.e. throughout more matches, makes negative correlation with the final score. Although there is no statistically significant difference between winning and defeated teams, it could be said that the teams which have more ball cleaance throughout longer period of time (more matches in a row) are weaker in managing technical–tactical parameters of the game. Teams with better scores are better in managing the game, therefore, weaker teams try to violate communication among attacking players using ball clearance. It is clear that they are not able to take the ball, but they try to violate the incresed communication among attacking players by using ball clearance so as to prevent the attacking players to score a goal.

Table 1 shows the structure of ball clearance. We can conclude that there is almost equal number of ball clearance to team–mates (32%) and to opposing players (25%), whereas there is larger number of ball clearnce ouside the playground (43%). Such distribution shows that during ball clearance, it is rather difficult to control the direction with which the ball will be cleared, especially if the ball coming through the air is cleared. Due to the fact that his goal is very close to him, the defending player's goal is to move the ball as far as possible from his goal. Although there are some characteristic playground zones in which the ball should be cleared in the methodology of teaching and training of deffending players, the direction and the goal of ball clearance depend on team–mates who should anticipate the direction of the ball and react in a due time towards the characteristic ball clearance zones.

Finally, according to results for the variable of ball clearance, it is possible to say that it does not differ winning from defeated teams, even though it makes some negative coorelation with the final score in the league system of competition.

References

1. Bašić, D., Barišić, V., Jozak, R. i Dizdar, D. (2015). *Notacijska analiza nogometnih utakmica*. Zagreb: Leonard Media.
2. Hughes, M. (2004). Notational analysis – A mathematical perspective. *International Journal of Performance Analysis in Sport*, *4*(2), 97-139.
3. Hughes, M. (2004a). Performance analysis – a 2004 perspective. *International Journal of Performance Analysis in Sport*, *4*(1), 103-109.
4. Hughes, M. i Franks, I.M. (2004). *Notational analysis of sport: Systems for better coaching and performance in sport*. London: Routledge.
5. Hughes, M., Cooper, S.M. i Nevill, A. (2002). Analysis procedures for non-parametric data from performance analysis. *International Journal of Performance Analysis in Sport*, *2*(1), 6-20.
6. Hughes, M., Cooper, S.M., Nevill, A. i Brown, S. (2003). An example of reliability testing and establishing performance profiles for non-parametric data from performance analysis. *International Journal of Computer Science in Sport*, *2*(1), 34-56.
7. Hughes, M.D. i Bartlett, R.M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, *20*(10), 739-754.
8. Hughes, M.D., Cooper, S. i Nevill, A. (2004). Analysis of notation data: Reliability. U M.D.Hughes i I.M. Franks (ur.), *Notational analysis of sport* (str. 189-205). New York: Routledge
9. Redwood-Brown, A., Bussell, C. i Bharaj, H.S. (2012). The impact of different standards of opponents on observed player performance in the English Premier League. *Journal of Human Sport & Exercise*, *7*(2), 341-355.
10. Shafizadeh, M., Taylor, M. i Lago-Penas, C. (2013). Performance consistency of international soccer teams in EURO 2012: A time series analysis. *Journal of Human Kinetics*, *38*, 213-225.

COMPARISON OF PERFORMANCE OF TOP-LEVEL FEMALE JUDO COMPETITORS FROM DIFFERENT LEVELS OF JUDO COMPETITION

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Abstract

For female competitors, judo is a very challenging sport both from physical and psychological aspect, and in order to win one of the medals, female competitors need to beat down multiple rivals. Both competitors fighting in finals for first and second place, and competitors fighting for the bronze medal are in top level female competitors on the level they are competing. The goal of this research presents comparison of performance of top-level female competitors from different levels of European championships (2014, 2015 and 2016 year) in judo for cadets, juniors, U23 and seniors. By analyzing total (n=270) fights for medals on four different levels of competition, efficiency of individual throwing techniques and grappling techniques is analyzed as well as winning by penalty and winning by Golden score. The results showed that the female competitors, in fights for medal from different levels on competition behave differently, and there is an appearance of variation in attacking efficiency in individual judo techniques. U23 dominate in wins with the help of penalty, while juniors dominate in fights decided by Golden score. Cadets dominate in counter throws, and as competition level goes up, the number of counter throws goes down. These results are clearly showing the performances of top-level female competitors on different levels of competition and they can help in designing more efficient training.

Key words: *women, notation analysis, combat* sport, efficiency, *LTAD*

Introduction

Within one calendar year, European Judo Union (EJU) organizes competitions on four different levels (EC Cadets, EC Juniors, EC U23 and EC Seniors), with fights lasting for four minutes. These levels of competitions are closely fitted in Long-term athlete development (LTAD), in which cadet's age fits the phase Training to train, junior's age to phase Training to compete, and competitors U23 and senior's age fits the phase Training to win (Balyi et al., 2013) and all of these developing phases are characterized by their specificity in working with female competitors. In order to have a chance to fight for one of the medals, female competitors must go through multiple phases in one competition, first round, second round, eighths finals, quarter finals, semifinals, repechage, fight for third place and final fight. Female competitors fighting for winning gold, silver and two bronze medals in Top-Level competitors because they had 4-6 wins on one competition in order to win medal. This is why judo is a highly intensive activity in which competitors need to have highly developed energetic, technical, tactical and psychological potentials and good planning for the training session and training year (Pullkinen, 2001). Judo involves dynamic conditions of activity performance, includes constant exchange of attacks and defensive actions, breaking and re-establishing of balance, realization or not realization of counterattacks, readiness, preparatory actions and avoidance of opponent's actions. Achievement during the fight is greatly influenced by motor skills in different age categories (seniors, juniors and cadets), while in older groups, a high level of coordination skills is connected with candidates with high activity in second phase of the fight, while junior's increased activity during the fight is determined by coordination, speed and durability. High speed abilities is directly connected with its sports achievement. Miarka et al. (2014) established that the female competitors differentiate in gripping time before performing a throw and that it lasts 73 seconds for senior female competitors, 38 seconds for female juniors, 45 seconds for juveniles and 41 second for pre-juveniles. The recent comparison (Julio et al., 2011) between six different ages (from 9 to 20+ years) categories in female competitors in time range of ten years showed that the competitors who won medals at that period are not constant, and that only 5% of the competitors kept high level of competence, and that achievements on competitions in younger age categories are not connected with achievements in older age. In 10 years period, almost 93% of competitors did not repeat their results in senior state level. The goal of this research represents comparison of performances of top-level female competitors from different level of European championships in judo for cadets, juniors, U23 and seniors.

Methods

The sample of subjects represents the analysis of total number (n=270) fights from four different levels of competition in judo for European Judo Championships for senior medal (Kazan, Russia, 2016; Azerbaijan, Baku, 2015 and Montpellier, France, 2014) n=63 fights, U23 younger seniors European Judo Championships (Israel, Tel Aviv, 2016; Bratislava, Slovakia, 2015 and Wroclaw, Poland, 2014) n=63 fights, Junior European Judo Championships (Malaga, Spain; 2016, Oberwart, Austria 2015 and Bucharest, Romania, 2014) n=72 fights and Cadet European Judo Championships (Finland, Vantea; 2016, Sofia, Bulagaria, 2015 and Athens, Greece, 2014) n=72 fights in all weight categories with four different levels of competition for competitors.

For this research, the sample of variables are consisting next segments of judo fight: Efficiency of individual throwing techniques (Daigo, 2005) and grappling techniques (AEI), penalty as a way of winning and Golden Score (GS) as a way of winning. Data are collected from European championships in judo from different levels of competition (cadets, juniors, U23 and seniors) held 2014, 2015 and 2016 year based on notation analysis of video records of fights with open-access internet web sites (EJU, 2016), containing no ethical obstacles during analysis and the interpretation of the results because it was published in secondary form. In order to determine the accuracy of the measurements, repeated measures (re-test) of intra-observers and inter-observers were used, who analyzed all final fights from European Championships in 2014. 2015. & 2016.year for all age categories, under the same conditions and with the same equipment. After one week the same matches were reanalyzed. Percentage error in measuring was calculated by comparing the data from the first measurement (V1) with the data from the second measurement taking into account all the three stages of analyzed variables (V2) and using the equation: Percentage error = (V1-V2) / (Vmean) x 100% (Hughes, Cooper, & Nevill, 2004). Intra-observer percentage errors of reliability for all European Championships ranged from 0.00% to 0.00%, and the inter-observers reliability for all European Championships ranged from 0.00% to 0.18%, which is acceptable to 5%, which is the level of limiting error. Equation used for calculating the efficiency of individual throwing techniques and parterre techniques: AEI= Ippon x 10 + Wazari x 7 + Yuko x 5 / Total number of bouts (Adam, Smuraj & Pujszo, 2012). For winning by penalty and Golden score (GS), frequencies and percentage values are displayed.

Results

Results showed that, depending on level of competition, female top-level competitors show different behaviors during throwing techniques and parterre techniques (Table 1). Cadets dominate in Kesa gatame techniques, Juniors in O uchi gari leg throwing techniques, U23 convincingly in Uchi mata leg throwing techniques, while Seniors dominate in Soto maki komi throwing techniques. Sumi otoshi technique as a counter technique is high ranked within cadets, and within juniors and U23 it declines in its application, while within seniors it increases again. This indicators suggest a problem of imbalance (Kuzushi) during the attack attempt, and along that the possibility of application of Sumi otoshi, but also Tani otoshi technique whose high ranking on all four levels of competition confirms disadvantages in segment of imbalance the rival.

Table 1: Attacking efficiency of the first fifteen individual judo techniques with four different levels of competitions for female competitors

EC Cadet	AEI	EC JUNIOR	AEI	EC U23	AEI	EC SENIOR	AEI
Kesa Gatame	0.86	O Uchi Gari	1.00	Uchi Mata	1.22	Soto Maki Komi	0.60
O Uchi Gari	0.84	Tani Otoshi	0.83	Juji Gatame	0.79	Uchi maki komi	0.57
Sumi Otoshi	0.62	O Soto Gari	0.63	O Uchi Gari	0.61	Harai Goshi	0.50
Uchi Mata	0.61	Kesa Gatame	0.54	Tani Otoshi	0.58	Tani Otoshi	0.48
Yoko shiho Gatame	0.56	Ura nage	0.52	Ippon Seoi Nage	0.46	Juji Gatame	0.47
Tani Otoshi	0.47	Juji Gatame	0.42	Kami Shiho Gatame	0.42	Kesa gatame	0.47
Soto Maki Komi	0.43	Uchi Mata	0.42	Kesa Gatame	0.38	O Uchi Gari	0.42
Juji Gatame	0.41	Soto Maki Komi	0.38	Sode Tsurikomigos	0.26	Yoko shiho Gatame	0.39
Ura Nage	0.40	Uchi Makikomi	0.36	Uki Goshi	0.23	Uchi Mata	0.38
Kouchi maki komi	0.37	Sumi Otoshi	0.36	O Soto Gari	0.23	De Ashi Barai	0.38
Ippon Seoi Nage	0.37	Harai Goshi	0.35	Soto Maki Komi	0.19	Sumi Otoshi	0.38
Seoi Nage	0.36	Okuri Eri Jime	0.28	Harai Goshi	0.19	Seoi nage	0.33
De Ashi Barai	0.36	Tate Shiho Gatame	0.28	Sumi Otoshi	0.19	Ippon Seoi Nage	0.30
Sode Tsurikomi Goshi	0.33	Tai Otoshi	0.24	Okuri eri jime	0.16	Ko Uchi Gari	0.26
Kami Shiho Gatame	0.33	Ippon Seoi Nage	0.21	Yoko shiho Gatame	0.16	Kuzure Kesa Gatame	0.26

Penalties as a way of winning were mostly used by EC U23 competitors, while juniors and seniors are at approximately same level. The smallest number of wins by penalties (Table 2) is achieved by cadets. Wins by Golden score (Table 2), i.e. fighting after regular end time of 4 minutes, was mostly used by juniors whose structure of GS was three Shido, O Soto Gari, Harai Goshi and Uchi Gari with maximum efficiency i.e. Ippon. U23 competitors made win with GS with two Shido and one counter technique (Kaeshi Waza) as Yuko. Within seniors, only one Shido was in function of Golden Score.

Table 2: Win by penalty and win by Golden score

WIN BY PENALTY				WIN BY GOLDEN SCORE			
Cadet	Junior	U23	Senior	Cadet	Junior	U23	Senior
7 (9,7%)	13 (18,1%)	23 (36,5%)	13 (20,6%)	0 (0,0%)	6 (8,3%)	3 (4,8%)	1 (1,6%)

Discussion

Significance of quantification performances of situational efficiency of top-level female competitor's parameters is in the fact that they are gathered under the conditions of real fight during the European championship. These indicators showed the total number of efficiently performed throwing techniques of top-level female competitors (Cadet=22, Junior=22, U23=19 and Seniors=4) and parterre techniques (Cadet=7, Junior=11, U23=7 and Seniors=8). Attacking efficiency (AEI) of throwing techniques of top-level female competitors (Cadet=6.56, Junior=6.69, U23=5.04 and Seniors=6.22) and parterre techniques (Cadet=2.83, Junior=2.48, U23=2.23 and Seniors=2.23). Attacking efficiency (AEI) of hand (TE) throwing techniques of top-level female competitors (Cadet=0.92, Junior=0.61, U23=0.57 and Seniors=1.12), feet (ASHI) throwing techniques of top-level female competitors (Cadet=2.21, Junior=2.67, U23=2.24 and Seniors=2.0), hip (KOSHI) throwing techniques of top-level female competitors (Cadet=0.88, Junior=0.07, U23=0.91 and Seniors=1.22), rear sacrifice (MA) throwing techniques of top-level female competitors (Cadet=0.66, Junior=0.59, U23=0.18 and Seniors=0.07), side sacrifice (YOKO) throwing techniques of top-level female competitors (Cadet=1.27, Junior=1.76, U23=0.95 and Seniors=1.65). Attacking efficiency (AEI) of parterre techniques for holds-OSAE (Cadet=2.29, Junior=1.5, U23=1.12 and Seniors=1.44), joint techniques-KANSETSU (Cadet=0.41, Junior=0.42, U23=0.79 and Seniors=0.47) and strangulation techniques-SHIME (Cadet=0.13, Junior=0.56, U23=0.32 and Seniors=0.32). However, several researches have dealt with comparison of female competitors from different levels of competition and medal winners. Franchini et al. (2008) established that Super elite female competitors who won medals at World championships and Olympic games, used higher number of throws which resulted in points in different directions, winning higher number of points and higher number of wins in contrast to elite female competitors who did not win medals at the same competitions. Miller et al. (2015) by analyzing the efficiency of junior and senior throwing techniques at British Judo Championships held in 2013, showed that the most efficient techniques within Juniors are: Uchi mata (1.13), Seoi nage (0.68), O soto gari (0.59), Tai otoshi (0.45), O uchi gari (0.40), Ko uchi gari (0.27), Ippon seoi nage (0.25), Harai goshi (0.25), Ko soto gake (0.20) and Soto makikomi (0.20). According to efficiency, Seniors dominate in next throwing techniques: Uchi mata (1.40), Tani otoshi (0.81), Ko uchi gari (0.50), O uchi gari (0.49), Seoi nage (0.46), Harai goshi (0.35), Ippon seoi nage (0.33), O soto otoshi (0.30), Ko soto gari (0.25) and Tai otoshi (0.23). Sertić et al. (2016) reported that 10 most efficient throwing techniques in women's part from Croatian national championship for seniors in 2015. are: Ko uchi gari, Tai otoshi, Eri seoi nage, Seoi nage, Koshi guruma, Ko soto gari, Ippon seoi nage, Harai goshi, Tani otoshi and Soto makikomi. Deval et al. (2010) reports that cadets in 7 weight categories during Spanish Judo Cadets Championship and with the rules in which point Koka was taken into consideration, were the most dominant in next category techniques: -44 kg: Ko uchi gari, O uchi gari, Ko soto gake, Tani otoshi; -48 kg: Seoi nage, Tani otoshi; -52 kg: O soto gari, Ko uchi gari, O uchi gari; -57 kg: Seoi nage and Kuchiki taoshi, Harai goshi; -63 kg:Seoi nage, Ko uchi gari, Tani otoshi;-70 kg:Harai goshi and Tani otoshi and +70 kg: Ko uchi gari, O uchi gari, O soto gari, Harai goshi and Tani otoshi. Earlier researches between three different levels of competition: National Championship of Bosnia and Herzegovina (2006), Balkans Championship (2006) and European Championship (2004) for female senior competitors and all weight categories and with different rules (Kajmović et al., 2007) showed existence of differences in groups of judo techniques, subgroups of judo techniques, quantitative indicators for judo fights and situational efficiency of individual throwing techniques and grappling techniques. Techniques mostly used by female seniors from Bosnia and Herzegovina participants were: O uchi gari, Kesa gatame, Tani otoshi, Ippon seoi nage etc. Techniques mostly used by female Balkan's participants were: Uchi mata, Kesa gatame, Seoi nage, Harai goshi, O uchi gari etc. Techniques mostly used by female seniors from European championships participants were: O uchi gari, Uchi mata, Te guruma, Seoi nage, Tani otoshi etc. The existence of differences between cadet, junior, U23 and senior female competitors in efficiency judo performances is most probably in competition experience and level technical and tactical preparation. Most useful indicators were gotten by analyzing every weight category separately. And in the end, all listed researches above were conducted at competitions which took place with different rules of judo competitions. The latest changes in judo rules that occurred at the beginning of 2017, should give the scientific judo community a stimulus for researching judo competitions that contain new rules, which would give their contribution to the understanding of the new rules of judo match in the function of designing optimal training process for competitors at all levels.

Conclusion

The results of this research clearly showed that in contrast to different levels of competition from European championships in judo, top-level female competitors are behaving differently in segment of attacking efficiency of individual techniques in judo, penalties and Golden Score as a way of winning in fights for medals. Data from this analysis can be used for future research in order to identify the competitive requirements in different weight categories for women, as well as for research of tactical actions that can be used by competitors and coaches during or for future competitions and the development of specific judo situations during training.

References

1. Adam, M., Smuraj, M., & Pujszo, R. (2012). The individual profile of the technical-tactical preparation of the World judo Championships in 2010-2011. Journal of Martial Arts Antropology. 12 (2): 50-59.
2. Balyi, I., Way, R., & Higgs, C. (2013). *Long-term athlete development*. Human Kinetics.
3. Franchini, E., Sterkowics, S., Meira C.M., Gomes, F.R., &Tani, G. (2008). Technical variation in a sample of high level judo players. Percept Mot Skills. 106 (3): 859-69.
4. Daigo, T. (2005). *KODOKAN JUDO - Throwing techniques*. Tokyo - New York - London: Kodansha International.
5. Deval, C.V., García, G.M.J., Luís, M.F., & Díaz de Durana, L.A. (2010). Effective ways of struggles applied by teenage female judoka during Spanish Judo Cadets Championship. Archives of Budo, 6 (1): 39-44.
6. Europeaan Judo Union. (2016). http://www.eju.net/judo-video
7. Europeaan Judo Union. (2016). https://www.youtube.com/user/europeanjudo
8. Hughes, M., Cooper, S.M., & Nevill, A. (2004). Analysis of notation data: reliability. In Hughes, M., & Franks, I.M. (2004), (Eds.) Notational Analysis of Sport, 2nd edn: Systems for better coaching and performance in sport (pp.189-204). Second Edition. London: Routledge.
9. Julio, F.U., Takito, Y.M., Mazzei, L., Miarka, B., Sterkowicz, S., & Franchini, E. (2011). Tracking 10-year competitive winning performance of judo athletes across age groups. *Perceptual and Motor Skills,*113 (1), 139-149.
10. Kajmović,H., Rađo, I., & Kapo, S. (2007). Differences analysis of situational efficiency performances between three level of judo competition for female seniors. Book of Abstracts of the 12th Annual Congress of the European College of Sport Science (ECSS). Jyvaskyla, Finland, 11-14. Edited by Kallio, J., Komi, P., Komulainen, J., Avela, J.
11. Lech, G., Pałka, T., Tyka, A., Jaworski, J., Chwała, W., Sterkowicz, S., & Ambroży, T. (2015). Effect of motor abilities on the course of fight and achievement level in judokas at different age. Arch Budo Sci Martial Art Extreme Sport 2015; 11: 169-179
12. Miarka, M., Cury, R., Julianetti, R., Battazza, R., Julio, U. F., Calmet, M., & Franchini, E. (2014). A comparison of time-motion and technical–tactical variables between age groups of female judo matches, Journal of Sports Sciences, 32(16):1529-1538.
13. Miller, A.G., Collins, A.C., Stewart, J.M., & Challis, G.D. (2015). Throwing Technique and Efficiency in the 2013 British Judo Championships. International Journal of Performance Analysis in Sport, 15, 53-68.
14. Pullkinen, W. (2001). *The Sport Science of Elite Judo Athletes*. Pulkinetics, Inc.
15. Sertić, H., Cetinić, M., & Segedi, I. (2016). Technical Analysis of Croatian National Championship for Seniors. 3rd European Science of Judo Research Symposium & 2nd Scientific and Professional Conference on Judo: „Applicable research in judo" Proceedings book. Editors: Hrvoje Sertić, Sanda Čorak and Ivan Segedi. EJU, Croatian Judo Federation & Faculty of Kinesiology, University of Zagreb, Croatia. June 20-21. 2016, Poreč-Croatia. pp. 55-58.

MUSCLE PEAK FORCE OUTPUT EFFECTED BY DIFFERENT WARMUP PROCEDURES IN COMBAT SPORTS ATHLETES

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Purpose: Warm up in combat sports increases speed of muscle contraction and transmission of neuronal impulses, stimulates movement economy improving the muscle power and kinetic energy output when kicking (Costa et al., 2011; Chaabene et al., 2012). Main aim was to compare different warm up procedures and its effects on peak power output of tight muscles in well trained combat sport competitors.

Methods: Three groups of 10 karate (age: 23±0.7 years; height: 183±2.1 cm; weight: 79±4.2kg), boxing (age: 22.1±0.4 years; height: 181±5.9 cm; weight: 81±3.2kg) and tae-kwon do (age: 23.8±1.1 years; height: 185±1 cm; weight: 81.3±3.4kg) high level athletes were subjected to active - dynamic stretching protocol, passive stretching protocol and PNF procedure with equal duration and intensity and supervised by experience trainer. At least 72h passed between procedure after peak power of quadriceps and hamstrings (torque in Nm) was measured using isokinetic dynamometer at 60°/sec. Factorial ANOVA (3X3) along with Bonferroni post hoc test was used to reveal significant difference with.

Results: No significant differences were observed for age, height and weight between athletes. No significant differences were observed between dominant leg ($F=2.00$, $p=0.15$) and less dominant leg ($F=1.04$, $p=0.36$) quadriceps and dominant leg ($F=0.753$, $p=0.48$) and less dominant leg ($F=0.936$, $p=0.40$) hamstring peak power output.

Conclusions: Active warm up proven to be more beneficial than passive (Kapo et al., 2016.) which was not case in present research. Even that higher power peak values were observed after dynamic procedure it was undoubtedly nonsignificant trend and can be described as random fluctuation. A further research which should include specific combat testing could gave better answer.

References

1. Chaabène, H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and physiological profile of elite karate athletes. *Sports medicine*, *42*(10), 829-843.
2. Costa, P. B., Medeiros, H. B., & Fukuda, D. H. (2011). Warm-up, stretching, and cool-down strategies for combat sports. *Strength & Conditioning Journal*, *33*(6), 71-79.
3. Kapo, S., Smajlović, N., Kajmović, H., Čović, N., Ćirić, A., Ćutuk, M., Bejdić, A. (2016). Effects of different stretching protocols on knee muscles strength and power parameters measured by Biodex dynamometer. Tehnički vjesnik, 23(1). doi:10.17559/TV-20150506151811

ENDURANCE – SPEED CONFLICT IN SWIMMING

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Abstract

This study has analyzed the relationship between aerobic endurance and sprinting speed in young male swimmers during general mesocycle. Some scientists contend that endurance will reduce swimming speed (Maglischo, 2006). The aim of this paper is to investigate the existence of conflict between aerobic endurance and maximum swimming speed in age group swimmers during the general preparation phase.

For that purpose, 23 swimmers were tested, whose ages were between 12 and 13, with two specific tests in the water. The 2X25 meter front crawl maximal effort sprint test was used in the assessment of swimming speed. For the endurance assessment, the test of 1500 meter was used in applying front crawl technique.

Firstly, the results have shown huge increase of aerobic endurance. Secondly, they have indicated that there is no evidence of conflict between aerobic endurance and swimming speed.

Key words: *aerobic endurance, swimming speed, aerobic enzymes*

Introduction

The majority of all competitive swimming events are completed in less than three minutes by age group swimmers compared to top class swimmers. According to the annual calendar of events, the coaches divide training process in blocks. "Blocks Periodized" system includes general, specific, and competitive mesocycles. The main objective of general mesocycle is developing aerobic capacity and endurance, especially in age group swimmers where the alactatic component of workload is negligible or minor.

Some research and coaches experience have indicated that swimmers can decrease sprinting speed during the large amount of aerobic load (Maglischo, 2006).

Based on the physiological responses of athletes to different intensities, the workload volume can be divided into seven energy zones in swimming. These include Recovery (Rec), Endurance 1 (EN1), Endurance 2 (EN2), Endurance 3 (EN3), Sprint 1 (SP1), Sprint 2 (SP2), and Sprint 3 (SP3) (Maglischo, 2006).

Preparation for competing in each event involves varying the training load at various times during the season to have the swimmer peak at the main competition. The main targets of general mesocycle are improving aerobic capacity, maintaining anaerobic power, improving stroke mechanics, start, turns, improving overall muscular strength, increasing joint flexibility, etc. Therefore; general mesocycle consists of the Rec, EN1, EN2 and EN3 intensity zones mainly, with low load of SP1, SP2 and SP3 zones. The problem for the most swimmers face is that they must improve endurance and speed, to improve their performance at the same time.

According to some scientists, endurance training suppresses the activity of most anaerobic enzymes. Some of research points to the possibility of an antagonistic relationship between endurance training and sprint speed because endurance training reduces the rate of anaerobic metabolism. Some experts have even suggested that the rate of anaerobic metabolism is the most rapid when athletes are untrained (Maglischo, 2006). An analysis of the most successful coaches revealed that optimal workloads in the total training volume include 60-65% aerobic exercises, 25-30% of "mixed" aerobic-anaerobic activities, and 2-3% of anaerobic glycolytic and alactic work (Rushall). Under that condition, aerobic fitness can improve with training in children by approximately 5%. (Matos and Winsley, 2007). In general, aerobic training leads to a mean improvement of 5-6% in the peak VO2 of children or adolescents (Baquet et al., 2003).

Dr. Rushall created "Ultra-short Race-pace Training" (USRPT) theory. He did so on the basis of scientific studies validating the Principle of Specificity in swimming. According to that theory, the most effective swimming training is "race pace" swimming. In other words, swimming in the EN1 and END2 intensity zones is relatively a waste of time for sprinters and middle distance swimmers because their pace is much slower than in the race (Rushall, 2007, 2011).

Methods

The sample consisted of 23 male swimmers, aged between 12 and 13. All of them are participants of training programs at „HAPK Mladost“ swimming club, with at least 6 years of experience. Testing was conducted in the indoor swimming pool at PVC Mladost. All of them conducted swimming program during 9 weeks as follows:

	ZONE %						
	Rec (%)	**END1 (%)**	**END2 (%)**	**END3 (%)**	**SPR1 (%)**	**SPR2 (%)**	**SPR3 (%)**
GENERAL MESOCYCLE	30	33	23,3	10	2	0,5	1,2

The 2x25 meter front crawl maximal effort sprints test was used in the assessment of swimming speed with 3-minute pause. The test was performed from water (push off) at the coaches' signal, and the result was measured with one hundredth of a second accuracy. The average of two times is the final result for the test.

For the endurance assessment, a test of 1500 meter was used in applying a crawl technique, starting from the water (push off). Results' were measured with one hundredth of a second accuracy.

The same test was repeated at the end of a general mesocycle lasting 9 weeks with a total volume of 257,4 km.

Results

Statistica for Windows 12.0, statistical software package was used to compute and report the data. The normality of distribution for each variable was tested. In addition, minimal, maximal and mean values were calculated for all variables.

Table 1: Descriptive statistic pre-training parameters (Mean), minimum score (Minimum), maximum score (Maximum, standard deviation (Std. Dev.)

Variable	Descriptive Statistics				
	Valid N	Mean	Minimum	Maximum	Std.Dev.
25 m PRE	23	16,747	15,240	19,140	1,00693
1500 m PRE	23	1402,478	1236,000	1527,000	95,00616

Table 2: Descriptive statistic post-training parameters (Mean), minimum score (Minimum), maximum score (Maximum, standard deviation (Std. Dev.)

Variable	Descriptive Statistics (Tanja - rad)				
	Valid N	Mean	Minimum	Maximum	Std.Dev.
25 m POST	23	16,343	14,580	18,810	1,07619
1500 m POST	23	1320,478	1185,000	1482,000	89,43808

Based on the results listed in tables 1. and 2. it is obvious that applied swimming program positively effects on aerobic endurance and swimming speed.

Table 3: T-test for test 1500 meters

Variable	T-test for Dependent Samples Marked differences are significant at p < ,05000							
	Mean	Std.Dv.	N	Diff.	Std.Dv. Diff.	t	df	p
1500 m PRE	1402,478	95,00616						
1500 m POST	1320,478	89,43808	23	82,00000	39,63355	9,922356	22	0,000000

The results of t-test (Table 3) show significant differences in pre and post-training aerobic endurance test ($p<0.05$). Results indicated that the applied swimming program significantly increases aerobic endurance (82,00 sec).

Table 4: T – Test for test 25 meter

Variable	T-test for Dependent Samples Marked differences are significant at p < ,05000							
	Mean	Std.Dv.	N	Diff.	Std.Dv. Diff.	t	df	p
25 m PRE	16,74652	1,006929						
25 m POST	16,34348	1,076187	23	0,403043	0,492493	3,924784	22	0,000724

The results of t-test (Table 4) show significant improvements in sprinting speed test ($p<0.05$). Results indicated that the applied swimming program significantly increases swimming speed (0,40 sec) although aerobic endurance was increased at the same time.

Discussion and conclusions

The existence of conflict effects of endurance and speed training is a topic among swimming coaches and scientists. Some of them considered that large amount of endurance work volume will decrease sprinting speed. Some of them considered that swimmer could lose endurance when they performed a large amount of sprint training.

According to obtained results in this paper, it is obvious that there is no conflict between aerobic endurance and sprinting speed in swimming.

Analyzing the results obtained by t-test we notice that applied 9 weeks swimming program had a statistically positive influence on increasing aerobic endurance simultaneously with increasing swimming speed. Observing the differences in pre and post results of aerobic endurance it is noticeable that swimmers achieved significant better results in test of 1500 meters (82,00 sec). Simultaneously, the results in the test of 25 meters freestyle was significantly faster (0,40 sec). It is possible that different relations between EN2 and END3 zones may affect different results. Nevertheless, program as described above significantly increases endurance and sprinting speed simultaneously.

The obtained results may be useful for coaches in age group swimming, programming, planning and conducting training processes.

References

1. Baquet G., van Praagh E., Berthoin S. (2003). Endurance training and aerobic fitness in young people. Sports Med.; 33(15):1127-43.
2. Matos, N., Winsley R.J. (2007).Trainability of Young Athletes and Overtraining.
3. Journal of Sports Science and Medicine: 06, 353-367.
4. Maglischo, E.W. (2006). Swimming fastest. Human kinetics.
5. Rushall, B. S. (2014). Ultra short race-pace training and traditional training compared. Swimming Science Bulletin #43.
6. Rushall, B. S. (2015). Swimming energy training in the 21st century: The justification for radical changes. Swimming Science Journal, Swimming Science Bulletin #39. Second edition.

THE ANALYSIS OF THE OLYMPIC RESULTS OF ATHLETES IN MEN'S LONG JUMP

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Abstract

The purpose of the research was to predict achievements in the 2020 Tokyo Olympics, based on the analysis of the winners' results from the previous Olympics, from 1948 to 2016. The predicted values for the future long jump winners at the 2020 Tokyo Olimpic Games were obtained by approximating results of the winners from the previous years. According to the 2nd degree polynomial regression model the result is 8.16, while according to the 3rd degree polynomial regression model it is 8.18 m. The predicted results are consistent with the constant decreasing trend of the winners' results. The arithmetic means of the finalists' results show that the highest average result was achieved at the 2004 Athens Olympics (8.33 m), and the lowest at the 1952 Helsinki Olympics (7.26 m). The lowest range of results, i.e. the difference between the highest and the lowest finalists' result at the Olympic Games was noticed at the 2016 Rio Olympics. The lower range leads to a stronger and better competition. Furthermore, the secundary aim was to determine whether there is a statically significant difference between the results of the Olympic winners and the season's best results, starting with the 1976 Montreal Olympics to the 2016 Rio de Janeiro Olympics. The results have shown that there is no statistically significant difference, but the averagely lower results are achieved at the Olympic Games (8.50), when compared to the season's best results (8.58). All of the previously mentioned information might be of help to coaches and expert teams in preparing and applying plans and programs for the next Olympic period. In order to achieve the best possible levels of the fitness of the athletes, especially at the Olympic Games, the most prestigious sports competition, it is important to consider as many factors as possible which can influence the final result and, at the same time, decrease large variations in results.

Key words: *men's long jump, Olympic Games, season's best, predict achievements*

Introduction

At the time of the ancient Olympic Games long jump was one of the events comprising the athletics competition of pentathlon, and ever since the first modern Olympic Games in 1875, it has been a single, separate athletic discipline. The first jump over 7 m was performed by an Irishman John Lane in 1875, with a 7.045 m jump, and the first jump over 8 m was performed by Jesse Owens in 1935, with a 8.13 m jump. At the very beginnings of the discipline, the ancient Greeks used weights when performing long jump, but it is difficult to discern from the remaining ancient depictions whether it was a standing or a running long jump. Today, the most widely used techniques are the hang technique and the hitch-kick technique. The current men's world record of 8.95 m was set by Mike Powell back in 1991.

The Olympic Games present the highest level of competitive rivalry for an athlete in which the athletes are expected to achieve their best results, but very often what happens is quite the contrary. By keeping track of the results of the Olympic winners, a progressive trend of the development of results can be observed, up until the 1988 Olympics in Seoul, after which follows a slight decreasing trend in results. Although the development of technology, methodology of trainings, nutritional supplements, equipment and the conditions in which the top athletes train are at a very advanced level today, the achieved results point out to the complexity and the variety of internal and external factors influencing the athlete's performance. When taken in consideration that athletic coaches use individual longitudinal athlete's data in jump evaluation and prediction of their future performances (Liu, 2004), that kind of knowledge presents an important factor for coaches and expert teams when adequatly preparing athletes. Other researchers, such as Heazlewood (2006), Milinović, Milanović and Harasin (2008, 2009), also dealt with the similar problem of the analysis of the results' development trends, while Dyer (1989), Suter, Gembris and Taylor (2002) and Blythe and Kiraly (2015) dealt with predicting athletic performances on other levels of competition.

The primary aim of this research is to predict achievements in the 2020 Tokyo Olympics, based on the analysis of the winners' results from the previous Olympics, from 1948 to 2016. Furthermore, the aim is to determine whether there is a statically significant difference between the results of the Olympic winners and the season's best results, starting with the 1976 Montreal Olympics to the 2016 Rio de Janeiro Olympics.

Methods

Sample of respondents

In order to achieve the primary aim, the sample is composed of long jumpers, the Olympic Games winners from 1948 London Olympics to 2016 Rio de Janeiro Olympics. Therefore, the sample is composed of 18 long jump winners at the Olympic Games. In order to achieve the secondary aim of this paper, besides the already mentioned sample, the results of the long jumpers who have achieved season's best results during the last 11 olympic years (from 1976 Montreal Olympics) have been included in this research.

Sample of variables

The variable in this research is the athletic discipline of men's long jump. The data were collected from the official website of the International Olympic Committee (IOC) and from the *Track and field all-time,* Peter Larson's official website.

Data processing methods

The statistical analysis was performed with *Statistica 7* software package. The basic descriptive parameters were calculated for the variables in this research: arithmetic mean (M), standard deviation (SD), minimum (MIN) and maximum (MAX) result and range. The predicted values for the long jump at the 2020 Tokyo Olimpic Games were obtained by approximating results of the winners according to the models of 2nd and 3rd degree polynomial regression functions. The values show the estimated results for the 1st place in men's long jump at the 2020 Tokyo Olympics. The significance of differences between the winner's results at the Olympics and the season's best results during at the same olympic year were determined by the T-test for the independent samples. The level of significance was set to $p < 0.05$. The preconditions for the application of T-test for the independent samples were checked by the Kolmogorov-Smirnov (K-S test) and Shapiro-Wilk (S-W test) tests of normality, and the homogeneity of variances was checked by Levene's test.

Results and discussion

Table 1 shows the basic descriptive statistics of the results from the long jump finals at the Olympic Games. The arithmetic means of the finalists' results show that the highest average result was achieved at 2004 Athens Olympics (8.33 m), and the lowest at the 1952 Helsinki Olympics (7.26 m). The lowest range of results, i.e. the difference between the highest and the lowest finalists' result at the Olympic Games was noticed at the 2016 Rio Olympics and the highest range at the 1968 Mexico City Olympics. The highest range at Mexico City Olympics is quite expected, given that Bob Beamon's result of 8.90 m, the Olympic record, is still unreachable for athletes, despite the numerous modern training privileges. The possible explanation of that exceptional result might lie in the fact that the host city was located at an elevation of 2240 m. While elevation is often experienced as an aggravating circumstance for the athletes having to adjust to the conditions of thin air with low oxygen levels, especially in endurance sports, for some sports and athletic disciplines it has been a mitigating circumstance, especially for long jump, high jump and pole vault. Even though the progressive rate in winning results can be observed until 1988 Seoul Olympics, and afterwards the decreasing trend in results, it is noticeable that the range between the 1st and the 8th result is getting lower. The lower range leads to a stronger and better competition, and to more exciting outcomes of the finals.

Table 1: Descriptive parameters of the Olympic long jump finals results

Olympic year	Place	N	Range	Min	Max	M	SD
1948	London	8	.83	7.00	7.83	7.35	0.30
1952	Helsinki	8	.55	7.02	7.57	7.26	0.20
1956	Melbourne/Stockholm	8	.56	7.27	7.83	7.46	0.20
1960	Rome	8	.54	7.58	8.12	7.86	0.23
1964	Tokyo	8	.81	7.26	8.07	7.63	0.35
1968	Mexico	8	.96	7.94	8.90	8.17	0.31
1972	Munich	8	.49	7.75	8.24	8.01	0.15
1976	Montreal	8	.51	7.84	8.35	8.01	0.16
1980	Moscow	8	.52	8.02	8.54	8.18	0.16
1984	Los Angeles	8	.73	7.81	8.54	8.10	0.24
1988	Seoul	8	.83	7.89	8.72	8.18	0.29
1992	Barcelona	8	.80	7.87	8.67	8.22	0.30

1996	Atlanta	8	.44	8.06	8.50	8.20	0.14
2000	Sydney	8	.49	8.06	8.55	8.26	0.18
2004	Athens	8	.38	8.21	8.59	8.33	0.13
2008	Beijing	8	.34	8.00	8.34	8.17	0.10
2012	London	8	.38	7.93	8.31	8.10	0.11
2016	Rio de Janeiro	8	.33	8.05	8.38	8.21	0.13

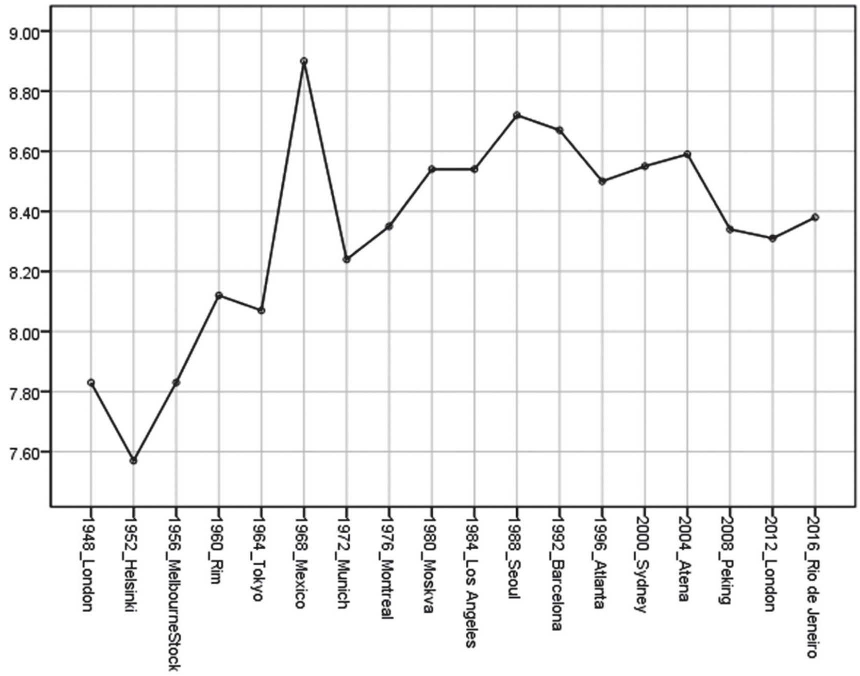


Figure 1: Graphic representation of the results of the Olympic long jump winners

This paper presents the values of estimating results of the Olympic long jump winners according to the models of 2nd and 3rd degree polynomial regression functions. The predicted values for the future long jump winners at the 2020 Tokyo Olimpic Games were obtained by approximating results of the winners from the previous years, according to the models of 2nd and 3rd degree polynomial regression functions (Table 2 and Table 3). The values show the estimated results for the 1st place in men's long jump at the 2020 Tokyo Olympics. Both models have high correlation and explained variance (2nd degree polynomial R=0.85, V=71.65%, 3rd degree polynomial R=0.85, V=71.67%). The predicted result is 8.16 according to the 2nd degree polynomial regression model and 8.18 according to the 3rd degree polynomial model. The values are lower than at the last 13 competitions, however, after the 1968 Mexico City Olympics, a strong decrease in results is noticeable, and up to this day no one has been able to get close to the 8.90 m Olympic result. Winners results vary from competition to competition and therefore it is difficult to predict future results because of the numerous factors affecting the final outcome. Still, there is a tendency that the future winner at the Olympic Games will achieve better results than predicted. Heazlewood (2006) did a research which dealt with predicting the success of the athletes in different athletic disciplines at the 2000 Sydney Olympics and the 2004 Athens Olympics. By using the mathematical functions, a comparison of achieved average finalists' results was carried out. The predicted values were higher than those achieved at both competitions. The predicted result for the Sydney Olympics was 8.36 m, while the achieved result was 8.26 m. In Athens, the predicted result was 8.42 m, while the achieved result was 8.33 m.

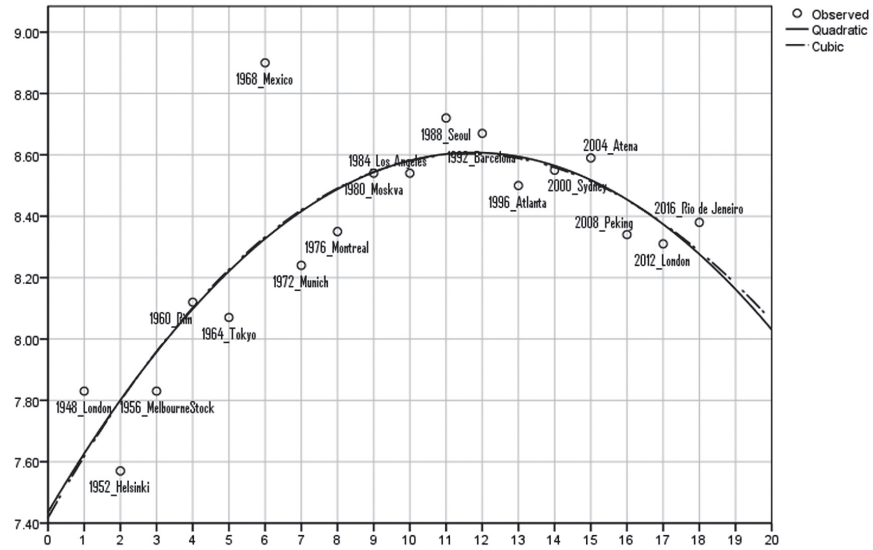


Figure 2: Graphic representation of the prediction of the Olympic long jump winners' results according to the 2nd and 3rd degree polynomial regression functions

Table 2: Approximation of the Olympic long jump winners' results according to the 2nd and 3rd degree polynomial regression functions

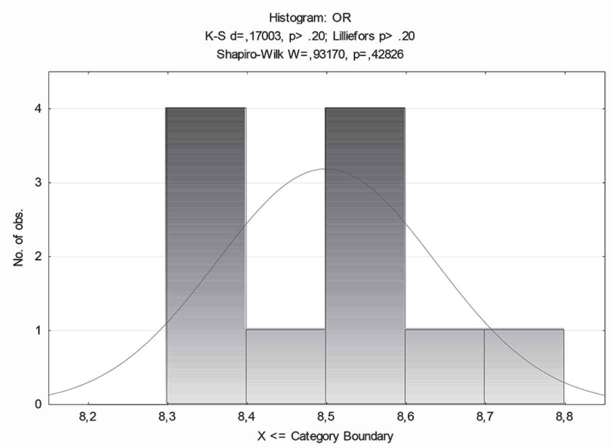
y= b0 + b1*x + b2*x**2			y= b0 + b1*x + b2*x**2 + b3*x**3			
R=0.846478			R=0.846602			
Explained variance =71.6526%			Explained variance =71.6735%			
b0	b1	b2	b0	b1	b2	b3
7.43574	0.19942	-0.00848	7.41778	0.20943	-0.00977	0.00005

Table 3: Estimated values and residuals for the Olympic long jump winners' results according to the 2nd and 3rd degree polynomial analyses of regression functions

		2nd DEGREE POLYNOMIAL		3RD DEGREE POLYNOMIAL	
	ORIG.REZ.	PROG.REZ.	REZIDUAL	PROG.REZ.	REZIDUAL
1948_London	7.83	7.63	0.20	7.62	0.21
1952_Helsinki	7.57	7.80	-0.23	7.80	-0.23
1956_Melbourne/Stock	7.83	7.96	-0.13	7.96	-0.13
1960_Rome	8.12	8.10	0.02	8.10	0.02
1964_Tokyo	8.07	8.22	-0.15	8.23	-0.16
1968_Mexico	8.90	8.33	0.57	8.33	0.57
1972_Munich	8.24	8.42	-0.18	8.42	-0.18
1976_Montreal	8.35	8.49	-0.14	8.49	-0.14
1980_Moscow	8.54	8.54	0.00	8.54	0.00
1984_Los Angeles	8.54	8.58	-0.04	8.58	-0.04
1988_Seoul	8.72	8.60	0.12	8.60	0.12
1992_Barcelona	8.67	8.61	0.06	8.60	0.07
1996_Atlanta	8.50	8.59	-0.09	8.59	-0.09
2000_Sydney	8.55	8.56	-0.01	8.56	-0.01
2004_Athens	8.59	8.52	0.07	8.51	0.08
2008_Beijing	8.34	8.45	-0.11	8.45	-0.11
2012_London	8.31	8.37	-0.06	8.38	-0.07
2016_Rio de Janeiro	8.38	8.28	0.10	8.29	0.09
2020_Tokyo		8.16		8.18	

The normality of distribution was checked by K-S and S-W tests (Histogram 1 and 2) It has been observed that the OR (Olympic winners' results) and SB (season's best results) meet the normality condition of p >0.05. Leven's test was used to check the homogeneity of variances where it also meets the precondition of p >0.05 (Table 4). In table 5 the results of the Olympic winners (OR) and the season's best results (SB) from the last 11 Olympic Games were compared, starting with 1976 Montreal Olympics. It is possible to determine from the results in Table 5 that there is no statistically significant difference between OR and SB results ($t_{(20)}$= - 1.36, p > 0.05). Although there is no statistically significant difference, it is noticeable that the SB results are higher in average than the Olympic winners' results (OR- AS= 8.50, SD= 0.14; SB- AS= 8.58, SD= 0.15). An example of the previous statement is the latest 2016 Rio de Janeiro Olympics result, where the long jump winner Jeff Henderson jumped 8.38 m, while ony a month before the Olympics Jarrion Lawson achieved the result of 8.58 m. Lawson took the 4th place at the Olympics by jumping 8.25, which might imply the absence of tapering. The result he achieved only a month before the Olympics was listed as the 61st best result of all times, which is also the best result in the last 5 years.

***Histogram 1** – OR- normality of distribution*



***Histogram 2** – SB- normality of distribution*

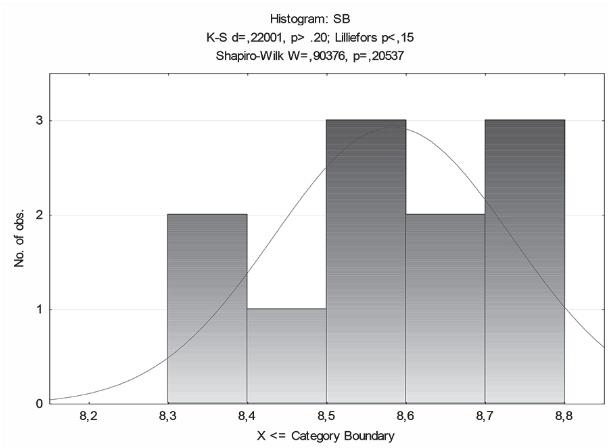
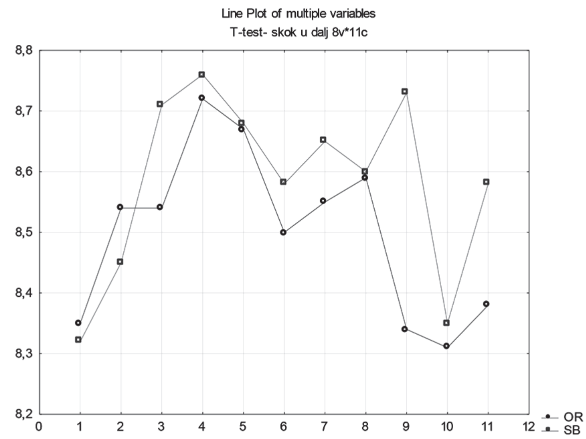


Table 4: Levene's test

Levene F (1, df)	Df Levene	P Levene
0,008348	20	0,93

Table 5: The differences between Olympic winners' results and season's best results

Group 1 vs. 2	AS 1	AS 2	t-value	df	p	N 1	N 2	SD 1	SD 2
OR vs. SB	8,50	8,58	-1,36	20	0,19	11	11	0,14	0,15



OR - Olympic winner's results, SB- season's best results

Figure 3: Graphic representation of OR and SB results

Besides tapering, the reason for regression of the results might lie in the more rigorous doping controls. Despite the fact that the first doping controls were carried out at the 1968 Mexico City Olympics, during the next three decades the International Olympic Committee and national Olympic Committees carried out their own doping control programmes but, considering the lack of consistency (Each Committee had their own list of prohibited substances and methods) and the justifiable fear of the conflict of interest, the World Anti-Doping Agency (WADA) was founded as late as 1999 (according to Pajčić and Petković, 2008), and it is known that the best results in in long jump, high jump, triple jump, pole vault and some throwing disciplines were achieved before 1999. Also, it is important to mention that Russian athletes were banned from the competition in Rio de Janeiro. The International Association of Athletics Federations (IAAF) banned Russian athletes from participating at the Olympic Games for manipulating the positive samples at doping tests at the Sochi Winter Olympic Games and at the World Athletic Championship in Moscow in 2013. The world champion in Moscow was Russian long jumper Aleksandr Menkov with the result of 8.56 m, but whether he is also a part of systematic manipulation or not, is the question which might be answered yet. The only permission to participate at the Rio Olympics was given to Daria Klishina, among 67 suspended Russian athletes, according to the verdict of the Court of Arbitration for Sport (CAS).

Conclusion

The variety of factors can influence the results' development trends, such as tapering, level of physical fitness, climate conditions or psychological factors. The numerousness and the complexity of factors which influence the final results impede precise prediction of the results based only on the development trends to date. This paper presents the analysis of the results of the Olympic long jump winners from 1948 to 2016. The result of the future winner of the 2020 Tokyo Olympics is based on the winners' results from previous years. According to the 2nd degree polynomial regression model the result is 8.16, while according to the 3rd degree polynomial regression model it is 8.18 m. The predicted results are consistent with the constant decreasing trend of the winners' results. The progressive rate in winning results can be observed until 1988 Seoul Olympics and of average results of the finalists is noticeable until the 2004 Athens Olympics. The lowest range of results is noticed at the 2016 Rio Olympics, which implies to the stronger competition between the finalists. Furthermore, the results of the Olympic long jump winners at the last 11 Olympic Games were compared to the season's best results at the same olympic year (starting with the 1976 Montreal Olympics). This paper demonstrates that the averagely lower results are achieved at the Olympic Games (8.50), when compared to the season's best results (8.58). However, sometimes the Olympic finals are held in less than ideal conditions and the possibility of having the right conditions at a competitions during the season is much higher (temperature, direction and strength of the wind, elevation). All of the previously mentioned information might be of help to coaches and expert teams in preparing and applying plans and programs for the next Olympic period. In order to achieve the best possible levels of the fitness of the athletes, especially at the Olympic Games, the most prestigious sports competition, it is important to consider as many factors as possible which can influence the final result and, at the same time, decrease large variations in results.

References

1. Antekolović, Lj., Baković, M. (2008). Skok u dalj. Zagreb: Miš.
2. Blythe, D.A.J., Kiraly, F.J. (2015). Prediction and Quantification of Individual Athletic Performance, Plos One; 11(6).
3. Dyer. K. (1989). Prediction of records and elite perfomances, New Studies in Athletics, 3:11-24, London.
4. Gembris, D., Taylor, J.G., Suter, D. (2002). Trends and random fluctuations in athletics. Nature; 417 (506).
5. Heazlewood, T. (2006). Prediction Versus Reality: The Use of Mathematical Models to Predict Elite Performance in Swimming and Athletics at the Olympic Games. Journal of Sports Science and Medicine; 05, 541-547.
6. Liu Yuanlong (2004). Track and Field Performance Data and Prediction Models: Promises and Fallacies. Economics, management, and optimization in sports, 225-233,
7. Milinović, I., Milanović, D., Harasin, D. (2008). Analiza razvoja trenda olimpijskih rezultata pobjednica u bacanju koplja. 17. Ljetna škola kineziologa Republike Hrvatske,
8. Milinović, I., Milanović, D., Harasin, D. (2009). Analiza razvojnih trendova olimpijskih rezultata bacačica kugle. 18. Ljetna škola kineziologa Republike Hrvatske,
9. Pajčić, M., Petković, T. (2008). Doping i kazneno pravna odgovornost. Zbornik radova Pravnog fakulteta u Splitu, god. 45, 3/2008., str. 551-582.

COMPETITION PERFORMANCE OF ELITE MALE AND FEMALE HANDBALL TEAMS: FEATURES AND DIFFERENCES

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Abstract

In this study the two parts of the sample of entities consisted of 30 male and 30 female handball matches (60+60 opponents) played at the preliminary part of the competition at the Olympic games held in London 2012. The sample of 17 variables consists of frequencies of some performed technical-tactical elements and successfully and unsuccessfully performed technical-tactical elements during the handball matches in phases of offense and defense. Mann-Whitney's U test revealed significant differences between male and female handball teams in three variables. Male teams had significantly higher number of unsuccessful shots from 6 meters (S6MU; p=0,03) and significantly higher number of 2-min penalties (2M; p=0,00). Female teams had a significantly higher number of turnovers (TO; p=0,01). On behalf of the obtained and analyzed frequencies of observed activities it can be concluded that there are minor statistically significant differences between male and female elite handball teams and there are great similarities in competition performance.

Key words: *technical-tactical activities, offense phase, defense phase, similarities*

Introduction

The handball game is characterized by complex situations so there is a need for objective registration of activities in those situations in competition conditions. During a match it is possible to note every successful and unsuccessful activity of each player. In that way objective performance indicators of players are obtained which allow a higher level of objective assessment of differences for example of winning and defeated teams. Therefore, the main subjects of this study are the features and differences of male and female handball team in in-game performance which is represented through standard performance indicators of players situation efficiency.

Czerwinski (1998), Taborsky (2008), Vuleta D. et al. (2009, 2015), Rogulj et al. (2011), Foretić et al. (2011), Hianik (2011) and Skarbalius (2011) have found mainly in their studies that the victorius teams are characterized by offense phases which end with counterattack shots and breakthrough shots and the defeated teams by longer attacks on set defenses.

Ohnjec et al. (2008), Hianik (2011), Taborski (2013), Varbanov (2013), Yamada (2014) and Bajgorić et al. (2016) have confirmed that the female game is characterized by a higher number of shots performed from backcourt position and successful shots from wing position and pivot players position. These indicators of situation efficiency have a significant impact on the outcome of handball matches.

For this study the research of Foretić et al. (2011) is most important. A sample of 24 male teams which played at World Cup held in Croatia in 2009 and 24 women teams which played at the World Cup in France in 2007 the was used with the aim to determine and explain the differences in standard parameters of situation efficiency between top men and top women handball teams. The differences determined are in the percentage of efficiency of shots from 6 meters, frequencies of backcourt position shots, frequencies of successful backcourt position shots, 7 meters shots, successful 7 meters shots, breakthrough shots, successful breakthrough shots and turnovers.

The purpose of this study was to assess the differences in indicators of situation efficiency of male and female handball teams which played in the preliminary round at the Olympic games held in London 2012. The main hypothesis is that there is a statistically significant difference between male and female handball teams in standard performance indicators of situation efficiency.

Methods

To test the hypothesis the data was used from 30 male and female handball matches played in the preliminary phase of the Olympic games in London 2012. The frequencies of activities have been analyzed from 60 matches in which there were 120 opponents. The sample of 17 variables (Table 1.) consisted of counted frequencies of technical-tactical activities performed in offense phases (14) and in defense phases (3).The variables are: shot from 6 meter successful (S6MS), shot from 6 meter unsuccessful (S6MU), shot from wing position successful (SWS), shot from wing position unsuccessful

(SWU), shot from backcourt position successful (SBCS), shot from backcourt position unsuccessful (SBCU), shot from 7 meter successful (S7MS), shot from 7 meter unsuccessful (S7MU), shot from counterattack successful (SCAS), shot from counterattack unsuccessful (SCAU), shot from breakthrough successful (SBTS), shot from breakthrough unsuccessful (SBTU), assist (AS), turnover (TO), steal (ST), block (BL), 2 minute penalty (2M). The data was acquired over the internet from official IHF-statistic datasheets (obtained from the official statistical protocol) at *www.ihf.info/*. Descriptive parameters of arithmetic means (AM), standard deviations (SD) and medians (M_e) have been calculated for male and female teams. The normality of distribution of the variables was tested with the Kolmogorov-Smirnov test in which the maximal empirical relative cumulative frequency deviation from the theoretical relative cumulative frequency (maxD) was calculated (Pauše, 1993). The differences between male and female handball teams have been determined with the use of Mann-Whitney U test in which the values of Sum of ranks (∑R) for male (M) and female (F) teams, (U) values and (Z) values were calculated for each variable. The level of error of 5% in conclusion was set as a margin. The statistical program Statistica 13.2 was used for data analysis.

Results

The Kolmogorov-Smirnov test revealed that the distribution of variables: S6MS, S6MU, SWS, SWU, S7MS, S7MU, SCAS, SCAU, SBTS, SBTU, TO, ST, BL, 2M deviate from normal distributions. In such case the Mann Whitney U test was applied for testing the hypothesis and determining the differences between teams.

Table 1: Descriptive parameters, Kolmogorov-Smirnov test results, Mann-Whitney U-test results of differences between male and female handball teams.

	Male teams			Female teams								
	AM	SD	M_e	AM	SD	M_e	maxD	∑R (M)	∑R (F)	U	Z	p
S6MS	5,20	2,51	5,00	4,68	2,62	4,00	***0,126***	3896,50	3363,50	1533,50	1,40	0,16
S6MU	**2,30**	**1,63**	**2,00**	**1,73**	**1,67**	**1,00**	***0,204***	**4046,50**	**3213,50**	**1383,50**	**2,18**	**0,03**
SWS	4,03	2,04	4,00	3,83	1,96	3,50	***0,178***	3737,00	3523,00	1693,00	0,56	0,58
SWU	3,35	1,39	3,00	2,95	1,71	3,00	***0,188***	3954,50	3305,50	1475,50	1,70	0,09
SBCS	7,73	3,03	8,00	6,70	3,10	6,50	0,095	3934,00	3326,00	1496,00	1,59	0,11
SBCU	11,67	5,53	11,00	11,95	4,26	12,00	0,102	3530,00	3730,00	1700,00	-0,52	0,60
S7MS	2,47	1,52	2,00	2,73	1,93	2,50	***0,159***	3548,00	3712,00	1718,00	-0,43	0,67
S7MU	0,80	0,86	1,00	1,05	1,14	1,00	***0,236***	3453,00	3807,00	1623,00	-0,93	0,35
SCAS	4,15	2,79	4,00	4,05	2,49	4,00	***0,137***	3644,00	3616,00	1786,00	0,07	0,94
SCAU	1,30	1,17	1,00	1,37	1,37	1,00	***0,229***	3636,50	3623,50	1793,50	0,03	0,97
SBTS	2,63	1,68	2,00	3,17	2,04	3,00	***0,159***	3390,00	3870,00	1560,00	-1,26	0,21
SBTU	1,18	1,35	1,00	1,38	1,30	1,00	***0,226***	3434,50	3825,50	1604,50	-1,02	0,31
AS	13,52	5,24	12,00	12,62	3,98	13,00	0,106	3740,50	3519,50	1689,50	0,58	0,56
TO	**12,58**	**4,04**	**12,50**	**15,88**	**5,08**	**16,00**	***0,109***	**2916,00**	**4344,00**	**1086,00**	**-3,74**	**0,00**
ST	4,00	2,14	4,00	4,62	2,31	4,00	***0,146***	3381,50	3878,50	1551,50	-1,30	0,19
BL	2,87	2,65	2,00	2,52	1,73	2,00	***0,172***	3590,50	3549,50	1760,50	-0,05	0,96
2M	**4,07**	**1,85**	**4,00**	**3,10**	**1,87**	**3,00**	***0,130***	**4144,50**	**3115,50**	**1285,50**	**2,70**	**0,01**
KS-crit$_{p=0,05}$ = 0,124												

AM – arithmetic mean, SD – standard deviation, M_e – median, maxD – the maximal empirical relative cumulative frequency deviation from the theoretical relative cumulative frequency, ∑R(M) – sum of ranks for male teams, ∑R(F) – sum of ranks for female teams, U - value for testing the significance of differences between groups Z – approximation of U parameter; p – level of error in conclusion

When the frequencies of variables of male and female handball teams obtained in this study are compared to the frequencies of variables in previous studies by Foretić et al. (2011), Rogulj et al. (2011) and Vuleta et al. (2015) it can be concluded that they are mainly similar. If the differences between male and female teams are observed there are 3 differences in variables (S6MU, TO, 2M) which are statistically significant and there are other lesser differences in other variables (Table 1.). In the variable S6MS - shots six meter successful, male teams in a study from Foretić et al. (2011) had a higher value than male teams in this study (5,79 vs. 5,20 in this study) and female teams from that study had also a value higher (5,63 vs 4,68 in this study) than in this study. In the variable S6MU - shots six meter unsuccessful, male teams in a study from Foretić et al. (2011) had a higher value than male teams in this study (3,00 vs. 2,30 in this study) and female teams from that study had also a value higher than in this study (3,91 vs 1,73 in this study). The number of turnovers (TO) in this study is significantly lower (12.58) with male than with female teams (15.58). When comparing the results of this study in the variable turnovers (TO) to the results in the study of Foretić et al. (2011) both male (14,87 vs 12,58 in this study) and female (18,49 vs 15,88 in this study) teams in this study had lower values. Male teams had almost the same number of 2-min penalties as in the study of Foretić et al. (2011) and women had lower results compared the study. Male teams perform more successful shots from counterattacks (4,15 vs 4,05 female) and female teams perform more successful shots from breakthroughs (3,17 vs 2,63 male). Male teams perform more successful 9 meter shots (7,73 vs 6,70 female) and female teams perform more unsuccessful shots from 9 meters (11,95 vs 11,67 male). Male teams perform more blocks (2,87 vs 2,52 female) and more successful shots from 6 meters (5,20 vs 4,68 female).

Discussion

Out of 17 observed variables (14 variables of offense and 3 variables of defense) in this study the statistically significant differences between male and female teams have been determined in 3 variables: S6MU – shots from 6 meters unsuccessful (p=0,03), 2M – two minute penalty (p=0,00), TO – turnovers (p=0,01). Similar results have been obtained by Foretić et al. (2011) in the number of turnovers and not in the number of 2 minute penalties, however they confirmed differences in the successfulness of 9 meter shots, number of blocked shots and successfulness from 7 meter shots. The determination of statistically significant differences between male and female teams in three variables of performance indicators of which male teams had higher number of unsuccessful shots from 6 meters and 2 minute penalties and lower number of turnovers points out to the fact that there are minor differences, which is unexpected. How to explain these obtained differences and greater similarities between male and female teams in play? Since out of 17 variables which were observed in 14 there were no statistically significant differences which means that the model of play of male and female teams is similar in both offense (6 – meter successful shots, wing position shots, backcourt position shots, 7 meter shots, counterattack shots, breakthrough shots except from 6 meter unsuccessful and turnovers) and defense phases (steals and blocks except 2 minute penalties). It can be assumed that the dynamics of the female play has come closer to the dynamics of the male play due to the application of „fast center" tactic. Such faster type of play requires the application of similar technical-tactical activities which could have caused the similarities between male and female teams represented through standard performance indicators both in offense and defense phases. Physical fitness which has improved also had an influence on the similar performance of women to male play, since it is known that physical fitness has an important influence on technical-tactical activity of players in all phases of the game. It is important to point out that due to the faster type of play and higher game intensity, female teams had significantly higher number of turnovers (technical errors, missed passes, etc.). Male teams had a statistically significant higher number of 2 minute penalties (2M, p = 0.01) which points to the fact that defenses are played more aggressively than with women teams. Significant difference has been determined between the teams in the variable of shots from 6 meter unsuccessful with the error of 3% in conclusion with a higher number with male teams. This can be explained with higher quality level of goalkeeper saving and lower quality of player shots from pivot player position. A higher number of shots from 6 meter distance from goal occurred due to the fact that backcourt players of male teams are to some extent more dangerous for the opponents goal than female backcourt players. Such situation causes defense players to make deeper defensive actions against opponents leaving a lot of free space behind their backs around the 6 meter line thus allowing pivot players and other players to shoot more often.

Conclusion

In this study, on the sample of 30 handball matches of male players and 30 handball matches of female players played at the Olympic games in London in 2012. by using 17 variables of technical-tactical activity acquired by notation in the official statistical protocol, differences between male and female handball teams have been determined. The differences are in variables unsuccessful shots from 6 meters (S6MU; p=0,03), 2-min penalties (2M; p=0,00). And turnovers (TO; p=0,01). With the used variables it is possible to assess the differences between male and female handball teams and such obtained differences are lesser than expected. Such findings lead to the conclusion that female performance is getting very close to the male performance in the technical-tactical point of view.

References

1. Bajgorić, S., Rogulj, N., Gudelj Ceković, I. (2016). Differences in attack situational activity indicators between successful and less successful teams in elite women`s handball. Acta Kinesiologica 10 (2016) Issue 2:21-25.
2. Czerwinski, J. (1998). Statistical analysis of the men's European Championship held in Italy in 1998. European Handball, 2:10-18.
3. Foretić, N.; Rogulj, N.; Srhoj, V.; Burger, A. and Rajković, K. (2011) Differences in Situation Efficiency Parameters between Top Men and Women Handball Teams. EHF Scientific Conference 2011. Science and Analytical Expertise in Handball. Vienna. 243-247
4. Hianik, J. (2011). The Team Match Performance Indicators and their Evaluation in Handball. EHF Scientific Conference 2011. Science and Analytical Expertise in Handball. Vienna. 252-256.
5. Ohnjec, K., Vuleta, D., Milanović, D. & Gruić, I. (2008). Performance indicators of teams at the 2003 World Handball Championship for woman in Croatia. *Kinesiology*, 40(1), 69-79.

6. Pauše, Ž. (1993). Uvod u matematičku statistiku. Zagreb: Školska knjiga.
7. Rogulj, N., Foretić, N., Burger, A. (2011). Differences in the course of result between the winning and losing teams in top handball. Homo Sporticus 13 (1): 28-32.
8. Skarbalius, A. (2011). Monitoring Sport Performance In Handball. EHF Scientific Conference 2011. Science and Analytical Expertise in Handball. Vienna. 325-330.
9. Taborsky, F. (2008). Cumulative indicators of team playing performance in handball (Olympic Games Tournaments 2008). EHF Periodical.
10. Taborsky, F. (2013). The Comparison of Cumulative Indicators of Team Playing Performance between Genders: Olympic Games Handball Tournaments 2008 and 2012. Proceedings of the *2nd EHF Scientific Conference,,* "Women and Handball" Scientific and Practical Approaches, Vienna 22 - 23 November 2013. (str. 13-18). Vienna: European Handball Federation.
11. Varbanov, I. (2013). Tendencies in Modern Handball Affecting Women's Teams after the Olympic Games in London and the European Championship 2012. Proceedings of the *2nd EHF Scientific Conference,,* "Women and Handball" Scientific and Practical Approaches, , Vienna 22 - 23 November 2013. (str. 288-294). Vienna: European Handball Federation.
12. Vuleta, D. Milanović, D. & sur. (2009). Science in handball. Zagreb: Faculty of Kinesiology, University of Zagreb.
13. Vuleta, D., Milanović, D., Sporiš, G. (2015). Indicators of situational efficiency of winning and defeated male handball teams in matches of the olympic tournament 2012. Acta Kinesiologica 9, 1: 40-49.
14. Yamada, E., Aida H.,Fujimoto, H.,Nakagawa, A. (2014). Comparison of Game Performance among European National Women's Handball Teams. *International Journal of Sport and Health Science* Vol. 12 p. 1-10.

DIFFERENCES AMONG MALE AND FEMALE TOP LEVEL BASKETBALL TEAMS IN COMPETITION EFFICIENCY PARAMETERS

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Abstract

The purpose of the present study was to determine differences in situational efficiency parameters between male and female basketball teams playing on the Olympic Games in London 2012. Sample of entites was consisted of 24 teams (12 male and 12 female, 76 games, 152 opponents) watching separately according to sex differences. Sample of variables was comprised of 13 situational efficiency parameters analyzed in the study. Multivariate analysis of variance (MANOVA) was used to determine overall differences between successful and unsuccessful teams. Also, to see which variables differentiated groups the most, discriminant analysis with standardised canonical coefficient (SCC) was performed. Statistical significance was set up at p≤0,05. Results showed that variables 2 points-made (F-value= 5,23; SCC= -0,46; p<0,05), 3 points-made (F-value= 9,56; SCC= -0,55; p<0,01), 3 points-fail (F-value= 7,31; SCC= -0,43; p<0,01), free throws-fail (F-value= 8,18; SCC= -0,39; p<0,01), offensive rebounds (F-value= 4,17; SCC= 0,37; p<0,01) and personal fouls (F-value= 6,12; SCC= -0,32; p<0,05) differentiated male from female teams the most and on the acceptable statistical level. In conclusion, differences between male and female basketball teams primary represent shooting skills and accuracy, with cognitive stability and calmness during the game. Female team deficiencies come from different anthropometrical, motor and functional abilities between male and female teams, which results in different basketball play.

Key words: *basketball, male and female teams, competition efficiency parameters, differences*

Introduction

Several studies have been conducted exploring differences between successful and unsuccessful teams among male (Ibanez et al., 2003; Trninić et al., 2002; Melnick, 2001, Sampaio and Janeira, 2003; Nakić, 2004) and female (Gomez et al., 2006; Sampaio et al., 2004; Koh et al., 2012, Nakić, 2004) basketball players. Results showed that, among male and female players, what differentiated successful from less successful teams were defensive rebounds, along with 2 point shots-made and assists.

Less studies have been done exploring which situational indicatiors best discriminated male and female basketball players. Sampaio et al. (2004) wanted to explore which game-related statistics best discriminate performances according to sex of players and level of competition. Obtained results showed that 2 points-fail, steals and blocks discriminated players according to sex, while assists and turnovers best discriminated players according to level of competition.

Nakić (2004) investigated which situational indicators best discriminated male from female basketball teams on European basketball championship in 2003. Obtained results showed that the biggest differences were in unsuccessful 2 point-shots, successful and unsuccessful 3 point-shots, personal fouls and steals. Smaller differences were obtained in offensive rebounds, unsuccessful free thows, defensive rebounds, turnovers, assists, successful 2 point-shots, successful free throws and blocks.

As it known to the authors, no other study examined which situational indicators were the best discriminators between male and female basketball teams on the Olympic Games. So, the aim of the present study was to determine which standard situational indicators differentiated male from female basketball teams on the Olympic Games in London in 2012.

Methods

Sample of entities

Sample of entities was consisted of 24 teams (12 male and 12 female teams, 76 games, 152 opponents derived by sex differences) in this order: A group (15 games), B group (15 games), quater-finals (4 games), semi-finals (2 games), finals (1 game) and 1 game for the 3rd place in both male and female basketball teams.

Sample of variables

Sample of variables was comprised of 13 situational indicator that in objective and emphirical way evaluate player's and team's efficiency during the game. All data were collected from the official FIBA website page. Criterium variable was determined categorically, giving the code according to sex differences (male basketball teams= 1; female basketball teams= 2).

Data analysis

For all parameters, descriptive statistics were calculated as followed: arithmetic mean and standard deviation. For determinating situational indicator, which differentiated male from female temas the most, discriminate analysis was used. Statistical significance was set up at p≤0,05.

Results

Statistical data of situational efficiency parameters and *discriminant differences between male and female basketball teams*

Table 1: Basic descriptive parameters and discriminant differences between male and female basketball teams

Variables/ Descriptive parameters	N	Means±SD		F-value	Standardized canonical coefficients (SCC)	Factor structcture – rott 1
		Male	Female			
2P-M	76	21.45±4,67	20,85±6,02	5.23*	-0,46*	-0,06
2P-F	76	21,58±5,22	27,39±6,05	1,73	0,26	0,55
3P-M	76	7.88±4,53	4,76±2,20	9,56**	-0,55**	-0,47
3P-F	76	14,41±4,57	11,00±3,43	7,31**	-0,43**	-0,45
FT-M	76	13,91±5,39	12,55±5,18	0,78	-0,13	-0,14
FT-F	76	6,01±3,36	4,28±2,54	8,18**	-0,39**	-0,31
RB-0	76	11,21±4,42	13,01±4,36	4,17**	0,37**	0,22
RB-D	76	26,76±4,76	26,67±5,42	0,97	0,15	-0,01
AS	76	17,17±6,50	15,83±5,57	2,47	0,33	-0,12
PF	76	20,67±4,51	17,79±4,20	6,12*	-0,32*	-0,35
TO	76	13,49±4,16	15,88±4,23	1,80	0,20	0,30
ST	76	5,92±3,37	6,78±3,16	2,54	0,24	0,14
BS	76	3,10±2,10	3,42±2,46	0,03	-0,02	0,08

*P<0,05
** p<0,01

Table 1. showed basic parameters of arithmetic means and standard deviations, for each of the parameter and p-value. Also, statistical differences between winning and defeated male and female basketball teams were marked using asterisk (*) next to each parameter.

Presenting shooting results, from the total of 3215, 2 points-made, male teams, during whole competition scored 1630 points for 2, which was 50,70%, in contrast to female teams, who scored 1585 points for 2 or 49,30%. Opposed to successful 2 points-made, female teams made more 2 points-fail (2082 or 55,94%) opposed to male teams (1640 or 44,06%). From the total of 961 successful shots for 3 points, male teams scored 599 shots for 3 points (62,33%), opposed to 362 (37,67%) scored by female basketball teams. In variable 3 points-fail, male basketball teams performed higher unsuccessful scores for 3 points (1095 or 56,71%) than female basketball teams (836 or 44,29%). Results from free throws-made showed higher percentage of realization by male teams (1057 or 52,56%) in contrare to females (954 or 47,44%). Also, in variable free throws-fail, male basketball teams had higher numerical value (457 or 58,44%) than female (325 or 41,56%) teams. Female basketball teams did more offensive (989 or 53,72% vs. 852 or 46,28%), while similar results were obtained in variable defensive rebounds (males2034 or 50,09% vs. females2027 or 49,91%). Also, male teams performed better in assists (1305 or 52,03% vs. 1203 or 47,97%), but had higher results in personal fouls-made (males 1571 or 53,58% vs. females 1352 or 46,42%). Results in variable turnovers (males 1025 or 54,08 vs. 1207 or 45,92%), steals (males 450 or 46,63 vs. females 515 or 53,37) and blocks (males 233 or 47,26% vs. females 260 or 52,74%) showed that female basketball teams performed better.

Results in table 1. showed statistically significant coefficients and each parameter correlation with significant root. Also, significant variables which differentiated groups the most were highlighted and marked with asterisk (*= p<0,05; **= p<0,01). Results showed that, on a global level, male and female basketball teams had statistical differences between results in situational indicators, looked from separate variables. In partial, variables that statistically differentiated male and female basketball teams were *2* points-made (F-value= 5,23; SCC= -0,46; p<0,05), 3 points-made (F-value= 9,56; SCC= -0,55; p<0,01), 3 points-fail (F-value= 7,31; SCC= -0,43; p<0,01), free throws-fail (F-value= 8,18; SCC= -0,39; p<0,01), offensive rebounds (F-value= 4,17; SCC= 0,37; p<0,01) and personal fouls (F-value= 6,12; SCC= -0,32; p<0,05).

Discussion

The aim of present study was to determine significant differences between male and female basketball teams within standardise situational indicators playing on the Olympic Games in London 2012.

Based on the results from table 1., number of ***2 point shots*** represented primary situational indicator in the basketball game. Well-organized and structured phase of attack had to be consisted of contolling the ball and line movement of each player, which gave the opportunity for other players to have open shot for 2 points. Male basketball teams performed higher percentage of 2 points-made than female basketball teams, which meant that opened shot for 2 points within the shooting rank made top level realization in the game. One of the most crucial indicators to perform 2 point shot were screens in the phase of attack, “reading” the defense formation, correct passing the ball, with high level of throwing the ball into the basket, along with speed and rhythm of throws.

According to results in table 1., male basketball players had more **shots for 3 points** (7,88 vs. 4,76; p≤0,05) than female basketball teams. Also like 2 point shots indicator, *shot for 3 points-made* represented one of the key factor to win the game. From the tactical point of view, it was necessary to accomplish harmony of movement rhythm, along with action accuracy, which would affect on situational and positional precision of attack. Only high-organised game produced high percentage of shots. In organised game, shooter had to be responsible for open shot realization with seaking of selective proper shot to finish the attack.

Nevertheless, male teams performed poorer in ***3 points-fail*** than the female teams (14,41 vs. 11,00; p≤0,05), probably beacuse they had greater tries of scoring for 3 points during the basketball game. When we compared percentage efficiency of male and female basketball players, from total of 1694 shots for 3 points among male basketball teams, only 599 (or 35,36%) were successfully, while 1095 shots (or 64,64%) were unsuccessfully. From total of 1198 shot for 3 points, female basketball players had 362 (or 30,22%) successful shots, while 836 (or 69,78%) unsuccessful. Although male teams showed greater values in this variable, converting it in percentages, female basketball players had weaker result (males 64,64% vs. females 69,78%).

Table 2. also showed that male teams performed weaker in ***free throws-fail*** (males 6,01 vs. females 4,28). In the game, great attention needed to be presented during the free thows, because they have determined more and more final score in the last decade. In great number of cases, that deciding shot could be scored with free thows. Those shots were performed like a ritual, where the most important thing was to have concentration, breathing and shot rhythm (Trninić, (2002).

Aggresive *offensive rebounds* in the phase of attack represented significant indicator for successfulness. According to Trninić et al. (2002), offensive rebounds were defined as extension of aggresion of attack that opened the option of greater shoot percentage. This meant that the team had to close the way towards the basket. In that way, team who got in possesion of the ball had bigger percentage of shots and more succesfull transition from the phase of attack to defense and vice versa. According to results in present study, female basketball teams performed better in this variable, which meant that they had higher percentage of jumps in the phase of attack with the continuation of attack and better selective shot to finish the attack.

Also, table 1. presented results from ***personal fouls*****,** showed that males had higher value (20,67) opposed to females (17,79). Male basketball teams also had negative percentage efficiency (1571 or 53,58%) opposed to female teams (1352 or 46,42%). It was assumed, that every team, according to tactical needs, did fouls, especially during 1st and 2nd quarter, where opponent’s play was not allowed. Along with that, in final minutes of basketball game, personal fouls were used for more frequent gaining possession of the ball in situations where opponent’s team contolled the result by keeping the ball.

Study from Sampaio et al. (2004) showed that *2 points-unsuccessful*, *steals*and *blocks* differentiated male from female basketball game. More precisely, male players performed better in *2 points-unsuccessful* variable (13,9%) and *blocks* (46%), but poorer in *steals* (-34,1%). Authors explained their findings by different physical performance that configure game tactics and strategies. Also, main differences between those two groups were in anthropological profile (height, weight, body proportion and composition) and everyday activities (Durkin, 1987; taken from Sampaio et al., 2004).

Nakić (2004) showed that male and female basketball teams differentiated the most in unsuccessful 2 point shots, successful and unsuccessful 3 point shots, personal fouls and steals, which was similar to our results. The author explained unsuccessfulness shots for 2 points by technical and motor inferior abilities, where in fast reactions, female basketball teams couldn’t achieve higher precission. Also, after unsuccessful shots for 2 and 3 points, team transition in the phase of defense was not well-organized, which allowed the opponent to achieve easy shots. Female players had more steals, probably because of organising attack problems (tactical preparedness), concentration decreasing and unbalanced lines of the players in the phase of attack. Opposed to male teams, female players usually play zone defense, where collective defense is more pronounced, than the individual defense. That led to lower level of aggresion and personal fouls.

Conclussion

In conclusion, differences between male and female basketball games within standardise situational indicators playing on the Olympic Games in London 2012 primary represent shooting skills and accuracy, with cognitive stability and calmness. Players of both gender had only several statistical differences among situational efficiency parameters. This means that, although it is expected that male players perform better in the game, especially because genetic constitution and higher percentage of muscle-mass, female players were much more coordinated (less *personal fouls*, more *offensive rebounds*, *steals*, *turnovers* and *blocks*) during the game. Whether male population have had better shooting efficiency, female population have compensated that difference with mentioned coordination efficiency indicators. This could be explained by lower center of gravity, which automatically means higher speed, quickness and overall coordination. Nevertheless, more studies need to be conducted in all sports to determine which situational parameters discriminate gender population the most.

References

1. Gómez, M.A., Lorenzo, A., Sampaio, J. and Ibáñez, S.J. (2006). Differences in game-related statistics between winning and losing teams in women's basketball. *Journal of Human Movement Studies, 551*, 357-369.
2. Ibáñez, S.J., Sampaio, J., Sáenz-López, P., Giménez, J., and Janeira, M.A. (2003). Games statistics discriminating the final outcome of junior world basketball championship matches. *Journal of Human Movement Studies*, *45*, 1-19.
3. Koh, K.T., Wang, C.K.J. and Mallett, C.J. (2012). Discriminating factors between successful and unsuccessful elite Olympic Female basketball teams. *International Journal of Performance Analysis in Sport*, *12*(1), 119-131.
4. Melnick, J. (2001). Relationship between team assists and win-loss record in the NationalBasketball Association. *Perceptual and Motor Skills, 92*, 595-602.
5. Nakić, J. (2004).Differences in standard and derived situation efficacy parameters between men's and women's basketball teams in senior European basketball championships in 2003. Unpublished master thesis. Zagreb: Faculty of Kinesiology.
6. Sampaio, J., Ibáñez, S., and Feu, S. (2004). Discriminative power of basketball game statistics by level of competition and sex. *Perceptual and Motor Skills*, *99*, 1231-1238.
7. Trninić, S., Dizdar, D., Lukšić, E. (2002). Differences between winning and defeated top quality basketball teams in final tournaments of European club championship. *Coll. Antropol*., *26*(2), 521-531.

CHANGE OF FEMALE DOUBLE SCULL ROWERS' PHYSICAL AND FUNCTIONAL CAPACITY IN THEIR PREPARATION FOR 2016 OLYMPIC GAMES

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Abstract

The purpose of the work was to carry out investigation on peculiarities of Lithuanian elite female double scull rowers' physical and functional capacity during yearly training cycle, preparing for the Olympic Games.

Methods*:* Two female double scull rowers aged 22 (I) and 27 (II) were investigated. During yearly training cycle, the rowers participated in four expanded researches. The first testing (I) was carried out at the beginning of preparatory period (November), the second (II) and the third (III) – in the middle of preparatory period (February and April), and the fourth (IV) – during the competitive period (June). Rowers' body development, anaerobic alactic muscle power and aerobic power were investigated.

Results: Absolute and average 10 sec working power during yearly training cycle used to increase, reaching their peaks during competitive period. Maximum power increase for the first rower was from 596 to 645 W and from 482 to 615 W for the second. Mean anaerobic alactic power of the rowers increased respectively from 483 to 530 W and from 372 to 486 W. Power of the rowers' performed wok at the limit of lactic anaerobic threshold used to increase during yearly training cycle – from 235 to 248 W for the first athlete, and from 205 to 235 W for the second. During yearly training cycle, VO_{2max} at the critical intensity limit for the first rower increased from 52.2 to 60.3 ml/kg/min and from 53.5 to 59.0 ml/kg/min.

Conclusions: Maximum and mean absolute and relative anaerobic alactic muscle power of our investigated athletes had a tendency to increase during yearly training cycle, from the beginning of preparatory period till competitive period. The training loads applied during yearly cycle were of positive impact on the change of aerobic power indices at the critical intensity and anaerobic threshold limits.

Training of Lithuanian female double skull rowers proved to have been well organized. Their physical and functional capacity indices were of positive change and progressed during yearly cycle. These factors had a positive effect on excellent achievements in international events, as Lithuanian female double scull crew were the bronze medal winners in 2016 Rio de Janeiro Olympic Games.

Key words: *rowing, yearly cycle, special power, aerobic capacity*

Introduction

Lithuanian female double scull rowers successfully participate in international rowing competitions. In 2013, they became the world champions, and in Rio de Janeiro Olympic Games they won a bronze medal.

Analysis of the world scientific literature dealing with the issues of rowers' training and their adaptation to training loads disclose variable factors, which are important in achieving the best results in rowing (Yoshiga, Higuchi, 2003; Driller et al., 2009; Izquierdo-Gabarren et al., 2010; Jackson, Mäestu, 2012; Smith, Hopkins, 2012). Many scientific articles deal with the structure of rowers' training load during yearly training cycle, with the content of mezo- and micro-cycles, as well as with the training methods applied. Numerous publications deal with the process of rowers' body adaptation to training loads (Mäestu et al., 2005), bus still missing are the explorations on the issues of elite rowers' physical and functional capacity change ahead of the athletes' participation in important competitions.

The issues of Lithuanian rowers' training and change of their physical and functional capacity are explored; the results of the findings are presented in scientific literature (Petkus, 2010; Masilionis et al., 2013). Nevertheless, the explorations on the data of this feature and its change during the final period of preparation for the Olympic Games are not enough.

The purpose of the work was to carry out investigation on peculiarities of Lithuanian elite female double scull rowers' physical and functional capacity during yearly training cycle, preparing for the Olympic Games.

Methods

Two female double scull rowers aged 22 (I) and 27 (II), body mass 64.3 and 63.0 kg, BMI 20. and 21.7 were investigated. During yearly training cycle, the rowers participated in four expanded researches. The first testing (I) was carried out at the beginning of preparatory period (November), the second (II) and the third (III) – in the middle of preparatory period (February and April), and the fourth (IV) – during the competitive period (June). Rowers' body development, anaerobic alactic muscle power and aerobic power were investigated.

Effectiveness of anaerobic alactic energy production was evaluated by establishing momentum and mean working power in 10 sec ergometer rowing test ("Concept II"). Lactic anaerobic threshold was measured by performing constantly increasing work on ergometer till reaching 4.0 mmol/l lactate concentration. Indices of pulse rate (PR) and power of performed work (W) were recorded. Functional power of cardiovascular systems was estimated by recording indices of resting pulse rate, orthostatic testing and after standard working load. Aerobic power was analyzed by gas analyzer "Oxycon Mobile", establishing lung ventilation (LV), pulse rate (PR), oxygen consumption (VO_{2max}, VO_2), oxygen pulse (OP), working power (W), working efficiency (ml/1W) at critical intensity (CIT) and ventilatory anaerobic (VAT) thresholds. Lactate concentration (La) was established.

Results

Anaerobic alactic muscle power is of paramount importance for the rowers, performing initial strokes in start. At the beginning of preparatory period, both absolute and mean 10 sec working power of the investigated athletes were of the least values. During yearly training cycle, these indices used to constantly increase and reached their greatest values during competitive period. Maximum power for the first athlete increased from 596 to 645 W, for the second – from 482 to 615 W. Mean anaerobic alactic muscle power of these rowers increased respectively from 48 to 530 W and from 372 to 486 W During yearly training cycle, rowers' working power at anaerobic threshold used to increase: from 235 to 248 W for the first, and from 205 to 235 W for the second athlete (Table 1).

Table 1: Change of Lithuanian female double scull rowers' indices of anaerobic alactic muscle power and anaerobic threshold (AT) during yearly training cycle

Rowers	10 s max		10 s average		Anaerobic threshold	
	W	W/kg	W	W/kg	PR, b/min	W
I testing						
I	596	9.1	483	7.4	175	235
II	482	7.6	372	5.9	168	205
II testing						
I	624	9.6	517	8.0	175	237
II	491	7.8	378	6.0	162	235
III testing						
I	641	9.6	530	7.9	172	240
II	561	8.8	448	7.1	175	234
IV testing						
I	645	10.1	530	8.3	172	248
II	615	9.8	486	7.7	184	235

Changes of the cardiovascular functional power indices were not significant, however, during competitive period, the first athlete's results reached the highest values.

During preparatory cycle, two testings of athletes' aerobic power using gas analyzer were carried out. The first testing was performed at the beginning of the preparatory period; the second took place during competitive period, one and a half months prior to the Olympic Games. Significant increase of aerobic power indices was established: VO_{2max} at the critical intensity threshold for the first rower increased from 52.5 to 60.3 ml/kg/min, power of the performed work – from 360 to 370 W, oxygen volume per heart beat – from 17.9 to 28.7 ml/b, while lactate concentration after this work increased from 6.2 to 8.9 mmol/l. Accordingly, an increase was observed in the second rower's aerobic power results, too: lung ventilation indices increased from 131 to 156 l/min, VO_{2max} – from 52.2 to 59.0 ml/kg/min, working power – from 320 to 360 W, oxygen volume per heart beat – from 18.7 to 20.0 ml/b, while lactate concentration after the work increased from 7.3 to 8.3 mmol/l. (Table 2). At the anaerobic threshold, both athletes' indices changed the same way, reaching highest values during the second testing (Table 3).

Table 2: Change of Lithuanian female double scull rowers' indices of aerobic power at critical intensity threshold (CIT) during yearly training cycle

Rowers	CIT limit							La, mmol/l
	LV l/min	PR, b/min	VO_{2max} l/min	VO_{2max} ml/kg/min	OP ml/b	W	O_2 W/ml	
I testing								
I	137	193	3.46	52.5	17.9	360	9.6	6.2
II	131	181	3.38	52.2	18.7	320	10.6	7.3
II testing								
I	147	188	3.98	60.3	28.7	370	10.8	8.9
II	156	189	3.77	59.0	20.0	360	10.5	8.3

Table 3: Change of Lithuanian female double scull rowers' indices of aerobic power at ventilatory anaerobic threshold (VAT) limit during yearly training cycle

Rowers	VAT limit						
	LV l/min	PR b/min	VO_2 l/min	VO_2 ml/kg/min	OP ml/b	O_2% of VO_2 max	W
I testing							
I	123	182	3.40	51.6	18.7	320	10.6
II	112	172	3.28	50.7	19.1	280	11.7
II testing							
I	128	179	3.62	55.0	26.1	330	11.0
II	118	178	3.56	55.7	20.6	300	11.9

Discussion

Numerous scientific literature sources, dealing with rowers' physical and functional capacity, pay much attention to rowers' anaerobic alactic muscle power analysis (Hartman et al., 1993; Riechman et al., 2002;). In rowing, this method of energy production is mostly characteristic in start, for the first strokes performance. After 10–15 strokes, work changes to anaerobic glycolytic and aerobic character, its intensity decreases below critical intensity threshold (Riechman et al., 2002; Mejuto et al., 2012). This is the reason why rowers' preparation requires much attention for development and testing of anaerobic alactic muscle power; 10 strokes maximum power efforts test is the most suitable test to measure the named feature (Izquierdo-Gabarren et al., 2010). Basing on the data of the test's authors, the results of this test are in close correlation with 2000 m rowing results ($p<0.01$), with blood lactate concentration after the work ($p<0.01$), as well as with mean work power, reached in this distance ($p<0.05$). Maximum and relative anaerobic alactic 10 sec duration work power of our investigated rowers used to increase in time-period from the beginning of preparatory up to competitive periods. B. Metikos et al. (2015) applied rowing trials using the lowest, medium and the highest adjustable resistance settings (i.e., "1", "5" and "10" on the resistance control dial) on the ergometer Concept II for the investigated persons of different mastership level, including rowers, thus proving this test being reliable and valid tool for assessing working capacity both for the persons with low fitness level and elite rowers.

In rowers' training, the loads of aerobic character prevail. Their effect is best characterized by the indices, estimated at anaerobic threshold and critical intensity limits. Almost all scientific works, dealing with rowers' preparation, present discussion on the change of VO_{2max} index, which is the main aerobic power index; altogether, much attention is paid to analysis of other indices of aerobic power and their correlation (Ingham et al., 2002; Mäestu et al., 2005;). For instance, the example found in literature showed that VO_{2max} index of Croatian light weight rowers used to increase from November to July by 7 percent (Mikulic, 2012). The latter author also draws attention to the fact that VO_{2max} during the season might experience no greater than 10 percent change.

The results of our research demonstrated that during the final cycle of preparation for Olympic Games, aerobic power of the rowers was in remarkable progress and reached the results of the similar level athletes, presented in the literature by most researchers in this field – VO_{2max} reaching from 60 to 65 ml/kg/min (Steinacker, 1993). J. Mäestu et al. (2005) proved close correlation ($r=0.56$) between working power and oxygen consumption at anaerobic threshold. According to their conclusion, this relation might serve as an important diagnostic index to establish aerobic power. The results of our research showed little difference between lactic and ventilatory anaerobic thresholds working power. These indices did not show significant increase during the period of investigation, however, VO_2 increase within this limit was considerable.

Conclusions

Maximum and mean absolute and relative anaerobic alactic muscle power of our investigated athletes had a tendency to increase during yearly training cycle, from preparatory to competitive periods.

Training loads, applied during yearly training cycle, were of positive effect on the change of aerobic power indices at the limits of critical intensity and anaerobic threshold. Significant increase of the rowers' VO_{2max} from the beginning of preparatory period till competitive period was established: for the first athlete, it used to increase from 52.5 to 60.3 ml/kg/min, for the second – from 52.2 to 59.0 ml/min/kg. During the period of investigation, oxygen consumption of Lithuanian rowers at anaerobic threshold increased, too. Such level of the indices is in line with the best world rowers' results of aerobic power, presented in literature sources.

Preparation of Lithuanian female double scull rowers was well organized. During yearly training cycle, their body and functional capacity were in progress. Due to such factors, the athletes demonstrated excellent results in international event: Lithuanian female double scull rowers won the bronze medal in 2016 Rio de Janeiro Olympic Games.

References

1. Driller, M., Fell, J., Gregory, J., Shing, C., & Williams, A. (2009). The effects of high-intensity Interval training in well-trained rowers. *International Journal of Sports Physiology and Performance*, *4*(1), 110 -121.
2. Hartmann, U., Mader, A., Wasser, K., & Klauer, I. (1993). Peak force, velocity, and power during five and ten maximal rowing ergometer strokes by world class female and male rowers. *International Journal of Sports Medicine*, *14*(1), 42–45.
3. Ingham, S.A., Whyte, G.P., Jones, K., & Nevill, A. M. (2002). Determinants of 2,000 m rowing ergometer performance in elite rowers. *European Journal of Applied Physiology, 88,* 243-246.
4. Izquierdo-Gabarren, M., Expósito, R., deVillarreal, E., & Izquierdo, M. (2010). Physiological factors to predict on traditional rowing performance. *European Journal of Applied Physiology, 108*(1), 83-92.
5. Yoshiga, C., & Higuchi, M. (2003). Rowing performance of female and male rowers. *Scandinavian Journal of Medicine and Science in Sports*, *13*(5), 317-321.
6. Jackson, E., & Mäestu, J. (2012). The impact of low intensity specific and nonspecific strength-endurance training on submaximal work capacity in trained male rowers. *Acta Kinesiologiae Universitatis Tartuensis*, *18*, 47-55.
7. Mäestu, J., Jürimäe, J., & Jürimäe, T. (2005). Monitoring of performance and training in rowing. *Sports Medicin, 35*(7), 597-617.
8. Masilionis, M., Petkus, E., Milašius, K., Dadelienė, R., & Skernevičius J. (2013). Preparation of Lithuanian elite double sculling rowers in yearly training cycle. *Sporto mokslas, 4*(74), 23-29.
9. Mejuto, G., Arratibel I., Cámara, J., Puente, A., Iturriaga G., & Calleja-González, J. (2012). The effect of a 6-week individual anaerobic threshold based programme in a traditional rowing crew. *Biology of Sport, 29*(4), 297-301.
10. Metikos, B, Mikulic, P., Sarabon, N., & Markovic, G. (2015). Peak power output test on a rowing ergometer: A methodological study. *Journal of Strength and Conditioning Research, 29*(10), 2919-2925.
11. Mikulic, P. (2012). Seasonal changes in fitness parameters in a World champion rowing crew. *International Journal of Sports Physiology and Performance*, *7*(2), 189-192.
12. Petkus, E. (2010). *Training of Lithuanian high performance rowers.* Doctoral thesis, Vilnius, VPU, 155 p.
13. Riechman, S., Zoeller, R., Balasekaran, G. Goss, R., & Robertson R. (2002). Prediction of 2,000 m indoor rowing performance using a 30 s sprint and maximal oxygen uptake. *Journal of Sport Science, 20,* 681-687.
14. Smith, T. & Hopkins, W. (2012). Measures of rowing performance. *Sports Medicine*, *42*(4), 343-358.
15. Steinacker, J. (1993). Physiological aspects of training on rowing. *International Journal of Sports Medicine*, *14*(1), 3-10.
16. Steinacker, J.M., Lormes, W., Lehmann, M., & Altenburg, D. (1998) Training of rowers before world championships. Medicine and Science in Sports and Exercise *30*, 1158-1163.

INFLUENCE OF DISMOUNTS FROM BALANCE BEAM ON DIFFICULTY VALUE OF ROUTINE IN SENIOR CATEGORY ON EUROPEAN CHAMPIONSHIP IN BERN 2016.

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Abstract

Purpose of this paper was to determine the influence of most frequent dismounts from balance beam on performance difficulty value, in senior category at European Championship 2016. in Bern. Research was conducted on a sample of 51 female competitors in the Qualification competition. Dismounts from balance beam and faults in performance were evaluated through video material of the competition on behalf of three gymnast experts, national judge at HGS. D – score was used for technique and E – score for performance evaluation. Statistica 12 was used for data analysis. With employment of regression analysis with error level of 5% it was determined that dismounts of D and E difficulty value explain 51.9% of the variance of predictor variable of D – score, because the routine is also comprised of additional elements which form a whole. Double piked somersault of E difficulty value and dismounts with rotations around longitudinal axis of D and E difficulty value, were utilized in 37.25% cases, each, which can be contributed to attractiveness and prevalence of performance on other apparatus. Results have shown that E – score contributes to the final score of routine by 70%, because every difficulty value is monitored through whole performance and E – score evaluates performance and faults. Correlation coefficient between D – score and an E dismount is 0,69, because difficulty criteria of an element is an elementary part of D – score. There is a tendency between competitors to finish a routine with a more attractive element to impress the judges and audience and to raise the starting score.

Key words: *artistic gymnastics, dismounts, balance beam, D-score, E-score*

Introduction

Balance beam is an attractive apparatus of gymnastic all – around, on which, safety, balance and personal style are shown through routine. Contents and grading of routine is prescribed by Code of Points (FIG, 2013). On European Championship 2010., it was seen that junior competitors perform less elements and that only a few use harder acrobatic elements to increase the value of routine (Miletić et al., 2011). Dismount from the beam is an important part for fulfilling composition requirements, depending on the difficulty of the dismount the gymnast will attain 2,5 points or less to D – score. Precise landing is the last element which judges see and can influence lower deduction for errors made in dismount. Dismount landing needs to be performed on feet to be counted into D – score. Gittoes et al., 2013., describe that the strategy of landing from tucked or piked somersault is individual and that it depends on coordination of joints which adapts in relation to the level of skill of the performer. Basic purpose of this paper is to determine which dismounts are used on European Championship in Bern and their influence on D – score and E – score of routine on a balance beam.

Methods

Research was conducted on a sample of 51 female competitors on European Championship in Bern (Switzerland), in the year 2016 in the qualification part of the competition (C-I) on balance beam. Analysis of routines was done over video, by three national gymnastic judges who evaluated difficulty value of dismounts and errors. Official results from the competition on balance beam were used for analysis, D – score, E – score and final score. Variables which have been used are an elementary part of routine on balance beam. Variable KO (final score) represents final score, the result of routine and is comprised of D and E score. Variable D – score is the difficulty value of the routine. E – score is the performance value of the routine. Variables DISMOUNT C, DISMOUNT D and DISMOUNT E are difficulty values of elements, where C=0,30, D=0,40 and E=0,50 points. Variable DSG is used for double tucked backward somersault dismount. Variable DSS is used for double piked backward somersault. SSO is used for somersaults with rotations over longitudinal axis and SS is used for dismounts which include somersaults without rotations over the longitudinal axis of the body.

Statistica 12 was used for data analysis. Basic descriptive parameters, correlation coefficients and frequencies were calculated for predictive and criteria variable. The influence of individual dismounts on D – score of routine was determined by regression analysis.

Results

Basic descriptive parameters of measured variables are shown in Table 1: KO, D – score, E – score, DISMOUNT D, DISMOUNT E, DISMOUNT C, DSG, DSS, SSO and SS.

Table 1: Descriptive indicators

Variables	Descriptive Statistics				
	Valid N	Mean	Minimum	Maximum	St.Dev.
KO	51	13,12	10,23	14,73	0,97
D - score	51	5,45	4,30	6,30	0,52
E - score	51	7,68	5,73	8,73	0,68
DISMOUNT D	51	0,16	0,00	0,40	0,20
DISMOUNT E	51	0,25	0,00	0,50	0,25
DISMOUNT C	51	0,03	0,00	0,30	0,09
DSG	51	0,08	0,00	1,00	0,27
DSS	51	0,75	0,00	2,00	0,98
SSO	51	1,12	0,00	3,00	1,46
SS	51	0,71	0,00	4,00	1,54

Results of frequencies for variable DISMOUNT VALUE are shown in Table 2. E difficulty of dismount is represented in 50,98%, D difficulty in 39,22% and C difficulty in 9,80%.

Table 2: Frequency - DISMOUNT VALUE

Categories	Table of frequency: DISMOUNT VALUE			
	Count	Cumulative Count	Percent	Cumulative Percent
D	20	20	39,22	39,22
E	26	46	50,98	90,20
C	5	51	9,80	100,00

Results of frequencies for variable DISMOUNT TYPE are shown in Table 3. Most represented are DSS and SSO with 37,25%. Variable SS is represented in 17,65% and variable DSG in 7,84%.

Table 3: Frequency – DISMOUNT TYPE

Categories	Table of frequency: DISMOUNT TYPE			
	Count	Cumulative Count	Percent	Cumulative Percent
DSG	4	4	7,84	7,84
DSS	19	23	37,25	45,10
SS	9	32	17,65	62,75
SSO	19	51	37,25	100,00

Correlation coefficients are shown in Table 4. with level of statistical error $p<0,05$. Correlation between variable KO and D – score is 0,74 and between variables KO and E – score $r = 0,86$.

Table 4: Correlation coefficients of measured variables of scores and dismounts on level of statistical significance of p<0,05

Variables	Correlation coefficients with level of significance: p < ,05000 N=51					
	KO	D - score	E - score	DISMOUNT D	DISMOUNT E	DISMOUNT C
KO	1,00	**0,74***	**0,86***	**-0,42***	**0,54***	-0,20
D - score	**0,74***	1,00	**0,28***	**-0,45***	**0,69***	**-0,42***
E - score	**0,86***	**0,28***	1,00	-0,25	0,23	0,03
DISMOUNT D	**-0,42***	**-0,45***	-0,25	1,00	**-0,82***	-0,26
DISMOUNT E	**0,54***	**0,69***	0,23	**-0,82***	1,00	**-0,34***
DISMOUNT C	-0,20	**-0,42***	0,03	-0,26	**-0,34***	1,00

Results of regression analysis shown in Table 5. with level of statistical error p<0,05 shows that predictor variables explain 99,9% of variance of criteria variable KO. D – score contributes to a final score of routine by 54% (b*=0,54), E – score contributes to the final score by 70% (b*=0,70).

Table 5: Results of regression connection of variable KO with D and E scores with level of statistical significance p<0,05

N=51	Criteria variable: KO (final score) R= ,99953639 R2= ,99907300 Adjusted R2= ,99903437 F(2,48)=25866, p <0,0000 Std.Error of estimate: ,03015					
	b*	Std.Err. of b*	b	Std.Err. of b	t(48)	p-value
Intercept			-0,10	0,06	-1,69	0,10
D - score	**0,54**	**0,00**	**1,01**	**0,01**	**117,11**	**0,00**
E - score	**0,70**	**0,00**	**1,00**	**0,01**	**153,59**	**0,00**

Regression analysis results shown in Table 6, with level of statistical error p<0,05 shows that predictor variables explain 51,9% of variance of criteria variable D – score. Variable DISMOUNT E has shown as significant b*=0,97.

Table 6: Results of regression connection of variable D – score with dismounts, with level of statistical significance p<0,05

N=51	Regression Summary for Dependent Variable: D - score R= ,72058699 R2= ,51924562 Adjusted R2= ,49921418 F(2,48)=25,922 p<,00000 Std.Error of estimate: ,36508					
	b*	Std.Err. of b*	b	Std.Err. of b	t(48)	p-value
Intercept			**4,80**	**0,16**	**29,40**	**0,00**
DISMOUNT E	**0,97**	**0,17**	**1,99**	**0,36**	**5,59**	**0,00**
DISMOUNT D	0,34	0,17	0,90	0,46	1,97	0,05

Discussion

Descriptive parameters of measured variables from qualifications on European Championship in Bern in 2016, on balance beam, show differences between scores in routines. Final score of routine on balance beam varies in 4,5 points between the best and worst result. D – score between the heaviest and easiest routine differs in two points. Errors represented in E – score varies in three points. The reason is differences in starting score of routine, which is higher or lower between competitors, performance itself and corresponding errors. Differences between difficulty values are lower in relation to performance values, which indicates that performance is the criteria which determines the final score. Table of frequency for dismount values indicates that most performed dismounts were E difficulty in 50,98%, D difficulty in 39,22% and C difficulty in 9,80% of cases. In relation to the type of dismount, table of frequency has shown that in 37,25% of cases double piked backward somersault was performed, which belongs to E difficulty value and in 37,25% of cases dismounts with rotations around the longitudinal axis of the body were performed, which depending on the type of rotation and somersault weigh 0,4 or 0,5 points. 17,65% belong to somersault dismounts without any rotation around longitudinal axis of the body, which were of C or D difficulty value. Double tucked backward or forward somersault was performed the least, in 7,84% of cases, because it is harder to stop a rotation in tucked position than in pike position. Body needs to be extended for landing during the second somersault and in cases of tucked rotations it often happens that gymnasts finish the rotation too late and because the rotation is too strong, it is harder to control. High values of correlation coefficients r=0,74 between final score and D – score, r=0,86 between final score and E – score point out that difficulty of the routine is the basis for its final score and that performance is what a gymnast displays and judges score. Negative correlation of r=-0,42 between final score and dismount D and of r=-0,42 between final score and dismount C indicates that with increase of one variable, there is a decrease of the other variable, in this case, if the final score was increased, then there would be less dismounts of D and C difficulty. Results obtained by regression analysis show that in difficulty value of routine, D – score, dismounts of D and E difficulty explain 51,9% of variance of criteria variable D – score, because routine is comprised of more elements that form a whole. Results have shown that D and E – score have an important role, but performance of routine, E – score contributes by 70% to the final score of routine. Reason for that is in multiple factors: category of competitors, difficulty value of elements and judges. In order to increase the D – score of routine, it is formed from higher difficulty categories of an element, because as Miletić et al. have shown in a research from 2011, several gymnasts perform higher and harder acrobatic elements in order to raise the value of routine, while most perform easier elements and less of them in order to prevent fall from apparatus. Gymnasts usually perform a dismount, which is attractive and weighs as more points as possible as the last element. Piked and tucked somersaults are considered as basic dismounts for competitors (Gittoes et al., 2001). Marinšek and Ćuk, 2010., have conducted a research on characteristics of dismounts through somersaults on 97 senior gymnasts and have concluded that axis of rotation, number of rotations over transversal axis of the body and height of somersault significantly effect on dismount and errors on landing. Strategy of dismount through tucked or piked somersault is individual (Gittoes et al., 2013). In regard to acquired data, the reason for double piked somersault being the most used dismount is in its E difficulty value and connection of performance on other apparatus (vault, uneven bars, floor). Technically speaking, somersault dismounts from balance beam are similar to those on floor, but the main difference is in construction of the apparatus, its width, length and non-elasticity of balance beam, which requires different placing of arms or legs during take-off. Difference between floor and balance beam during performance of double piked backward somersault is in the attained height of the jump, which is 2,61± 0,07m on floor and 2,21m on balance beam (Mclaughlin et al., 1995). Trajectories of movement of various segments of body during a performance of somersault start from take-off which results with maximum height of flight, rotation phase, which is performed around the center of gravity and before the final landing, rotation is minimized by extending the body and preparation for dismount (Prassas et al., 2006). With as high as possible attractively of routine as a goal and therefore the starting score, coaches and competitors aim towards as high as possible values of elements. Importance of awareness about actual dismounts from balance beam can serve as a help for judges during judging, because they can prepare themselves better and in reviews of element trends on competitions.

Conclusion

It can be concluded, from acquiring data that dismount as the last element in routine is used with as high as possible difficulty and therefore attractive. Most present dismounts are double piked backward somersault and dismounts with rotations around longitudinal axis of the body. Difficulty value of dismounts greatly contributes to an increase of D – score. Balance beam is a specific apparatus in female artistic gymnastics with a narrow surface on which elements are performed, what makes it very attractive. Through routine on balance beam, gymnast displays creativity and personal style along with performance technique, as a meaningful choreography of acrobatic and dance elements. Artistic gymnastics changes over time and some elements which were formerly represented are substituted with harder, modern elements.

References

1. FIG (2013). Code of points Woman artistic gymnastics. Moutier: Federation International de Gymnasstique.
2. Gittoes, M. J., Irwin, G., & Kerwin, D. (2013). Kinematic landing strategy transference in backward rotating gymnastic dismounts. *Journal of applied biomechanics*, *3*, 253-260.
3. Gittoes, M. J. R., Irwin, G. I., Mullineaux, D., Kerwin, D. G. (2001).Whole body and multi joint kinematic control strategy variability during backward rotating dismounts from beam. J Sports Sci. 2001;29:1051–1058. PubMed doi:10.1080/02640414.2011.576690
4. Miletić, Đ., Kalinski, S. D., & Božanić, A. (2011). How does the performance of acrobatic elements effect final beam results in artistic gymnasts. In D. Milanović i G. Sporiš (ur.), 6th international scientific conference on kinesiology. Opatija, 2011. *Proceedings Book*, 537-540.
5. Marinšek, M., & Čuk, I. (2010). Landing errors in the men's floor routine are caused by flight characteristics. *Biology of Sport*, *27*(2), 123.
6. McLaughlin, P. A., Geiblinger, H., & Morrison, W. E. (1995). Take off kinematics of beam dismounts. In *ISBS-Conference Proceedings Archive* (Vol. 1, No. 1).
7. Prassas, S., Kwon, Y. H., & Sands, W. A. (2006). Biomechanical research in artistic gymnastics: a review. *Sports Biomechanics*, *5*(2), 261-291.

HEALTH OR RIVALRY - WHAT MOTIVATES TO TAKE PART IN RUNNING EVENTS FROM POLAND AND CZECH REPUBLIC

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The aim of the study is to determine the runners' motivation from Poland and the Czech Republic in the context of their participation in the running competition.

In this study, correlations between age, experience, training period and motives for participation in the competition by comparing the cross-country runners from both countries was searched. The study searched the place of health in the structure of motives.

The study involved 847 runners from Poland and 118 from the Czech Republic. The method of a diagnostic survey was carried out using questionnaires.

Competition with ourselves, overcoming own limits, improving physical fitness are the main motives of runners who participate in running events. Motives related to health are placed on the following points. Polish runners are more sport goal-oriented, this may result from the fact that in the Czech Republic recreational sport is more grounded in culture. Running events are an important element of cross-country passion, since up nearly 45% of runners from the Czech Republic and more than half from Poland would limit the practice, or stop it, if they did not have eligibility to participate in the competition.

Organizers of sports and recreation events which are road running should rather educate runners in the direction of healthy behaviors. They should enrich the content of health education emphasizing the value of active participation and healthy lifestyle over a sports rivalry.

THE EFFECTS OF KNEE EXTENSOR AND FLEXOR STRENGTH AND ASYMMETRY ON SPRINT CYCLING PERFORMANCE OF COMPETITIVE ROAD CYCLISTS

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Abstract

The purpose of this study was to characterise bilateral strength asymmetry of knee extensor and flexor muscles among competitive level road cyclists as well as examine the effect of muscle strength, pedalling technique and bilateral asymmetry of those parameters during the 30-second seated fatiguing cycling sprint performance. The cycle sprint exercise was performed on Cyclus2 ergometer in seated position and average relative power (W/kg), bilateral pedalling power contribution and pedalling smoothness (PS) were captured. The isokinetic strength of knee extensors (EX) and flexors (FL) were measured on 60 and 180°/s testing speed and expressed as relative (Nm/kg) Peak Torque (PT) and Average Torque (AvT) of 20 repetitions. The results of the current study demonstrate that during the 30-second maximal cycling sprint the strongest predictor of performance was knee extensors' ability to generate high average torque during 20 repetitions. However, at higher cycling power there was evident reduction in the smoothness of pedalling witch may have a potentially detrimental effect, and that was also reflected in the bilateral asymmetry of knee flexors strength and strength endurance performance among the test subjects.

Key words: *Cyclus2, Peak Torque, Isokinetic, Pedalling smoothness*

Introduction

Road cycling is a sport where the cyclist spends most of one's training and competition time on low intensity level but the success in mass start races is highly related to cyclist's ability to produce high power in short time (Jeukendrup et al., 2000). During submaximal cycling the dominating muscles in pedalling power production are knee extensors with relative contribution up to 70% (Broker and Gregor, 1994), but during maximal cycling the most dominating muscle group is hip extensors. What is more, there is an increase in the knee flexors' contribution to the power production (Elmer et al., 2010; Martin and Brown, 2009). It is found that up to 10-second seated sprint cycling power is strongly correlated with hip extensors and moderately with knee extensors and flexors isokinetic strength in competitive road cyclist's population (Rannama et al., 2013). In non-cyclists' population the mean 30-second Wingate cycling test power correlated strongly with knee flexors and extensors isokinetic peak torque at 180°/s and moderately with hip flexors and extensors at the same speed (Smith, 1987). There is some evidence that not only the strength ability of lower limbs' muscles, but also the bilateral symmetry in leg muscles strength is an important factor of higher performance in multi joint closed kinetic chain exercises such a vertical jump (Bailey et al., 2013) and maximum 5-second cycling power (Rannama et al., 2015).

The existence of bilateral asymmetry in cycling pedalling technique and lower limbs muscle activation is quite well documented (Carpes et al., 2011; Edeline et al., 2004; Smak et al., 1999) but there is limited evidence about asymmetry levels of knee extensors and flexors, as most loaded muscle groups in cycling. Moreover, there is a lack of evidence how the symmetry level or existence of asymmetry in the mentioned muscle groups is related to performance during maximal fatiguing sprint cycling exercise. At the moment the literature published on the relationships between various asymmetries and cycling performance is rather limited and inconsistent.

The purpose of this study was to characterise bilateral strength symmetry of knee extensor and flexor muscles among competitive level road cyclists and examine the effect of muscle strength, pedalling technique and bilateral symmetry of those parameters during the 30-second seated fatiguing cycling sprint performance.

Methods

Participants of the current study included 36 competitive junior (n=11) and U23 (n=25) class male road cyclists (19.3±1.9 years, 181.4±6.6 cm, 73.8±7.5 kg). All athletes participating had had at least 5 years of focused endurance cycling training and competition experience, and had annual cycling distance above 12000 km during the last season. The participants were free of injuries and the study was conducted during the preparation period of cycling season.

All *experimental procedures* for one person were made on the same day. The experimental cycling exercise was performed on the Cyclus 2 cycling ergometer (Avantronic, Cyclus 2, Leipzig, Germany) using the athlete's personal racing bike. After a 30-minute warm-up the cyclists performed a 30 sec maximal cycling test in isokinetic mode with the target cadence 100 rpm in seated cycling position hands on the drops. The average power of 30 seconds was normalized with cyclist's body mass and was included in the future analyses as performance measure. In order to measure the pedalling kinetics and between legs bilateral differences in pedalling power and technique, each participant's bicycle was equipped with a pair of Garmin Vector power meter pedals (Garmin Vector™). The same Vector pedals were used throughout testing and were calibrated before each testing session according to the manufacturer's guidelines. The pedalling technique was described by the 30 seconds average pedalling smoothness (PS =POWavg/POWmax*100(%)) collected from Garmin Vector pedals with 1 second intervals, independently for the left and right side throughout the experimental exercise. Furthermore, the absolute between legs bilateral symmetry index (ASI(%)=100*|Right-Left|/0.5*(Right+Left)) was calculated for POW and PS.

After the cycling exercise a 15-minute active and 5-minute passive recovery time was allowed before the strength test started. A HUMAC NORM (Computer Sports Medicine, Inc. Stoughton, MA, USA) isokinetic dynamometer was used to assess knee extensors (EX) and flexors (FL) strength in isokinetic mode and in seated position. All test procedures and dynamometer settings were carried out in accordance with the HUMAC NORM user manual and the "gravity correction" features were used in all tests to avoid gravity effect of limb weight. All tests were performed concentrically and velocities 60°/s (maximum strength) and 180°/s (speed strength and strength endurance) were used. At each test velocity, the subject performed 3 submaximal warm-up trials followed by 5 (60°/s) or 20 (180°/s) maximal test trials after a 60-second recovery. In testing speed of 180°/s the subject was instructed to start as fast as possible to measure the peak torque value, too. A recovery period of 2 minutes between test velocities and at least 5 minutes between body sides was used and testing order of body sides was randomised. The peak torque (PT) of the best trial in 60 and 180°/s testing speed were captured as maximum strength variables and average torque (AvT) of 20 repetitions (captured between 20 and 70 degree knee flexion angle to avoid no isokinetic values, 0 is fully extended knee position) was taken as measure of strength endurance variable. For the future analyses all strength values were normalized with the body mass (Nm/kg) and the mean values of right and left leg were used in statistical procedures. Moreover, the bilateral thigh muscles ASI-s (%) were calculated according to the formula presented above.

Data analysis was performed by using the IBM SPSS Statistics version 21.0 for Windows. All the data were tested for their normal distribution (Kolmogorov-Smirnov test), descriptive statistics were computed for all variables and expressed as a mean±SD. The two tailed T-test for paired samples was exploited to compare ASI-s of different muscle groups and pedalling kinetics variables. The Pearson correlations analysis was performed to determine the relationships between sprint cycling performance test and isokinetic strength tests variables. Significance level for all tests was set at $p<0.05$. To examine the relationships between cycling power (dependent variable) and pedalling smoothness, thigh muscles strength and strength and pedalling symmetry variables (independent variables), the stepwise multiple linear regressions were performed. The entry significance level for independent variables was $p<0.05$, while the removal significance level was set at level $p>0.10$.

Results and discussion

The descriptive statistics of cycle sprint power and pedalling technique and symmetry is presented in Table 1 and the results of isokinetic strength tests are presented in Table 2. The Pedalling Smoothness ASI was significantly ($p<0.05$) higher than Power ASI and Knee EX ASI in all testing conditions. Knee FL ASI was significantly higher than Knee EX ASI in average torque values of 20 repetitions at testing speed of 180°/s. The muscle ASI results are similar to previously described trained long distance runners' population in which the knee flexors asymmetry was also the largest at high testing speed (Dellagrana et al., 2015).

Table 1: The descriptive statistics of 30-second sprint cycling performance and pedalling technique parameters

N= 36	Minimum	Maximum	Mean	SD
30 sec absolute Power (W)	567.3	1043.3	769.4	100.8
30 sec relative Power (W/kg)	9.04	12.25	10.42	0.84
Pedalling Smoothness (%)	27.9	40.0	32.8	2.8
Power ASI (%)	0.0	15.7	3.8	3.5
Pedalling Smoothness ASI (%)	3.0	15.2	8.7*	3.6

*-Significantly different from Power ASI

Table 2: Descriptive statistics of thigh muscles isokinetic strength characteristics

N=36		Strength (Nm/kg)				ASI (%)			
		Knee Flexors		Knee Extensors		Knee Flexors		Knee Extensors	
Parameter	**Velocity**	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Peak Torque	60 °/s	1.89	0.25	3.06	0.41	5.9	4.9	6.1	5.3
Peak Torque	180 °/s	1.37	0.16	2.13	0.21	7.1	5.8	5.4	3.1
Average torque of 20 rep	180 °/s	0.95	0.13	1.65	0.18	7.9	5.9	5.2*	4.2

*-Significantly different from Knee Flexors AvT ASI

Table 3: Relationships between 30-second cycling power, pedalling technique and isokinetic strength variables

Power (W/kg)	1							
Pedalling Smoothness (%)	-.388*	1						
Knee Flexsors PT at 60 °/s	.411*	-.072	1					
Knee Extensors PT at 60 °/s	.498**	-.034	.730**	1				
Knee Flexsors PT at 180 °/s	.485**	-.308	.760**	.523**	1			
Knee Extensors PT at 180 °/s	.687**	-.312	.639**	.792**	.635**	1		
Knee Flexsors AvT at 180 °/s	.477**	-.131	.698**	.404*	.847**	.576**	1	
Knee Extensors AvT at 180 °/s	.747**	-.227	.580**	.688**	.589**	.924**	.593**	1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

The relative 30-second average sprint cycling power is significantly and positively (Table 3) correlated with thigh muscles isokinetic strength variables, but the strongest correlations are with Knee EX strength and strength endurance measured at testing speed 180°/s, which is comparable to previous findings (Rannama et al., 2013; Smith, 1987). The relationships between knee FL strength and cycling power are on moderate level. The higher cycling power production is also moderately associated with less smoother pedalling power production and is in line with previous findings indicating that stronger cyclist tends to produce power more impulsively during pushing phase (Coyle et al., 1991).

Table 4: Relationships between 30-second cycling power and asymmetries in pedalling technique and isokinetic strength variables

Power (W/kg)	1								
Power ASI (%)	.200	1							
Pedalling Smoothness ASI (%)	.273	.353*	1						
Knee Flexsors PT ASI at 60 °/s	-.198	-.070	.356*	1					
Knee Extensors PT ASI at 60 °/s	.077	.271	.021	.243	1				
Knee Flexsors PT ASI at 180 °/s	-.364*	-.113	.212	.405*	.172	1			
Knee Extensors PT ASI at 180 °/s	.095	-.262	-.205	.202	.197	.146	1		
Knee Flexsors AvT ASI at 180 °/s	-.357*	-.079	.007	.236	.053	.310	.213	1	
Knee Extensors AvT ASI at 180 °/s	-.030	.108	-.026	-.006	-.065	.186	.532**	.252	1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 4 demonstrates that less symmetrical Knee FL strength and strength endurance values in higher testing speed are significantly (r=-0.364 and -0.357) related to lower cycling performance. Furthermore, the pedalling smoothness ASI is moderately positively correlated with Knee EX PT ASI at 60°/s, but no significant relations exist between Power and isokinetic strength ASI. The same tendencies are presented in regression model where the Knee EX strength of 1 Nm/kg ads 2.8 W/kg cycling power, one % of difference in strength endurance of Knee FL reduce power approximately by 0,04 W/kg and one unit higher pedalling smoothness value associates with 0.08 W/kg power reduction. The results of the current study conform some previous findings. Firstly, bilaterally summary maximal performance does not only depend on muscle strength, but also on how equally the strength is distributed between body sides (Bailey et al., 2013; Rannama et al., 2015), and secondly, monitoring leg muscles strength symmetry during the training process may provide additional information in order to develop strength training programs.

Table 5: Regression model of 30-second sprint cycling performance measured as a body mass corrected average power (W/kg)

N=36		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
R	0.820					
R Square	0.673					
Adjusted R Square	0.640	B	Std. Error	Beta		
(Constant)		8.645	1.540		5.612	0.000
Knee Extensors AvT at 180 °/s (Nm/kg)		2.822	0.506	0.620	5.580	0.000
Knee Flexsors PT ASI at 180 °/s (%)		-0.038	0.015	-0.269	-2.475	0.019
Pedalling Smoothness (%)		-0.079	0.032	-0.265	-2.454	0.020
Dependent Variable: Power (W/kg)					Full Model	0.000

Conclusion

The results of the current study demonstrate that during the 30-second maximal cycling sprint the strongest predictor of performance was knee extensors' ability to generate high average torque during 20 repetitions. However, at higher cycling power there was evident reduction in the smoothness of pedalling witch may have a potentially detrimental effect, and that was also reflected in the bilateral asymmetry of knee flexors strength and strength endurance performance among the test subjects.

References

1. Bailey, C., Sato, K., Alexander, R., Chiang, C. Y., & Stone, M. H. (2013). Isometric force production symmetry and jumping performance in collegiate athletes. *Journal of Trainology*, *2*(1), 1-5.
2. Broker, J.P. & Gregor, R.J. (1994). Mechanical energy management in cycling: source relations and energy expenditure. *Medicine and Science in Sports and Exercise*, 26(1), 64-74
3. Carpes, F. P., Mota, C. B., & Faria, I. E. (2010). On the bilateral asymmetry during running and cycling–A review considering leg preference. *Physical Therapy in Sport*, *11*(4), 136-142.
4. Coyle, E. F., Feltner, M. E., Kautz, S. A., Hamilton, M. T., Montain, S. J., Baylor, A. M., ... & Petrek, G. W. (1991). Physiological and biomechanical factors associated with elite endurance cycling performance. *Medicine and science in sports and exercise*, *23*(1), 93-107.
5. Dellagrana, R. A., Diefenthaeler, F., Carpes, F. P., Hernandez, S. G., & de Campos, W. (2015). Evidence for isokinetic knee torque asymmetries in male long distance-trained runners. *International journal of sports physical therapy*, *10*(4), 514.
6. Elmer, S., Barratt, P., Korff, T., & Martin, J. (2010). Joint-specific power production during submaximal and maximal cycling. In *ISBS-Conference Proceedings Archive* (Vol. 1, No. 1).
7. Jeukendrup, A. E., Craig, N. P., & Hawley, J. A. (2000). The bioenergetics of world class cycling. *Journal of Science and Medicine in Sport*, *3*(4), 414-433.
8. Martin, J. C., & Brown, N. A. (2009). Joint-specific power production and fatigue during maximal cycling. *Journal of biomechanics*, *42*(4), 474-479.
9. Rannama, I., Bazanov, B., Baskin, K., Zilmer, K., Roosalu, M., & Port, K. (2013). Isokinetic muscle strength and short term cycling power of road cyclists. *Journal of Human Sport and Exercise*, 8(2), S19-S29
10. Rannama, I., Port, K., Bazanov, B., & Pedak, K. (2015). Sprint cycling performance and asymmetry. *Journal of Human Sport and Exercise*, 10(1), S247-S258
11. Smak, W., Neptune, R. R., & Hull, M. L. (1999). The influence of pedaling rate on bilateral asymmetry in cycling. *Journal of biomechanics*, *32*(9), 899-906.
12. Smith, D. J. (1987). The relationship between anaerobic power and isokinetic torque outputs. *Canadian journal of sport sciences*, *12*(1), 3-5.

ANALYSIS OF PERFORMANCE INDICATORS IN WINNING TEAMS OF DIFFERENT AGE GROUPS OF TOP LEVEL FEMALE VOLLEYBALL PLAYERS

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Abstract

The aim of this research was to determine if there are significant differences in performance indicators between cadet, junior and senior winning teams in top level female volleyball. On a sample of games played at European Championships, this research was conducted by analysing a total of 32 285 game actions performed by winning teams while examining the following six phases in volleyball: Serve, Reception, Attack, Block, Defence and Counterattack. For each of the mentioned six phases, statistically significant differences were determined by using the Student t-test between pairs of individual age groups: cadet and junior players differ in Serve, Reception and Defence; cadet and senior players differ in Serve, Attack and Defence; junior and senior players differ in Serve, Reception and Defence. The obtained results provide information on performance indicators of different age groups in female volleyball and they can be applied in increasing the quality of training programming, game management and in the selection and development of top level female volleyball players.

Key words: *performance indicators, top level volleyball, female volleyball players, age groups, Student t-test*

Introduction

Notational analysis in sports (Hughes & Franks, 2004), as part of which analysis of performance indicators in top level volleyball is also performed, represents a procedure that can provide relevant data in the direction of development and transformation of technical and tactical abilities of volleyball players during practice or in competitions, which shall ultimately enable accomplishing top level competitive results. When discussing a sample of top level volleyball players and competitions, this mentioned sample can be stratified according to gender and age of the competitors. Pursuant to this principle, international national team competitions can be divided into men's and women's in terms of gender, whereas with consideration to age, competitions can be organized in cadet, junior and senior categories (as of recent, also for young senior teams). The justification for organizing competitions according to gender in sports in general, thus also in volleyball, can be found in the specificity and diversity of the status of basic anthropological characteristics between men and women, while the justification for competitions in chronologically different age groups can be found in the diverse specific preparation of players as a result of training and competitive belonging to a particular age group, but also as a result of the player selection process. This type of stratification of a top level sample in relation to gender and age groups also specifies a separate generalisation of scientific conclusions resulting from research on performance indicators responsible for success in playing volleyball.

Upon reviewing previous research in relation to indoor volleyball, it can be noted that authors only analysed performance indicators on samples of top level national team or league competitions for separate age groups (Campos et al., 2014; Đurković et al., 2008; 2008; Marelić et al., 1999; Marelić et al., 2004). Furthermore, García-de-Alcaraz et al. (2016) researched the evolution of game demands in the development from younger to international senior volleyball players. Finally, Joao et al. (2009) compared performances in high level competitions in relation to gender.

According to the above-mentioned, the aim of this research was to determine the differences in performance indicators on a sample of top level competitions in female volleyball between three different age groups: cadet, junior and senior competitions.

Methods

For the purpose of this research, a selection of volleyball matches from European Championships were chosen (2002, 2003 and 2005) in different age groups (cadet, junior and senior). Upon considering the aim of this research, the entities are represented in sets of teams that won an individual game. As it was already mentioned, the analysis consisted of 32 volleyball teams, i.e. 98 volleyball games during which 332 sets were played, so that eventually a total of 32 285 game actions were analysed. Emphasis must be put on the fact that fifth sets were not included in this analysis due to the different number of points required for winning the set.

The variables in this research describe the performance indicators of six volleyball game phases: Serve, Reception, Attack, Block, Defence and Counterattack. The numeric quantification of performance indicators was separately measured for each of the selected game phases in such a manner that each performance was assigned a grade, on a scale from 1 to 5, and used for assessing the quality of the analysed performance, with 1 as the lowest grade and 5 as the maximum grade (modified according to Eom & Schutz, 1992; Đurković et al., 2008; Marelić et al., 2004). By using the specialized computer programme Data Volley 3 (Data Project, S.l.r.), the registration of performance indicators was conducted in the previously defined manner. Further, values of the coefficient for each individual game phase were calculated by multiplying the number of performances accomplished on an individual scale with the grade for the performance, which is then finally divided with the overall number of performances. The numeric values resulting from such a procedure indicated the development level of the measured characteristic, while the calculated values were then finally entered and analysed with the Statistica 8 programme (StatSoft, Inc.), where they were used for calculating the descriptive parameters and for determining the differences between the separate age groups through the usage of the Student t-test. In determining the reliability of the measuring procedures, the test-retest method with two attempts of registration during an interval of 30 days was used, while with the SPSS 11 (SPSS, Inc.) programme, the interclass correlation coefficient (ICC) was calculated with values for all the variables between (.85) and (.95).

Results

For each of the volleyball phases in the chosen three age groups (cadets, juniors and seniors), Table 1 shows frequency percentages and the arithmetic mean of frequencies for each of the 5 performance grades in one volleyball set for teams who won a particular match.

Table 1: Descriptive statistics of grade frequencies for volleyball phases in one set

			Performance grade				
Variable	Age group		1	2	3	4	5
Serve	cadets	%	9.4	41.7	12.5	27.0	9.4
		M	2.53	10.24	3.17	6.65	2.62
	juniors	%	10.5	28.9	20.0	30.8	9.8
		M	2.82	7.13	4.99	7.60	2.60
	seniors	%	7.9	41.7	23.1	21.2	6.1
		M	2.35	10.28	5.76	5.24	1.94
Reception	cadets	%	7.9	4.6	18.1	15.8	53.6
		M	1.90	1.43	3.25	2.83	9.04
	juniors	%	7.8	3.6	20.8	28.5	39.3
		M	1.81	1.23	3.69	4.95	6.72
	seniors	%	5.4	3.8	13.5	29.4	48.0
		M	1.77	1.40	2.77	5.40	8.81
Attack	cadets	%	7.9	8.1	16.4	21.7	45.8
		M	1.62	1.81	2.32	3.32	6.49
	juniors	%	7.6	7.0	12.8	23.1	49.4
		M	1.73	1.70	1.79	3.38	6.91
	seniors	%	6.5	7.2	14.4	21.2	50.8
		M	1.78	1.73	2.30	3.40	8.11
Block	cadets	%	25.2	17.8	21.6	8.6	26.8
		M	3.08	2.17	2.81	1.65	3.17
	juniors	%	31.8	10.1	20.4	10.5	27.2
		M	3.60	1.71	2.58	1.67	3.11
	seniors	%	31.7	13.3	17.7	10.8	26.5
		M	3.94	2.13	2.43	1.95	3.32
Defence	cadets	%	21.5	5.9	23.0	16.5	33.1
		M	3.03	1.35	3.10	2.46	4.52
	juniors	%	21.7	7.9	30.4	23.7	16.3
		M	2.55	1.55	3.42	2.71	2.23
	seniors	%	13.1	4.7	26.7	29.0	26.4
		M	2.52	1.42	4.40	4.79	4.38
Counterattack	cadets	%	9.6	5.9	18.8	21.4	44.3
		M	1.86	1.64	2.75	3.49	6.47
	juniors	%	8.3	7.1	14.1	22.5	48.0
		M	1.71	1.54	1.86	3.22	6.34
	seniors	%	7.3	7.7	15.1	26.2	43.7
		M	1.70	1.72	2.22	4.09	6.50

Note: % – percentage of frequency in each grade; M – mean

Table 2 shows descriptive statistics for performance indicators coefficients for each age group that were assessed through the six phases of volleyball.

Table 2: Descriptive statistics for the coefficients of performance indicators

Variables	M ± SD		
	cadet	junior	seniors
Serve	2.86 ± 0.24	3.00 ± 0.27	2.76 ± 0.25
Reception	4.05 ± 0.34	3.89 ± 0.32	4.13 ± 0.32
Attack	3.93 ± 0.37	4.03 ± 0.35	4.05 ± 0.32
Block	2.95 ± 0.49	2.91± 0.53	2.88 ± 0.42
Defence	3.33 ± 0.52	3.03 ± 0.51	3.52 ± 0.39
Counterattack	3.87 ± 0.40	3.97 ± 0.37	3.95 ± 0.38

Note: M – mean; SD – standard deviation

Further analysis in Table 3 presents results of the Student t-test, where certain volleyball game phases showed statistically significant differences between certain pairs of different age groups.

Table 3: Differences in performance indicators between pairs of certain age groups

Variables	P		
	cadets - juniors	cadets - seniors	juniors - seniors
Serve	.00*	.01*	.00*
Reception	.00*	.08	.00*
Attack	.06	.02**	.56
Block	.61	.31	.63
Defence	.00*	.01*	.00*
Counterattack	.07	.18	.60

Note: *significance level p<.01, **significance level p<.05 (Student t-test)

Discussion and conclusion

According to the results of descriptive values for coefficients of performance indicators (Table 2), the conclusion can be made that all age groups in general show higher values in Reception, Attack and Counterattack phases, whereas lower values are demonstrated in Serve, Block and Defence phases. The mentioned results are understandable considering the sequence of performing the mentioned phases in volleyball, as well as their generated relations.

Upon observing statistical differences between the pairs of groups in different game phases, the demonstrated results lead to the conclusion that junior players (3.00) are more efficient than cadet players (2.86) and seniors (2.76). Somewhat lower values in the performance of serves of senior players can generally be attributed to the causal relationship between the Serve and Reception phases, where a higher performance in Reception suggests a lower performance indicators in Serve.

In addition, cadet players show slightly higher indicators in Reception than junior players (4.05, 3.89), as well as do seniors in comparison to junior players (4.13, 3.89). In this particular phase of the game, senior players demonstrate the highest indicators which is a result of their extremely high percentage of successful performances 77.4% (grade 4,5) and a low percentage of errors 5.4% (grade 1; Table 1). The above-mentioned results indicate that high indicators in Reception presupposes a high level of performance of the related technical elements, as well as suggests a longer period required for the acquisition and stabilization of the mentioned elements.

The Attack phase demonstrated statistically significant differences only between cadet and Senior players (3.93, 4.05). However, similar as in Reception, Seniors show the highest indicators as a result of the high percentage of ideal performances of 50.8% (grade 5; Table 1), suggesting that Senior players averagely attain the most points in a set (8.11) among all three age groups in this phase. Firstly, the high indicators in the Attack phase can be explained as a result of the high indicators in Reception, which enables a better organization for a quick and versatile spike, whereas a second reason comes from the fact that spikers in senior volleyball primarily possess a wider range of different spike techniques, as well as better stability and motor abilities required for the successful performing of the mentioned elements.

When observing the differences in the Defence phase, the conclusion can be made that senior players (3.52) are both more efficient than cadet players (3.33) and junior players (3.03). It is interesting that seniors demonstrated the highest values in Defence as the indicators level in this phase of the game depends on Serves and Blocks, values that are relatively low. Furthermore, the obtained results for Defence can also be accounted for by mentioning that senior players are more efficient in performing different tactical systems, as well as in ball control during the performance of individual technical elements in the Defence phase.

Finally, the conclusion can be made that the obtained results present valuable and critical information on performance indicators for six volleyball game phases and that their application can be found in the differentiated planning and monitoring of the training process and in competition management and control for a particular age group, as well as for improving the quality in the process of player selection and in developing top level female volleyball players.

References

1. Campos, Fabio A.D., Stanganélli, Luiz C. R., Campos, Leandra C. B., Pasquarelli, Bruno N. & Gómez, Miguel-Ángel (2014). Performance indicators analysis at Brazilian and Italian femalevolleyball leagues according to game location, game outcome, and set number. *Perceptual & Motor Skills*, 118 (2), 347-361.
2. Đurković, T., Marelić, N. & Rešetar, T. (2008). Influence of the position of players in rotation on differences between winning and losing teams in volleyball. *International Journal of Performance Analysis in Sport*, 8 (2), 8-15.
3. Eom, H.J. & Schutz, R.W. (1992). Statistical analyses of volleyball team performance. *Research Quarterly for Exercise and Sport*, 63 (1), 11-18.
4. García-de-Alcaraz, A., Valadés, D. & Palao, J.M. (2016). Evolution of Game's Demands From Young to Elite Players in Men's Volleyball. *International Journal of Sports Physiology and Performance*, 1-21.
5. Hughes, M. & Franks, I. (2004). *Notational Analysis of Sport 2nd Edition - Systems for better coaching and performance in sport*. London: Routledge.
6. Joao, P., Vaz, L., Mota, M., Mesquita, I. & Sampaio, J. (2009). Statistic between winning and losing teams by competition levels and gender in Volleyball. In Loland, S., Bø, K., Fasting, K., Hallèn, J., Ommundsen, Y., Roberts, G. & Tsolakidis, E. (Eds.), *Book of Abstracts of the 14th Annual Congress of the European College of Sport Science, Oslo, Norway, 24-27 June 2009, "Sport sciences: Nature, Nurture and Culture",* 52.
7. Marelić, N., Janković, V., Viskić-Štalec, N. & Matković, B. (1999). Differences in game phases between the sets and team achievement in junior volleyball. *Croatian Sports Medicine Journal*, 14 (1), 3-9.
8. Marelić, N., Rešetar, T. & Janković V. (2004). Discriminant analysis of the sets won and the sets lost by one team in A1 Italian volleyball league - a case study. *Kinesiology*, 36 (1), 75-82.

METRICAL CHARACTERISTICS OF NEWLY CONSTRUCTED TESTS FOR ASSESSING SPECIFIC MOTOR ABILITIES IN HANDBALL GOALKEEPERS

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Abstract

On the sample of 86 male handball goalkeepers aged 15-25, we have analysed metrical characteristics of three newly constructed measuring instruments to assess the following specific motor abilities: explosive power in performing a characteristic defending movement, hand reaction and absolute power of take off. The results of research revealed good metrical characteristics of the newly constructed tests. With regard to the research results, we defined normative values of the test results for certain age categories in goalkeepers. The research results can have functional implementation in selection and training processes with handball goalkeepers.

Key words: *male, test results, speed, power*

Introduction

In modern handball there are attacking players with very strong and precise shots (Van den Tillaar and Ettema, 2003) who require a high level of condition and technical-tactical preparation in goalkeepers (Olsson, 2010), in addition to specific morphological profile (Šibila and Pori, 2009). A goalkeeper's activity is performed mostly in aerobic regime, and within condition preparation, special attention is given to motor abilities dominant for situational efficiency in goalkeepers; speed, agility, explosive power, coordination and flexibility (Pori et al., 2011). Condition abilities are evaluated through a battery of motor-functional tests (Holm et al., 2004). However, it is neither appropriate to apply the same tests on different sport games, nor it is appropriate to apply the same tests on different playing positions within a certain sport game. In accordance to this, and starting from the specific goalkeeper's role, the purpose of this paper is to analyse metrical characteristics of the three newly constructed measuring instruments to assess specific and dominant motor abilities in male handball goalkeepers. Motor efficiency is one of the most important guidelines for situation and result efficiency in goalkeepers (Chaouachi et al., 2009) and it presents a dominant factor of each selection or training process in handball (Castro et al., 2011). By analysing metrical characteristics, we will establish orientation normative values of results in motor tests and morphological features for different age groups. Further on, we will determine differences in motor abilities and morphological characteristics between goalkeepers of different ages and qualities. Finally, we will analyse relations between motor abilities and morphological characteristics in different age groups.

Methods

The sample of respondents

The sample of respondents includes 86 male handball goalkeepers aged 15-25. According to their age, the goalkeepers are categorised in three groups: seniors (aged -19, n=26), juniors (aged 17-18, n=33) and cadets (aged 15-16, n=27). All the respondents are the participants of International handball goalkeepers' camp which has been held in Makarska since 2011.

The sample of variables

The sample of variables involves 3 newly constructed measuring instruments to assess dominant motor abilities in the goalkeepers as it follows:

The speed of reaction in the OPTOJUMP SYSTEM (OPT) – the test was constructed with the purpose of measuring characteristic reaction and performance speed in an unknown pattern. The measuring was done by using Optojump device (Microgate Bolzano Italy). The experiment involved the following procedure. After the usual warm-up (running, stretching etc.), the respondents were positioned at a certain distance from the target so that the target centre (the intersection of diagonals of four fields with 6 cm diameters, separated 12 cm from each other) could be touched by a stretched arm. Optojump measuring system was fixed on the target. The target was adjustable so that the target centre was set in the line with each respondent's horizontally stretched arm. By a specially designed laser, the respondents received a visual signal showing a certain field which they were supposed to touch as quickly as possible. The laser beam was connected to the Optojump system by the originally derived electronic module and the time of operation was measured from the moment the laser was switched on to the moment when a respondent cut off the Optojump beam (in milliseconds). The task was done by the dominant hand and the starting position was the same for all the respondents (hand on the hip). The task was not announced in advance, and light signals randomly appeared in four field. The test measured the specific reaction speed with the starting movement which is the basic goalkeeper position.

The absolute power of leg abduction on a dynamometer by left foot (DIN) –The test is performed in the upright position where a respondent is not holding on to a stable object. The dynamometer is fixed to one of his lower legs and it is fixed to the wall at the same time. To perform the test, we used the electronic crane *Kern* dynamometer made in Germany. A respondent pulls his leg and dynamometer by leg abduction, using the maximum contraction of abductor muscles of the lower leg while the person in charge of measuring marks the highest force value on dynamometer generated by a respondent. The test is repeated by a dominant leg.

Explosive power of take off (RAZ)

The measuring was done by Optojump photocell system (Microgate, Bolzano, Italy). In this test 2 receiving bars formed 1 square meter space for measuring specific handball goalkeeper jumping ability. At the beginning of the test, a participant is standing still with completely stretched legs and arms in an abducted position. When feeling ready to move, the participant performs a fast semi-squat and from that position performs an explosive jump with both legs. The jump is finished in a motion specific for handball goalkeepers; widespread legs touching opened palms in hips level. Both arms and legs should be completely stretched. After reaching the highest point, the participant lands with both legs. The result is measured in centimetres.

In addition to variables to assess motor abilities, we analysed three variables to assess morphological characteristics such as body height (TV), body weight (TT) and body mass index (BMI).

Data processing methods

The data were processed by Statistica 6.0 programme package. We established the test sensitivity by basic descriptive statistical parameters. We also calculated correlations between three particles of measuring for each test to establish reliability. Cronbach alpha reliability coefficient (α) and average correlation coefficients between the particles of each test (II r) were calculated as well. Homogeneity was established by variance analysis (ANOVA) between measuring particles of each test. Pragmatic validity of tests was determined by univariate variance analysis and by post hoc analysis via LSD test among three age categories of respondents.

Results and Discussion

Sensitivity

Table 1: Descriptive statistics

VARIABLE	AS	Min	Max	SD	Skew	Kurt	MaxD
Specific motor abilities							
OPT 1	0,46	0,38	0,64	0,06	1,36	2,10	,14
OPT 2	0,44	0,36	0,54	0,04	0,57	0,47	,10
OPT 3	0,44	0,37	0,57	0,05	0,85	1,00	,10
OPT AS	0,44	0,38	0,58	0,04	1,74	5,93	,13
DIN 1	21,18	12,10	32,00	5,17	,21	-,65	,08
DIN 2	20,90	12,80	36,70	5,67	,78	,39	,11
DIN 3	20,78	11,90	32,40	5,04	0,41	-0,30	,07
DIN AS	20,95	12,83	33,53	5,10	,50	-,18	,09
RAZ 1	34,93	20,90	48,80	5,77	-,11	-,32	,10
RAZ 2	34,26	16,80	47,90	5,96	-,46	,61	,08
RAZ 3	34,77	20,60	50,20	6,04	,20	,08	,08
RAZ AS	34,65	19,43	47,93	5,70	-,24	,00	,08
Morphological characteristics							
WEIGHT	79,77	43,00	100,00	10,29	-,61	,73	,10
HEIGHT	184,87	161,00	200,00	6,64	-,71	1,72	,08
BMI	23,29	16,59	29,75	2,46	-,09	,02	,08

Test Max D = ,15 (p=,01)

Table 1 displays basic descriptive and distribution parameters calculated in order to establish sensitivity of analysed measuring instruments. The results reveal satisfactory sensitivity of all the tests. We can draw a conclusion there is a satisfactory sensitivity in the analysed tests and they can be applied to diagnose motor efficiency in goalkeepers of different quality and ages. The same table displays descriptive and distribution parameters of morphological variables which are expectedly within the limits of normal distribution.

Reliability

Table 2: Correlation between measured particles

TEST	OPT 1	OPT 2	OPT 3
OPT 1	1,00	0,50*	0,42*
OPT 2	0,50*	1,00	0,37*
OPT 3	0,42*	0,37*	1,00
TEST	**DIN 1**	**DIN 2**	**DIN 3**
DIN 1	1,00	0,90*	0,83*
DIN 2	0,90*	1,00	0,93*
DIN 3	0,83*	0,93*	1,00
TEST	**RAZ 1**	**RAZ 2**	**RAZ 3**
RAZ 1	1,00	,90*	,88*
RAZ 2	,90*	1,00	,88*
RAZ 3	,88*	,88*	1,00

*- significant correlations on the level p < ,05

Table 3: Inter – item correlation and Crombach alpha reliability coefficient

VARIABLES	II r	Crombach alpha (α)
OPT	0,42	0,67
DIN	0,89	0,95
RAZ	0,91	0,96

With the purpose of establishing reliability by newly constructed measuring instruments, we calculated correlations between measuring particles (table 2) and average inter-particle correlations and Crombach alpha reliability coefficient (table 2). Evidently, statistically significant positive correlations between measuring particles prevail in all of the three analysed tests. The highest correlations have been marked in DIN test used to assess specific absolute power of lower leg abductor muscles. It is understandable since this test has the unambiguous object of measuring which is likely to be less subjected to impacts of other anthropological, but also outer factors than other tests where the movement structure, apart from the motor one, is to a larger extent determined by information component. Table 3 presenting average inter-particle correlations and Crombach alpha reliability coefficients reveals a high level of this metrical characteristic in DIN and RAZ tests, and a slightly lower reliability in OPT test. The reasons are likely to be found in the specific structure of this test which is largely determined by the information component of movement. Namely, it is assumed that, apart from neuromuscular abilities affecting the result of the test, cognitive abilities have a larger impact, particularly the ability to intensify attention and maintain concentration, which had possibly been more under the influence of outer factors during testing.

Homogeneity

Table 4: Variance analysis between measuring particles

VARIABLES	II r	Crombach alpha (α)	F	p
OPT	0,42	0,67	1,70	,19
DIN	0,89	0,95	,06	,94
RAZ	0,91	0,96	,17	,85

In accordance with the obtained results (table 4), it is evident all the tests are homogenous on the level of statistical significance, i.e. there is no statistically significant high result variability among certain measuring particles with relation to intra-particle variability. Homogeneity is the best in the simplest DIN test, while it is slightly weaker, but still satisfactory within the frames of statistical significance in other tests. It has already been explained that due to a slightly more complex technical structure and coordination demands of these tests, they are more subjected to the information component, i.e. to the motor learning factor. These tests reveal a positive trend of results since the respondents achieved significantly better results with each new measuring (Table 1).

Pragmatic validity

Table 5: Univariate variance analysis among age groups

VARIABLE	AS seniors	AS juniors	AS cadets	F	p-level
Specific motor abilities					
OPT	,43	,44	,46	2,39	,11
DIN	23,32	22,53	16,88	7,75	,00*
RAZ	37,06	33,27	33,65	2,27	,11
Morphological characteristics					
WEIGHT	86,81	81,85	70,44	30,06	,00*
HEIGHT	189,00	184,52	181,33	11,00	,00*
BMI	24,31	24,05	21,38	16,19	,00*

*-significant differences on level p< ,05

Table 6: Post hoc variance analysis (LSD test)

VARIABLE	seniors/juniors	seniors/cadets	juniors/cadets
OPT	,83	,04	,03
DIN	,66	,00	,00
RAZ	,06	,09	,85

Pragmatic value of the tests has been analysed through differences among age groups assuming that goalkeepers at older ages should achieve better results due to a higher biological potential and longer engagement in the training process, which has been corroborated to a large extent. By analysing table 5, it is evident the largest statistical differences exist in DIN test, and some smaller ones in OPT and RAZ tests. A more detailed insight into differences among certain age groups is given by the LSD test from the aspect of post hoc variance analysis (table 6). The differences in DIN test are present between seniors and cadets and between juniors and cadets. Slightly less stressed differences are present in OPT test, again between seniors and cadets, and also between juniors and cadets, while in RAZ test we found no significant differences. Reasons are likely to be found in the object of OPT test measuring which measures reaction speed and is not, unlike other tests, under the influence of power which grows with the biological development. Muscle power which must be partially determined by biological development, and partly even by long-term training process, is the probable cause for statistically significant differences in DIN test. The obtained results can purposefully be used in training and selection procedures in handball. As these tests mostly apply to assess motor abilities which are genetically determined to a large extent, they are suitable for implementation in the process of primary and secondary goalkeepers' selection. Thus we can most frequently use the obtained average values of results in certain age groups which are considered to be international orientation normative regarding representative sampling. The results are applicable even in the valorisation of goalkeepers' motor efficiency during the implementation of training transformation procedures as well as in the evaluation of the efficiency of training processes at initial, transitive and final testing. Functional implementation is also possible in programming and creating individual training processes for every individual goalkeeper.

Conclusion

Due to physics and space conditions in which a goalkeeper is playing, this player is characterised by specific motor abilities, mostly by specific speed, agility and explosive power of defence movements in the frontal plane. In order to diagnose these abilities, we constructed and evaluated three new tests to assess specific motor abilities in handball goalkeepers, based on technologically contemporary diagnostic devices. They can be applied to assess specific power of dominant muscle groups of upper leg abductors, to assess specific explosive power in doing the defence movement and reaction speed of single movement, i.e. abilities predominantly significant for situation and competition efficiency in handball goalkeepers. We established good metrical characteristics which enable functional implementation of these tests in selection and training processes in handball.

References

1. Castro, J., Sequeira, P., Cruz, C. (2011). *Goalkeeper - Specific Training for Youngsters. Characterization of the Importance and Structure in the Formation Process of Handball Goalkeeper.* In Proceedings book of the 1th EHF scientific conference "Science and analytical expertise in handball". Vienna, pp. 238-242.
2. Chaouachi, A., M. Brughelli, G. Levin, Boudhina, J. Cronin, K. Chamari (2009). Anthropometric, physiological and performance characteristics of elite team handball players. *Journal of Sports Sciences,* 27(2): 151-157.
3. Holm, I., Fosdahl, M.A., Friis, A., Risberg, M.A., Myklebust, G., Steen, H. (2004). Effect of Neuromuscular Training on Proprioception, Balance, Muscle Strength, and Lower Limb Function in Female Team Handball Players. *Clinical Journal of Sport Medicine*, 14(2): 88-94.
4. Olsson, M. (2010). *Individualisation of goalkeeper training.* Ehf Periodical, www.ehf.com
5. Pori, M., I. Justin, T. Kajtna, P. Pori (2011). *Which Motor Abilities Have the Highest Impact on Competitive Performance of Slovenian Handball Goalkeepers?* Proceedings book of the 1th EHF scientific conference "Science and analytical expertise in handball". Vienna, pp. 294-298.
6. Šibila, M., Pori, P. (2009). Position-Related Differences in Selected Morphological Body Characteristics of Top-Level Handball Players. *Coll Antropol,* 33(4): 1079-1086.
7. Van den Tillaar, R., Ettema, G. (2003). Instructions emphasizing velocity, accuracy, or both in performance and kinematics of overarm throwing by experienced team handball players. *Percept Mot Skills,* 97(3): 731-42.

ANALYSIS OF BALL CONVERSION IN EUROPEAN AND AMERICAN PROFESSIONAL BASKETBALL GAMES

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Abstract

Start of offense significantly affects the development and execution of the offense. Evaluation of beginnings of offense in professional European and American basketball reveals proportional distribution of 12 applied modalities, however, statistical analysis showed significant differences between the two basketball systems. NBA comparatively demonstrates a higher frequency of offenses that start by winning the ball without time stoppage. In contrast, Euroleague shows significantly greater representation of offensive beginnings by inbounding the ball. The most common forms of offensive openings in basketball are by *Inbounding the ball from the baseline on back-court,* followed by *Opening of offense by a defensive rebound after an unsuccessful field-goal attempt.* Both forms are slightly more pronounced in the US professional basketball. A higher degree of offensive efficiency was shown after steals, as it was expected, however, the execution of such modality has also a higher success rate in the NBA. The research results indicate the specific characteristics of observed basketball systems based on correlation of conversion type and situational outcomes. Those explicit features partially affect the principles of appropriate game and training concept.

Key words: *European and American basketball, offence start, game structure*

Introduction

Examining the dependence of games' structural elements represents, among others, a valuable analytical approach to broaden the knowledge about basketball norms. By treating the game of basketball as a set of alternating phases of offence and defence it is important to examine the forms of their start, progression and outcome. The moment of change of ball possession from defence into offence and vice versa in basketball terminology is called "conversion". Due to the coherence of offence and defence, a form of conversion represents an important precondition of the following game phase. Therefore, tactical approach should aim to create a suitable opening of offense that will consequently ensure more successful outcome of offense.

This brings to a conclusion that a high-quality offence is generally a product of high-quality and controlled defence, which is primarily reflected by strict abidance of technical and tactical principles combined with an appropriate aggressiveness. In this context, the beginning of offence is, mainly indirectly, subject of analysis of numerous basketball studies which aim to evaluate the interdependence of its' structural components or to examine the impact of technical and tactical parameters on success in the game, as well as the ones that aim to analyse the individual and team tasks or to evaluate the standard indicators of situational efficiency.

Javier (1992) describes the importance of spatial and temporal characteristics of the game and motor interaction compliant with technique, tactics and team strategy. Defensive obstructions based on the integration of group tactical manoeuvres such as penetration, cuts, setting picks etc. has a positive effect on offensive efficiency as well as more appropriate prevention of possible fast-breaks by opponents (Remmert, 2003). By examining the effects of different types of defence, Gomez et al. (2007) emphasize the patient ball control on the offense as a prerequisite of controlled defence. Tsamourtzis et al. (2005) and Ortega et al. (2006) emphasize the objective of achieving a high number of offensive transitions which will generally ensure greater success of the offence. The research of individual factors of situational efficiency generally identifies shooting efficiency in the offensive phase and defensive rebounds in the defensive phase as dominant variables affecting victory in basketball (Karipidis et al., 2001.; Milanović et al., 2001.; Csataljay, 2009.; Ibáñez et al., 2008). Thus those modalities of conversion represent a key orientation towards success in the game.

The aim of this study is to determine the characteristics and differences between professional European and American basketball focusing on the analysis of different forms of offensive openings and evaluating their correlation with a successful or unsuccessful offensive execution. Comparison of American and European professional basketball is partially limited due to differences in basketball rules. Regulated specifics, such as primarily limitations in the defence, the dimensions of the court, etc. have a relative impact on the form of conversion which consequently affects the tactical implementation of the game, i.e. the typical execution of defensive and offensive tasks. Taking into consideration the differences in basketball rules between the two systems, the results of this study contribute to a more precise knowledge regarding the level of connections between observed research subject with game performance.

Methods

Sample of entities: Entity in this study represent basketball offenses whose limitations are not set according to the principle of change of possession but in accordance with the game rules. Overall sample is consisted of 5718 entities which are collected by notation analysis of 30 randomly selected playoffs matches in 2010 / 2011 season of which 2,604 entities were generated via complete evaluation of 15 Euroleague games and 3,114 from 15 NBA games.

Sample of variables: Start of the offense indicates the form in which the team began the offense, and generally the beginnings of offense are divided into two basic types: the *start of the offense by capturing the ball without stopping the game time* and *the start of the offense by inbounding the ball from the side line.* Those types generate 12 modalities which cover all forms of offensive openings. Those variables are:

1. Opening of an offense by the jump ball at the beginning of the 1st quarter; (OL-PL)
2. Opening of an offense by defensive rebound after an unsuccessful field goal attempt; (OL-SO-SI)
3. Opening of an offense by offensive rebound after an unsuccessful field goal attempt; (OL-SN-SI)
4. Opening of an offense after: held ball, intercepting the pass; steal, after blocked shot; (OL-UL)
5. Opening of an offense by defensive rebound after an unsuccessful last free throw; (OL-SO-SL)
6. By free-throws; (OL-ISB)
7. Opening of an offense by offensive rebound after an unsuccessful last free throw; (OL-SN-SL)
8. Inbounding the ball from the baseline on the backcourt; (UL-CL-PO)
9. Inbounding the ball from the side-line on the frontcourt; (UL-BL-PN)
10. Inbounding the ball from the side-line on the backcourt; (UL-BL-PO)
11. Inbounding the ball from the baseline on the frontcourt; (UL-CL-PN)
12. Inbounding the ball from the side-line at half-court, (UL-BL-SI)

Data processing includes analysis of corresponding modalities in absolute as well as relative values which are especially significant considering the difference in match duration between the two monitored systems. Scoring efficiency is determined by the offense benefit value (KIN) which indicates the relative ratio of their frequency and the number of points. Finally, a non-parametric data analysis method - χ^2 test is applied to compare European and American basketball in nominal variables at the 0.01 significance level. Data were analysed using *Statistica 8.0.* statistical package.

Results and discussion

The analysis of various beginnings of offensive phase in professional basketball on a comprehensive sample of entities (Tables 1 and 2) shows that majority of offenses begin by inbounding the ball (59.2% in the Euroleague; 55.5% in the NBA), and that is primarily by inbounding the ball from the baseline on the backcourt (38.9% in the Euroleague; 42.1% in the NBA), then from the side-line on the frontcourt (7.6% in the Euroleague, 6.9% in the NBA) and the side line on the backcourt (6.3% in the Euroleague; 5.6% in the NBA). Opening of an offense by capturing the ball without stopping the game time is recorded in 40.7% of cases in the Euroleague as opposed to 44.5% of cases in the NBA. Evaluation of related modalities reveals that those offense openings are predominantly presented by defensive rebound after an unsuccessful field goal attempt (20.4% in the Euroleague; 23.2% in the NBA), followed by steals (8.8% in the Euroleague; 9.7% NBA) and offensive rebound after an unsuccessful field goal attempt (7.3% in the Euroleague, 7.5% in the NBA).

From the results presented it can be generally concluded that offenses in basketball usually start after scored basket (40%). Despite the high frequency of this modality, the most offenses end up unsuccessfully even when combining them with neutral outcomes (OL-SN-SI, OL-SN-SL), in other words, those offense openings in which teams gain an additional opportunity to score. Such a hypothesis is confirmed offense benefit value which is generally less than one point per offensive possession.

Furthermore, from the efficiency viewpoint, it is evident a higher benefit value of offenses that began while ball was on the court (0.89 in the Euroleague; 0.94 in the NBA) than those started by inbounding the ball (0.80 in the Euroleague; 0.83 in the NBA). Such a situation is understandable because almost all transition offenses that hold the greatest efficiency potential are created by steals or defensive rebound (transitions starting by inbounding the ball are quantitatively negligible). From the practical aspect of the game these results emphasize the tactical orientation towards aggressive and mobile defences that present prerequisites for a greater number of primary and secondary transitions. Such tactical orientation is primarily reflected by the high pressure on the player with the ball and the players on the “first pass”, disabling an easy ball movement and, finally, by ensuring defensive rebound through a strict boxing-out after the shot attempt. Although it would be useful to examine the correlation of conversion modes in a particular type of offense (transitions or set-offenses) and its outcome, these results define the significance level of skilful and effective implementation of offenses that resist defensive pressure.

Table 1: Difference in the type of openings of offences between European and American professional basketball

Type of start of offence	Euroleague (freq.)	NBA (freq.)	Euroleague%	NBA%	Euroleague KIN	NBA KIN
OL	**1,062**	**1,387**	**40.78**	**44.54**	**0.89**	**0.94**
UL	**1,542**	**1,727**	**59.22**	**55.46**	**0.80**	**0.83**
	Chi2 = 8.177 df = 1, p = 0.0042					

Legend: OL – beginningof the offence by obtaining the ball without stopping the game time; UL – beginning of the offence by inbounding the ball from the side lines, KIN – offense benefit value; Chi2 – the value of chi-square test; df – degrees of freedom; p – level of significance (<0,05)

Table 2: Difference in the modalities of the beginnings of offense between European and American professional basketball

Modality of the beginning of offence	Euroleague (freq.)	NBA (freq.)	Euroleague%	NBA%
OL-SO-SI	**532**	**722**	**20.43**	**23.19**
OL-SN-SI	**191**	**232**	**7.33**	**7.45**
OL-UL	**229**	**303**	**8.79**	**9.73**
OL-SO-SL	**67**	**73**	**2.57**	**2.34**
OL-PL	**15**	**16**	**0.58**	**0.51**
OL-ISB	**13**	**34**	**0.5**	**1.09**
OL-SN-SL	**15**	**7**	**0.58**	**0.22**
UL-CL-PO	**1,013**	**1,312**	**38.9**	**42.13**
UL-BL-PN	**197**	**215**	**7.57**	**6.9**
UL-BL-PO	**163**	**175**	**6.26**	**5.62**
UL-CL-PN	**120**	**22**	**4.61**	**0.71**
UL-BL-SI	**49**	**3**	**1.88**	**0.1**
	Chi2 = 159.407 df = 11, p = 0.0000			

Legend: OL-PL – Opening of an offense by the jump ball at the beginning of the 1st quarter; OL-SO-SI – Opening of an offense by defensive rebound after an unsuccessful field goal attempt; OL-SN-SI – Opening of an offense by offensive rebound after an unsuccessful field goal attempt; OL-UL – Opening of an offense after: held ball, intercepting the pass; steal, after blocked shot; OL-SO-SL – Opening of an offense by defensive rebound after an unsuccessful last free throw; OL-ISB – By free-throws; OL-SN-SL – Opening of an offense by offensive rebound after an unsuccessful last free throw; UL-CL-PO – Inbounding the ball from the baseline on the backcourt; UL-BL-PN – Inbounding the ball from the side-line on the frontcourt; UL-BL-PO – Inbounding the ball from the side-line on the backcourt; UL-CL-PN – Inbounding the ball from the baseline on the frontcourt; UL-BL-SI – Inbounding the ball from the side-line at half-court.

Although the values of 12 set modalities of offensive openings in European and American professional basketball are highly correlated, recorded deviations generate statistically significant differences *($\chi^2 = 8.177$; $p = 0.004$).* The difference between Euroleague and NBA in this segment consequently affects the further course of the game flow.

Initiating the offense by rebound or a steal, as well as, inbounding the ball from the baseline show higher frequency in NBA basketball. This thesis is to some extent contradictory, since relatively more steals and greater rebounding efficiency in defense represents defensive success, however inbounding the ball from the back-court baseline is mainly due to opponents' successful shot, i.e., defensive failure. This arrangement of displayed values of modalities indicates certain specificities within the distribution of offenses between the observed systems of basketball. The results of the study by Cardenas et al. (1995) and Parra (2008) prove that the modality of defensive rebounds, followed by steals modality, is the most common method of initiating the fast-break. Refoyo (2009) also determines the dominance of these modalities, but in the reverse order of frequency. From this we can conclude that the NBA basketball demonstrates the increasing number of transition offenses which is consequently reflected with the highest efficiency (also seen in Table 1). This case is also confirmed in the study by Milanović et al. (2014).

Transition offenses feature random situational obstacles with unpredictable circumstances. The success of transitions is greatly influenced by individual reaction speed, technical skills and motor and cognitive abilities. Such constructrion makes transition offenses more challenging to improve during training process. Practicing fast-breaks should invove quick opening of after rebound and progressing according to eventual tactical decisions (movement through proper lanes of attack, dribbling and passing regulation, presence of picks, cuts and various types of offensive execution).

On the other hand, the given structure of offensive beginnings in European basketball indicate the orientation towards ball control in the Euroleague, thus emphasizing greater tendency towards se offense and systematized form of *motion offense*, which mainly aims at reduction of turnovers and prevention from opponent' transitions, however, it raises doubts regarding the productivity of the offense. Lower efficiency in European basketball can be, to some extent, justified by specific game rules which allow more freedom of mutual help in defence. Dynamic help side, unlimited double teams and, generally, continuous zone defense significantly affects the neutralization of field goal attempts, penetration and other offensive manoeuvres. The complexity of coordinated defence in the set phase requires diverse and more comprehensive technical and tactical (individual and team) preparation because the level of quality implementation of this type of defence will ultimately have the most significant impact on the final score.

Considering the obtained ratio of offensive beginnings and the fact that the transition offenses mainly start by capturing the "live ball", logically set offences commonly begin by one form of inbound from the side line which in this case is recorded as a greater incidence, i.e. the distinctive feature, of European basketball. Cruz and Tavares (1998) found that the greatest number of set offences start from the baseline after received basket (36%), followed by inbound behind other lines (24%) and defensive rebounds (11%). The modality *Inbounding the ball from the baseline in the defensive zone* (UL CL-PO) may serve as a convenient measure of offensive efficiency since it is almost always preceded by opponents scoring. The difference of approximately 3% for UL-CL-PO between two types of basketball implies higher scoring efficiency in the NBA and, at the same time, more successful defence in the Euroleague. It should be pointed out the relative impact of the difference in rules between the two monitored basketball systems. Different measures of restricting defence can certainly result in such a state. From defensive point of view, a greater freedom of collective defence in European basketball, puts comparatively limited zoning on geometrically larger court area of American basketball in disadvantage.

The practical implications of this study relate primarily to game tactics. Defensive rebounds and steals on defence are emphasized. The successful prevention of opponents' fast-break creation will primarily secure an organized and well-balanced offence, from which derive precise assignments, roles and responsibilities in transition and set defence. This is the only way a team can control game phases and suppress critical intervals during the game.

Conclusion

Examining the 12 modalities of starting the offence encountered in basketball, generally can be concluded that *Inbounding the ball from the baseline in the defensive zone* is the most common form of starting the offense. The frequency of this modality is somewhat more pronounced in professional American basketball. The next significant form of offensive beginning is evident in modality *Opening of an offense by defensive rebound after unsuccessful field goal attempt* which also demonstrates greater representation in the NBA. The results confirm the findings of previous research that such offenses regularly initiate high frequencies of fast-breaks which contain the greatest efficiency power. From these results it follows that basketball offenses usually start after conceding the basket (40%), followed by defensive rebounds (between 20 and 25%). The rest of modalities are represented by less than 10%. Analysis of differences between European and American professional basketball in variable *Beginning of offense* indicates specific practical features of the game. The NBA has recorded relatively higher frequency of offenses that started by attaining the "live ball" (without stopping the game time). Those instances of conversion from defence to offense, provide a greater chance for successful offensive outcome. In the Euroleague its shown a greater representation of offensive starts by inbounding the ball.

There is no question that characteristics of each system are, to some extent, a consequence of differences in game rules. Differences in court geometry and provisions restricting defence relatively affect different execution of defensive and offensive tasks which is reflected in a different structure of defence-offense conversion. However, the research proves the logical statement that a team ensures quality offence to a high extent by playing quality defense and vice versa.

Literature

1. Cárdenas, D., Moreno, M.I., Almendral, P. (1995). Analisis de los factores que inciden en la eficacia del contraataque en baloncesto. *Revista de entrenamiento deportivo,* 9(4), 11-16.
2. Cruz, J., Tavares, F. (1998). *Notational analysis of the offensive patterns in cadets basketball teams.* U: Notational Analysis of Sport IV. Proceedings of the IV World Congress (str. 112–119). Porto: Centre for Team Sports Studies, Faculty of Sport Sciences and Physical Education, University of Porto.
3. Csataljay, G., James, N., Hughes, M., Dancs, H. (2009). Performance differences between winning and losing basketball teams during close, balanced and unbalanced quarters. *Journal Of Human Sport & Exercise*, Vol.7 Iss. 2 (2012).
4. Gomez, M.A., Tsamourtzis, E., Lorenzo, A. (2007). Defensive systems in basketball ball possessions. *International Journal of Performance Analysis in Sport*, Volume 6, Number 1, June 2006, pp. 98-107 (10).
5. Ibáñez, S.J., García, J., Feu, S., Lorenzo, A., Sampaio, J. (2008). Effects of consecutive basketball games on the game-related statistics that discriminate winner and losing teams. *Journal of Sports Science and Medicine*, 88(3), 458–462.

6. Javier, O. (1992). *1250 ejercisios y juegos en baloncesto*. Vols. I., II., III. Barcelona: Editorial Paidotribo.
7. Karipidis, A., Fotinakis, A., Taxildaris, K., Fatouros, J. (2001). Factors characterizing a successful performance in basketball. *J Hum Mov Stu*, 2001; 14 (5): 385-398.
8. Milanović, D., Jukić, I., Bračić, M. (2001). *Influence of variables basketball shooting on the game results of the European Championships in Barcelona 1997.* U: D. Milanović (Ed.) Zbornik radova Kineziologija za 21. stoljeće (pp. 286–289). Opatija
9. Milanović, D., Selmanović, A., Škegro D. (2014). Characteristics and differences of basic types of offenses in european and american top-level basketball. In: Milanović, D; Sporiš, G. (Eds.). 7th International Scientific Conference on Kinesiology Proceedings Book, Zagreb: University of Zagreb,: Faculty of Kinesiology, 2014; Opatija, p. 400-403
10. Parra, J. (2008). *El contraataque: un analisis comparativo ACB-Mundial 06*. La Pizzara-AEEB. http://www.aeeb.es/v2/publicaciones.php?area=publicaciones~sub=pizzara
11. Refoyo, I., Romarís, I.U., Sampedro, J. (2009). Analysis of men's and women's basketball fastbreaks. *Revista de Psicología del Deporte*, 18 (3), 439−444.
12. Remmert, H. (2003). Analysis of Group-Tactical Offensive Behavior in Elite Basketball on the Basis of a Process Oriented Model. *European Journal of Sports Science*, vol. 3, iss. 3.
13. Ortega, E., Cardenas, D., Sainz de Baranda, M. P., Palao, J. M. (2006). Differences between winning and losing teams in basketball games in formation years (14-16 years old). *International Journal of Applied Sport Sciences*. 18 (2). 1-11.
14. Tsamourtzis, E., Karypidis, A., Athanasiou, N. (2005). Analysis of fast breaks in basketball. *International Journal of Performance Analysis in Sport*, 4 (2): 17-22.

ANTHROPOLOGICAL ANALYSIS OF THE CROATIAN U16 BASKETBALL MEN'S NATIONAL TEAM – A COMPARATIVE ANALYSIS OF TWO GENERATIONS

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Abstract

The aim of this research was to conduct a comparative analysis of anthropological characteristics of basketball players from the U16 Men's National Team born in 1997 or 1998 with the present U16 generation born in 2000 and 2001.

The participants in this research were twenty one (21) players, members of the U16 Men's National Team. The research included tests for assessing morphological characteristics, as well as test for motor and functional abilities.

Based on the obtained results, the conclusion can be made that the present generation of U16 basketball players born in 2000 or 2001 showed quite similar modal characteristics to the ones demonstrated by the U16 generation of players born in 1997 and 1998 in their results of tests for assessing morphological characteristics, motor and functional abilities.

Key words: *basketball, morphological characteristics, motor and functional abilities, U16*

Introduction

Basketball is a complex sports activity and, as such, it consists of simple and complex movements that are performed in conditions of different intensity during the cooperation of team players in a basketball game (Rupčić, T., Matković, B., Knjaz, D., 2010; McArdle WD., Katch FI., Katch VL., 2010). The above-mentioned requires players to demonstrate a high level of acquisition in motor skills – elements of basketball technique, development of physical conditioning and motor abilities, as well as good conative characteristics and cognitive abilities.

For a basketball players to be able to perform the mentioned activities, certain motor abilities must be at a high level of acquisition. According to Milanović (2010), motor abilities enable strong, quick, long, precise or coordinated performance of various motor tasks. From the aspect of motor abilities, basketball is dominated by agility (changes of direction with the ball, opening for ball reception, moving in defensive stance), lower-limb explosive strength (vertical jumping ability – offensive and defensive stance), upper-limb explosive strength (passing the ball), balance, shooting or passing precision, speed (starting speed and acceleration), endurance (aerobic and anaerobic), etc.

Agility is defined as the ability to decelerate, accelerate and change the direction of movement while maintaining good body control, which is closely connected with balance as it requires the player to perform continued transfer of the body's centre of gravity (Brown L. E. et al., 2004; Arthur et al., 1998; Brittengam, G., 1996; Costello et al., 1993; Murphy et al., 1997; 1998; Smythe, 1995) that is manifested in specific basketball movements, such as movements in the defensive stance, opening for ball reception, etc.

High aerobic capacity ensures the slower onset of fatigue and faster recovery in short breaks during a basketball game, whereas anaerobic energetic capacity assures endurance in high-intensity repetitive activities (Matković, R.B., Matković B., Knjaz, D., 2005).

The aim of this paper was to present a comparative analysis of morphological characteristics, as well as motor and functional abilities in U16 members of the Croatian National Team born in 1997 and 1998 with the present generation of Croatian U16 basketball players born in 2000 and 2001.

Methods

The sample of examinees was composed of twenty one (21) U16 National Team players. Ten (10) of them, born in 2001/2002, averagely aged 14.9±0.6. and eleven (11) of them, born in 1997/1998, averagely aged 15.7±0.4. All the participants were informed, both in written and orally, on the methods of implementation of the measurements, as well as on the purpose of the tests that were performed. Results of the 10 examinees born in 2001/2002 were compared with the results of research conducted by Borović et al., 2016 aimed at determining the modal characteristics of the 11 potential U16 National Team players, generation born 1997/98.

The sample of variables was composed of morphological characteristics and test for assessment of motor and functional abilities with validated metric characteristics (Metikoš et al., 1982; Blašković, Milanović and Matković, 1982; Jukić et al., 2008).

Morphological measures used in this research were body height, body weight and body mass index. Motor abilities for assessing agility were measured by using the 20-yard test (20Y) and Side-Step test (SSTEP). Explosive strength in sprinting was tested with the 20-meter run, while explosive strength in the vertical jumping ability was assessed with the Countermovement jump test (CMJ). The 300-metre sprint test was used for assessing the functional anaerobic endurance capacity (15x20 m).

Data processing was performed by using the programme package Statistica for Windows, ver. 12. The following parameters were calculated for each variable: arithmetic mean (AM), standard deviation (SD), minimum value (MIN) and maximum value (MAX).

Results

Table 1. presents descriptive statistical parameters of morphological characteristics, motor and functional abilities of the potential candidates for the U16 National Team born in 1997 and 1998 (Borović et al., 2016).

Table 1: Descriptive statistical parameters of morphological characteristics, motor and functional abilities of potential U16 Men's National Team players 1997/98

Variable	Valid N	AM	MIN	MAX	SD
BH (cm)	11	194,45	184,30	205,20	7,22
BW (kg)	11	81,87	70,90	95,50	7,63
BMI	11	21,67	18,80	23,80	1,75
CMJ	11	45,30	38,83	58,60	6,35
SSTEP	11	7,41	6,70	8,28	0,39
20Y	11	4,97	4,65	5,18	0,15
20m	11	3,397	3,26	3,67	0,13
300m - time	11	68,05	62,71	74,04	3,47

AM – arithmetic mean; MIN – minimum value; MAX – maximum value; SD – standard deviation; BH – body height; BW – body weight; BMI – body mass index; CMJ – Countermovement jump test; SSTEP – Side-Step test; 20Y – 20-yard test; 20m – 20-meter running test; 300m - time – 300-meter sprint test

The results presented in the above table were also used for a research conducted by Borović et al., 2016 aimed at determining the modal characteristics of potential U16 National Team players. The mentioned table was used for a comparison with the results of the present U16 generation of players who are also potential members of the National Team. Based on this research, it shall be determined if the 2000/2001 generation meets the modal characteristics demonstrated by the 1997/98 generation, as well as if their results show significant deviations when compared with the results in Table 1.

Table 2: Descriptive statistical parameters of morphological characteristics, motor and functional abilities of potential U16 Men's National Team players 2000/01

Variable	Valid N	AM	MIN	MAX	SD
BH (cm)	10	189,80	181,00	199,70	6,63
BW (kg)	10	77,76	66,30	104,10	11,82
BMI	10	21,46	19,00	26,00	2,05
CMJ	10	41,84	33,90	52,00	5,50
SSTEP	10	8,25	7,87	8,89	0,35
20Y	10	4,94	4,61	5,30	0,21
20m	10	3,40	3,13	3,75	0,17
300m - time	10	69,23	64,13	76,06	3,36

AM – arithmetic mean; MIN – minimum value; MAX – maximum value; SD – standard deviation; BH – body height; BW – body weight; BMI – body mass index; CMJ – Countermovement jump test; SSTEP – Side-Step test; 20Y – 20-yard test; 20m – 20-meter running test; 300m - time – 300-meter sprint test.

Table 3: T-test for independent samples – generation 1997/98 and 2000/01

Variable	AM 1	AM 2	T-value	df	p	Valid N 1	Valid N 2	SD 1	SD 2	F-ratio Variances	p Variances
BH (cm)	189,8	194,5	-1,53	19	0,142	10	11	6,64	7,223	1,184	0,810
BW (kg)	77,8	81,9	-0,96	19	0,351	10	11	11,83	7,635	2,399	0,189
BMI	21,5	21,7	-0,26	19	0,801	10	11	2,06	1,752	1,380	0,621
CMJ	41,8	45,3	-1,33	19	0,199	10	11	5,51	6,358	1,334	0,676
SSTEP	**8,3**	**7,4**	**5,11**	**19**	**0,000**	**10**	**11**	**0,35**	**0,394**	**1,256**	**0,742**
20Y	4,9	5,0	-0,32	19	0,751	10	11	0,21	0,156	1,814	0,367
20m	3,4	3,4	0,17	19	0,867	10	11	0,18	0,139	1,622	0,462
300m - time	69,2	68,1	0,79	19	0,437	10	11	3,36	3,472	1,066	0,933

AM – arithmetic mean; MIN – minimum value; MAX – maximum value; SD – standard deviation; BH – body height; BW – body weight; BMI – body mass index; CMJ – Countermovement jump test; SSTEP – Side-Step test; 20Y – 20-yard test; 20m – 20-meter running test; 300m - time – 300-meter sprint test.

Discussion

Upon analysing the results of measurements for assessing morphological characteristics, in terms of body height and body weight, the two generations of U16 players showed that the 2000/01 generation was slightly lower on average 189,80±6,63 cm, as well as lighter 77.76±11.82 kg when compared with the 1997/98 generation and their average body height of 194,45±7,22 cm and body weight of 81.87±7.63 kg. According to a research conducted in Lithuania by Kamandulis et al. (2013), the average height of their U16 players was 186.8±8.4 cm, while their body weight was 79.3±12.1. The results for body mass index for the 1997/98 generation (21.67±1.72 kg/m²) and the 2000/01 generation (21.47±2.05 kg/m²) was compared with the results of a research conducted by Marić, Katić and Jeličić, (2013) in which tests were performed in 5 basketball clubs from the U16 First League in Bosnia and Herzegovina where the measured body mass index was 20.81 kg/m². The above-mentioned results lead to the conclusion that the 1997/98 generation is a very high generation in relation to the 2000/01 generation and Lithuanian U16 players, whereas body mass index results show no significant deviations between the compared groups. The body mass index of U16 players from Bosnia and Herzegovina showed somewhat lower values than the ones measured for our examinees, however, their results undoubtedly belong in the group of persons with normal body mass index (Wilmore et al., 2008).

As one of the essential success factors in basketball performance, motor abilities were also assessed as part of this research. The results demonstrate that the 1997/98 generation accomplished higher results in CMJ tests (45.30±6.35cm) and in the 20-meter sprint (3,39±0,13 sec) when compared with the 2000/01 generation (CMJ 41,84±5,50 cm and 20 m 3,40±0,17 sec). The determined differences between the results are not as significant, however, they do indicate a slight advantage of the 1997/98 generation. Brekalo et al. (2013) also performed the mentioned 20-meter test with U16 basketball players from the top three clubs in Bosnia and Herzegovina. These results were 3,54±0,26 sec slower than both generations of Croatian U16 players. Coelho e Silva et al. (2008) conducted a research on a national level with U16 players in Portugal (n=28), averagely aged 15,0-15.9, using the CMJ test. In relation to our U16 players from both generations, Portuguese examinees demonstrated lower result in the mentioned CMJ test (37,9 cm).

The results of the 300-metre sprint test for assessing functional capacities showed a minimum time difference for the covered distance in both generations. The 2000/2001 generation covered the mentioned distance in 69,23±3,36 sec, whereas the 1997/98 generation did it in 68,05±3,47 sec. The conclusion can be made that the present U16 generation is very close to the model characteristics.

Table 3. demonstrates results of the T-test for independent samples between the two U16 generations of players which show statistically significant differences in benefit of the 1997/98 generation in relation to the 2000/01 generation in the Side-Step test for assessing motor abilities (SSTEP) p=0,00. There were no statistically significant differences between the two groups among the other measured indicators which leads to the conclusion that the present U16 generation is close to the modal characteristics demonstrated by the 1997/98 generation.

Conclusion

Based on the obtained results on morphological characteristics of the 1997/98 generation of U16 National Team players in relation to the 2000/01 generation, the conclusion can be made that from the aspect of longitudinal and transversal dimensionality, the 2000/2001 generation showed lower values. The reason for this can be found in their chronological age which was lower at the moment of the measurements. The results of most motor ability tests for the 2000/2001 generation are satisfactory in terms of modal values. A statistically significant difference was recorded in the Side-Step test (SSTEP) which is connected with agility. The mentioned motor ability can be influenced by the way of specific training and thus brought closer to the desired values.

When considering the results of the present U16 generation of players born in 2000 and 2001, it can be said that their level of motor abilities is at a very high level and that they can reach their potentials during their future training process, and in that way, bring their performance of technical and tactical elements to the most high level.

References

1. Arthur, M. & Bailey, B. (1998). Agility drills. Chapter 7 in Complete Conditioning for Football Champaign, IL: Human Kinetics. 191-237.
2. Blašković, M., Milanović, D., Matković, B. (1982). Analiza pouzdanosti i faktorske valjanosti situaciono motoričkih testova u košarci. Kineziologija, 14(5): 131-149.
3. Borović, I., Rupčić, T., Matković, R. B., Garafolić, H., Dadić M. (2016). Anthropological profile of u16 basketball players. Acta Kinesiologica, 10. 71-77.
4. Brekalo, M., Marić, K., Blažević, S., Kostovski, Ž., Crnjac, D. (2013). The influence of the basic motor skills on individual tests taken in order to evaluate the successfulness of the basketball game. PESH 2. 2:89-94.
5. Brittengam, G. (1996). Athleticsm for basketball. Chapter 5 in Complete Conditioning for Basketball. Champaign, IL. Human Kinetics. 69-87.
6. Brown, L.E., Ferrgano, V. A., Santana, J.C. (2004). Brzina agilnost eksplozivnost. Gopal Zagreb.
7. Coelho e Silva, Manuel J., Figueiredo, António J., Carvalho Moreira, Humberto & Malina, Robert M. (2008). Functional capacities and sport-specific skills of 14- to 15-year-old male basketball players: Size and maturity effects. European Journal of Sport Science. 8(5): 277-285.
8. Costello, F. & Kreis, E.J. (1993). Introduction to agility. Chapter 1 in Sports Agility. Nashvill, TN; Taylor Ssports Publishig. 2-3.
9. Jukić, I., Vučetić, V., Aračić, M., Bok, D., Dizdar, D., Sporiš, G., Križanić, A. (2008). Dijagnostika kondicijske pripremljenosti vojnika. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu, Institut za istraživanje i razvoj obrambenih sustava.
10. Kamandulis, S., Venckūnas, T., Masiulis, N., Matulaitis, K., Balčiūnas, M., Peters, D., & Skurvydas, A. (2013). Relationship between general and specific coordination in 8-to 17-year-old male basketball players. Perceptual and motor skills, 117(3), 821-836.
11. Marić, K., Katić, R., Jeličić, M. (2013). Relations between Basic and Specific Motor Abilities and Player Quality of Young Basketball Players. Coll. Antropol. 37. Suppl. 2:55-60.
12. Matković, B.R; Matković, B; Knjaz, D. (2005). Fiziologija košarkaške igre. Hrvatski športskomedicinski Vjesnik. 20 (2), 113-124.
13. McArdle WD, Katch FI, Katch VL. (2010). Exercise physiology. Nutrition, energy, and human performance. 7th edition. Baltimore: LWW, Walters Kluwer.
14. Metikoš, D., Prot, F., Horvat, V., Kueš, B., Hofman, E. (1982). Bazične motoričke sposobnosti ispitanika natprosječnog motoričkog statusa. Kineziologija, 14(5), 21-62.
15. Milanović, D. (2010). Teorija i metodika treninga. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. Društveno veleučilište Zagreb.
16. Murphy, P. & Forney, J. (1997). Agility training. Chapter 7 in Complete Conditioning for Basketball. Champaign, IL: Human Kinetics. 126-136.
17. Rupčić, T, Matković, B., Knjaz, D. (2010). Anthropological profile of basketball referees. Hrvat. Športskomed. Vjesn. 25: 16-22.
18. Smythe, R. (1995). Acts of agility. Training and Conditioning V (4):22-25, 27.
19. Wilmore, J.H., Cotill, D.L., Kenney, W.L. (2008). Body composition in sport. U: Physiology of Sport and Excercise. WIlmore, J., Costill D.L. (ed). 4th ed. Champaign, IL.: Human Kinetics. Pg: 318-327.

DIFFERENCES AMONG COACHES IN PLANNING AND PROGRAMING ACCORDING TO EDUCATION LEVEL

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Abstract

Goal of this research is to examine is there difference between coaches with different level of education according number of hours spent for planning and programming. The sample was comprised of 351 (298 male and 53 female) professional coaches from Sport Association of the City of Zagreb. A survey was conducted in order to collect the information's about their status via 25 questions and amount of time spent in 16 professional duties via their estimation. General profile of professional sport coach in Zagreb according to this research is that his mean age is 41,46 ± 9,37 years. one way Anova test are showing that there is no significant (p=0,18) statistical difference among coaches with different education level according to time allocated for planning and programming activities during the preseason, season and postseason. Also the Post-hoc Tuckey test has confirmed that there is no statistically significant difference between each three groups of coaches with different education level.

Key words: *coaching, number of hours, professional activities*

Introduction

Educational or certification issues for Coaches in different sports in Croatia are among important questions in scientific and professional sport community (Čustonja, Jukić & Milanović, 2011). There is a great importance of defining levels of professional skills and different levels of education in order to ensure competence of coaches working in sport, especially with youth athletes. Formal and informal education among sport coaches are differently honored in different countries but importance of basic education in the field of sport coaching is highly recommended (Wiersma and Sherman, 2005). According to Nelson, Cushlon and Potrac (2006) coaches are preferring informal way of learning. Despite the fact that informal way of learning is dominantly present among Coaches research of Smith et all. (1983) and Smoll et all. (1993) shows that *Coaches' Education Interventions*, are closely related with positive attitudes toward the sport, self-esteem and enjoyment in sport by youth athletes in United States. Of course, specific skills and knowledge in Coaching is the most important thing as in any other profession in the world. Unfortunately, there are many examples of well-known attitude "*anyone can coach*", especially in youth age (McCallister, Blinde, and Kolenbrander, 2000). The main problems that exists in youth sports coaching in general is that they do not have a proper supervision (Gilbert and Trudel, 2001) or, in US, the fact that they do not have to, as volunteers, have any coaching certificate (Gould et all., 1990). On the other hand, more recent investigation shows that in accordance with the intensive development of specific areas of interest in sport such as "Strength and Conditioning" and many others, level of education and more important acquired knowledge and skills are investigated through different studies. Defining the profile of high-school strength and conditioning coach Duehring and Ebben (2010) identified that 54% of coaches have master's degree as a level of education.

Coaches and coaching issues in Croatia are well explored in the study "Coaches and professional affairs in Croatian Sport". According to this document profile of Croatian coach in educational way is not satisfying. There is 37,2% of coaches undereducated for conducting professional jobs in sport as enacted in Croatian Sports Act. In conclusion there is a number of sport without at least one educated coach (Čustonja, Jukić & Milanović, 2011).

In the City of Zagreb, the capital of Croatia there are around 400 professional coaches financed from City budget. Educational structure of these coaches is better than the state level. Only 12,25% of coaches is undereducated and the other coaches are structured according to their level of education: Master's degree – 48,71%, Bachelor's degree – 18,23% and qualification course – 20,80% (Bok et all., 2015).The information's gathered through this study are important data to test certain hypothesis related to coaching in different sports.

In Sport Coaches job description Planning and programing is certainly one of the most complex activity and basic things in successful sport training process (Bok et all, 2015). Planning and programing is defined as set of actions in defining goal and duties of sport training process, time frames for certain periods (periodization), selection, proportion and distribution of training load (Milanović, Jukić & Vuleta, 2002).

Therefore, the goal of this paper is to investigate is there any differences among coaches in planning and programing of training according to their education level. Since planning and programming of training process is highly professional job it is assumption that less educated coaches need more time to spend in this activity.

Methods

The sample was comprised of 351 (298 male and 53 female) professional coaches from Sport Association of the City of Zagreb. A survey was conducted in order to collect the information's about their status via 25 questions and amount of time spent in 16 professional duties via their estimation. General profile of professional sport coach in Zagreb according to this research is that his mean age is 41,46 ± 9,37 years, he works with great number of athletes in different age categories and works to much paper work (Bok et all., 2015). According to level of education coaches were divided into three groups: university study level, professional study level and other study level coaches.

In the analysis of amount of professional work of Zagreb sport coaches 16 duties were defined as shown in table 1. The right amount of time spent in planning and programing of sports preparation is determined by coaches in preseason, season and postseason period.

Table 1: Professional duties of sport coaches in Sport Association of the City of Zagreb

PROFESSIONAL ACTIVITIES	
1	PLANNING AND PROGRAMMING OF SPORTS PREPARATION
TRAINING PROCES	
2	Preparation and inspection of facilities and equipment
3	Implementation and management of training process
4	Training analysis
COMPETITIONS	
5	Travelling to competitions
6	Participation in competitions
7	Competition analysis
ADDITIONAL PROFESSIONAL ACTIVITIES	
8	Scouting
9	Testing
10	Meetings with athletes
11	Preparation and reporting on professional work
12	Professional development and personal exercise
OTHER ACTIVITIES	
13	Meetings with parents
14	Educational care and health care
15	Motivation of participants
16	Additional work with members of national teams

Note: The information's in the Table are adapted from "Pedagoški standardi i normativi rada trenera u sportu" by Bok, D., Čustonja, Z., Hrženjak, M., Krističević, T., Matić, I., Milanović, D., Ricov, J., Šalaj, S. i Škegro, D.. Zagreb: Sportski savez Grada Zagreba i Sveučilište u Zagrebu Kineziološki fakultet.

Descriptive statistical parameters Mean and Standard deviation has been calculated for the variables Level of education (LE) and Number of hours spent for Planning and programing of sport preparation (NH). One way Anova was and Post-Hoc Tukey test are used to test the set hypothesis "There is statistically significant difference between coaches with different level of education in amount of time spent for Planning and programing of sports preparation". Statistical analysis of the collected data was made with statistical program STATISTICA 13 (Statsoft, Inc., Tulsa, OK, SAD) at the University of Zagreb, Faculty of Kinesiology.

Results

After the elimination of the Coaches who gave inaccurate data total number of 304 coaches has been processed in further analysis. Among examined coaches 33,04% graduated university level study, 23,64% graduated professional level study and 29,91% of coaches have high-school or qualification course level education for sport. The overall Mean amount of time spent for planning and programming of sports preparation is 244,7 hours with SD of 154,1 hours. Means and Standard deviations for each group of coaches are shown in table 2.

Table 2: Means and Standard deviations of time spent for planning and programming by coaches with different level of education

Variable	Mean	Standard deviation
UL	232,3829	148,7061
PL	231,4357	165,3454
QC	266,1833	149,7599

As shown in table 2 coaches educated on university (232,4 hours) and professional (231,4 hours) study level are spending almost the same amount of time for mentioned professional activity in their coaching. On the other hand coaches with qualification course level of education are consuming more time for planning and programming. Nonetheless results of one way Anova test are showing that there is no significant (p=0,18) statistical difference among coaches with different education level according to time allocated for planning and programming activities during the preseason, season and postseason. Also the Post-hoc Tuckey test has confirmed that there is no statistically significant difference between each three groups of coaches with different education level. P-level values are presented in table 3.

Table 3: Results of Post-hoc Tuckey test

	UL	PL	QC
UL		0,998989	0,232213
PL	0,998989		0,272894
QC	0,232213	0,272894	

Discussion

Results of statistical analyses conducted in this research shows that there is no statistically significant difference between coaches with different levels of education. However, despite this fact it is necessary to comment insight gained through this investigation. Education level among coaches in Sport Association of the City of Zagreb is well structured and ensure that more educated coaches are working with all categories of athletes (Bok et all., 2015). Compared to research on profile of strength and conditioning coaches in United States conducted by Duehring and Ebben (2010) it is obvious that education level is important as almost all surveyed coaches have some kind of license but more important most of the coaches have certain academic degree. Sports Act (2006) defined planning and programming as one of the specific skills of the coaches, furthermore the same document defined conditions who can coach. Unfortunately Sports Act did not regulated the issue of coaching entirely. Wide nomination of coaching profession without subordinate regulations and closely defined professional duties and levels of education and/or certification are the reason why coaching is still unsettled area of sport system in Croatia. The results of this study shows that coaches with course education level are spending more time for planning and programming. These coaches probably need more time for this professional activity due to their lower level of education.

Examination of relations between coaches and their level of education and number of hours spent in planning and programming is just one of the possible paths for better understanding of coaching system in Croatia. Most of the researchers agree that academic education vs courses is more important for coaching profession (Fernandez-Balboa, 1997; Howley and Howley, 1995 in Cushion, Armour & Jones 2003). Jones (2000; in Cushion, Armour &Jones, 2003) even claims that courses are not developing necessary qualities for coaching profession such as “intellectual, and practical competencies, namely, independent and creative thinking skills in relation to meaning making and problem solving.” This is why, goal for the future of coaching profession in Croatia should be pointed toward strengthening of academic levels of education. Without proper education coaching process and consequently sports system is degrading. Although experience is very important in coaching profession it is not enough just to be experienced (Douge & Hastie, 1993), formal knowledge developed through academic education can be observed as key factor of successful coaching. Top-level coaches have wide range of knowledge (Bergman Drewe, 2000) that Abraham et all. (2006) divided into three groups of knowledge; sport specific knowledge, pedagogy and sciences. Since wide range of specific knowledge and specific skills is necessary for successful coaching it can be concluded that education at academic level should be basic form of education for sport coaches.

Delimitation of this study was that relation of just one variable was examined and for sure there is lack of information about relationships of other important components of coaches' work.

Conclusion

Practically, the situation in Croatian sports is not resolved when discussion about sports coaches and their qualifications for coaching. In general in Croatia there is lack of investigations on sports coaching. This research showed that there is no differences among coaches with various level of education regarding amount of hours spent for planning and programming but definitely insight in literature imply that sport coaches should be well educated and have great amount of knowledge and specific skills. Therefore academic level of education is something that coaches should strive to.

References

1. Cushion, C. J., Armour, K. M., & Jones, R. L. (2003). Coach education and continuing professional development: Experience and learning to coach. *Quest*, *55*(3), 215-230.
2. Duehring, M. D., & Ebben, W. P. (2010). Profile of high school strength and conditioning coaches. *The Journal of Strength & Conditioning Research*, *24*(2), 538-547.
3. Fernandez-Balboa, J. (1997a). Knowledge base in physical education teacher education: A proposal for a new era. *Quest*, 49, 161-181.
4. Gilbert, W. and Trudel, P. (2001). Learning to Coach through Experience: Reflection in Model Youth Sport Coaches. *Journal of Teaching in Physical Education*, 21(1), 16-34.
5. McCallister, S. G., Blinde, E. M., & Kolenbrander, B. (2000). Problematic aspects of the role of youth sport coach. International Sports Journal, 4, 9-26.
6. Milanović, D., Jukić, I., & Vuleta, D. (2002). Planiranje i programiranje u području sporta. *U: Zbornik radova (ur. V. Findak) 11. ljetna škola kineziologa Republike Hrvatske, Rovinj, 22-26, lipnja 2002: 15*, *25*.
7. Nelson, L. J., Cushion, C. J., & Potrac, P. (2006). Formal, nonformal and informal coach learning: A holistic conceptualisation. *International Journal of Sports Science & Coaching*, *1*(3), 247-259.
8. Smith, R. E., Zane, N. W. S., Smoll, F. L., & Coppel, D. B. (1983). Behavioral assessment in youth sports: Coaching behaviors and children's attitudes. Medicine & Science in Sports & Exercise, 15, 208-214.
9. Smoll, F. L., Smith, R. E., Barnett, N. P., & Everett, J. J. (1993). Enhancement of children's self- esteem through social support training for youth sport coaches. Journal of Applied Psychology, 78, 602-610.
10. Wiersma, L. D., & Sherman, C. P. (2005). Volunteer youth sport coaches' perspectives of coaching education/certification and parental codes of conduct. *Research quarterly for exercise and sport*, *76*(3), 324-338.
11. Douge, B. & Hastie, P. (1993). Coach effectiveness. *Sport Science Review*, 2(2), 14-29.
12. Bergmann Drewe, S. (2000). An Examination of the Relationship between Coaching and Teaching, *Quest*, 52, 79-88.
13. Abraham, A., Collins, D. and Martindale, R., The Coaching Schematic: Validation through Expert Coach Consensus, *Journal of Sports Sciences*, 2006, 24(6), 549-564.

DIFFERENCES IN MORPHOLOGICAL CHARACTERISTICS AND SPECIFIC MOTOR ABILITIES IN MALE BASEBALL CADET PLAYERS

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Abstract

The study was conducted on the sample of 41 male baseball players aged 13-14, with the aim of determining which tests for measuring morphological characteristics and specific motor abilities can detect differences in relation to the players' quality of playing baseball. The differences were determined by using variance analysis, and the subjects were classified into two quality groups regarding the execution of basic baseball elements and the entire statistics of playing in attack and defense. Results referring to the playing quality show the largest differences in situational motor skills that assess the speed and explosive power, and morphological measures reveal the highest distinction in skin folds. The result information can help coaches in planning and programming the training process for cadets, and may serve as guidelines for the selection of baseball players at this age.

Key words: *baseball players, differences, groups*

Introduction

Baseball is one of the most popular sports in the world. The complexity of performance of its technical elements (hitting, playing defense, throwing and running around the bases) requires a high level of developed motor skills in a player, such as speed, power, accuracy, agility, balance and flexibility. Given the kinesiology diversity at different playing positions, it is evident why morphological domain and motor skills in baseball was the subject of several studies (Nakata et al., 2013; Tomašić et al., 2014). Studies show the importance of the morphological component (Carvajal et al., 2009) which can be observed in players themselves, since they get bigger and stronger every year. Although baseball seems to be a slow sport, it is full of fast movements such as throwing, running and hitting, which requires a high level of explosive strength in athletes (Tomašić et al., 2012). Given the importance of anthropological features for success in baseball, the intention of this study was to determine the morphological and specific motor characteristics of cadets in baseball, and compare the differences considering the technique of the basic elements in baseball. The test subjects are children aged 13-14, divided into two groups on selected and non-selected ones. The aim of this research is to use the battery of morphological and situational specific motor tests for baseball in order to determine the differences between the two groups, due to easier planning and programming of practice and to improve the players and the whole team as well as the selection of players in baseball at this age.

Methods

Subjects' sample

The sample involves 41 boys aged 13-14, cadet players from Nada SSM baseball club, Split. The test subjects were selected according to their playing quality on selected (N=22) and non-selected (N=19) players based on the performance of the basic baseball elements (hitting, throwing and catching) and overall statistics (statistics hitting AVG / OBP and statistics throws ERA) in season 2013. In addition to the players' quality and age, another condition to do the test was that all the subjects were clinically healthy and without any clear motor abnormalities, and to voluntarily take the test.

Variables sample

The sample of variables in this study represents a battery of 20 tests, ten out of which assess specific motor skills, and 10 tests assessing the morphological characteristics. For the assessment of situational motor abilities we selected ten measures: speed of the bat (BP), speed of hit balls (BUL), running around the bases (1B, 2B, 3B and HR), vertical jump (SUVIT), long jump (SUDIT) and throwing speed (MPH). For the assessment of morphological characteristics, we selected ten measures establishing constitutional types (according to Heath and Carter): knee diameter (DK), elbow diameter (DL), arm circumference in flexion (ONF), the scope of the lower leg (OPOK), forearm skin fold (KNAD), abdominal skinfold (KTRB), back skinfold (KLEDA), leg skin fold (KPODK), body weight (TEZ) and body height (VISI). The players' quality is defined based on the performance of basic elements of baseball (hitting, throwing and catching) and overall statistics (statistics hitting AVG and statistics throws ERA) playing from season 2013.

Data analysis

Data processing included calculation of basic descriptive and distribution statistical parameters such as arithmetic mean (X), standard deviation (SIG), minimal and maximal result values (Min, Max), coefficient of skewness (a3) and kurtosis (a4). Distribution normality test was conducted by Kolmogorov-Smirnov test on the significance level of $p < 0.01$. Differences in morphological characteristics and motor abilities between two groups were determined by univariate variance analysis (ANOVA). Data processing was done by Statistica (ver. 11) program.

Results and discussion

Table 1 displays basic statistical parameters for each variable: mean (AS), standard deviation (SD), range of results, the minimum (MIN) and maximum (MAX) value of the results, the asymmetry coefficient curve (SKEW) and kurtosis curve (KURT), the maximum difference between the received and expected cumulative frequency (MAXD). The values of the Kolmogorov-Smirnov test showed that all the variables are normally distributed, and that we can proceed with further data processing.

Table 1: Descriptive statistics

VARIABLE	AS	Min	Max	SD	a3	a4	MAXD
DK	9,30	7,50	11,10	0,78	-0,33	0,13	0,10
DL	6,16	5,00	7,60	0,61	0,35	-0,20	0,09
ONF	25,40	15,00	35,50	3,94	0,12	0,84	0,14
OPOK	33,46	26,50	43,50	4,04	0,25	-0,36	0,11
KNAD	10,59	4,40	38,20	6,28	2,59	8,68	0,24
KTRB	9,69	3,20	35,20	5,61	2,48	9,48	0,21
KLEDA	10,84	4,20	36,00	5,93	2,02	6,53	0,16
KPODK	14,09	6,20	42,20	6,86	2,24	6,54	0,22
TEZ	51,73	29,20	96,00	13,96	0,66	0,98	0,08
VISI	159,69	137,00	179,00	10,95	0,15	-0,60	0,11
DBL	31,60	12,00	57,00	9,33	0,52	0,76	0,10
BP	41,92	27,20	54,90	5,75	-0,20	0,63	0,09
BUL	47,96	29,30	78,90	9,38	0,60	1,74	0,09
1B*	5,18	4,16	6,62	0,51	0,62	0,17	0,16
2B*	10,87	8,60	15,25	1,22	1,14	2,60	0,14
3B*	16,83	13,94	21,22	1,89	0,54	-0,72	0,15
HR*	22,91	17,62	30,20	3,07	0,66	-0,47	0,17
SUVIT	2,08	1,65	2,60	0,25	0,74	-0,33	0,20
SUDIT	2,13	1,40	3,28	0,54	0,14	-0,89	0,12
MPH	43,04	25,90	62,40	8,05	0,03	0,10	0,07

TEST=0,25

Key: AS – arithmetic mean; Min – minimal value of result; Max – maximal value of result; SD – standard deviation; Skew – coefficient of asymmetry, Kurt – coefficient of kurtosis; Max D – deviation between cumulative and theoretic proportions; K-S p – significance of Kolmogor-Smirn test of the normality of distribution

In table 2, we used univariate variance (ANOVA) analysis to determine statistical significance in differences in morphological characteristics and specific motor abilities between the selected and non-selected subjects.

Table 2: Univariate variance (ANOVA) analysis of - morphological characteristics and specific motor abilities

VAR	Selected		Non-selected		F	P
	AS	SD	AS	SD		
DK	9,16	0,77	9,47	0,78	1,63	0,21
DL	6,09	0,54	6,24	0,68	0,66	0,42
ONF	24,57	3,11	26,23	4,30	2,10	0,16
OPOK	33,18	3,35	33,65	4,41	0,15	0,70
KNAD	7,91	1,84	13,01	7,51	**9,53**	**0,00**
KTRB	7,89	2,91	10,91	4,94	**5,96**	**0,02**
KLEDA	8,63	3,59	12,27	4,68	**8,06**	**0,01**
KPODK	12,62	3,67	14,70	6,74	1,58	0,22
TEZ	50,47	11,30	53,05	13,11	0,47	0,50
VISI	162,43	12,01	156,68	9,01	3,04	0,09
DBL	36,41	7,95	26,30	7,84	**17,16**	**0,00**
BP	43,68	4,90	39,99	6,10	**4,73**	**0,04**
BUL	52,34	9,10	43,15	7,21	**12,97**	**0,00**
1B*	4,88	0,33	5,51	0,48	**25,24**	**0,00**
2B*	10,12	0,69	11,70	1,15	**29,66**	**0,00**
3B*	15,62	1,07	18,17	1,69	**34,60**	**0,00**
HR*	20,96	1,76	25,06	2,77	**33,30**	**0,00**
SUVIT	2,18	0,27	1,96	0,18	**8,66**	**0,01**
SUDIT	2,45	0,42	1,78	0,42	**27,34**	**0,00**
MPH	48,38	5,59	37,17	6,01	**39,24**	**0,00**

Key: AS – arithmetic mean; SD – standard deviation; F – F-test, p – test of significants

Results of morphological characteristics indicate a statistically significant difference between selected and non-selected players in skinfold variables (KNAD, KTRB, KPOD), while the differences in diameters (DK and DL) and scopes (ONF, OPOK) are not significant. Since this is a sample undergoing a sensitive period of growth and development, it is expected that the differences between selected and non-selected players manifest precisely in the proportion of subcutaneous fat. Coaches frequently expect an athletic constitution in their male baseball players in addition to a maximum reduction of sub-skin adipose tissue since sub-skin adipose tissue is perceived as a ballast mass or a restrictor which, regardless of the playing position, has a negative influence on performance in the game. Adipose mass works as a limiting factor in achieving the dimensions which determine the intensity of the motor activity. Players with this morphological status improve their chances to succeed in baseball. Morphological criteria are based on the studies of baseball game which defines the model of the player for different playing positions (Carda & Looney, 1994). The model must be coordinated with the motoric-function criteria.

The same table shows evident statistically significant differences in all situational motor tests which proves that the division into selected and non-selected players was made correctly. Quality players are better in all specific motor tests, which is not surprising given that the baseball game abounds in explosive movement structures, primarily throwing and hitting the ball with fast sprints while running the bases. For the effective implementation of these elements in a baseball game, it is necessary to possess motor abilities such as throwing, jumping and sprinting, estimated in this battery of specific motor abilities. It is consistent with the model of motor functioning presented in the study by Tomašić et al. (2012).

Conclusion

Analyzing measures in the morphological domain, it was observed that children at this age do not differ too much, except in measures of subcutaneous adipose tissue, whereas in specific motor tests, the difference is evident in all tests.

As baseball abounds in explosive movement structures, primarily throwing and hitting the ball with fast sprints while running the bases, the battery of tests was designed for that purpose. Therefore, it is assumed that children with more body fat are slower and cannot perform certain motor tasks as well as the children with less body fat, which the results prove in this research. In fact, one can rarely find a kinesiology discipline in which fat is not a burden and an aggravating factor in achieving top results. Thus, at this age, players should try to reduce the subcutaneous adipose tissue as much as possible. Furthermore, one of the reasons that we have previously highlighted is the age of the subjects. In this age group, the human body undergoes specific changes (physical and mental) and it is assumed that not every child develops equally. On the basis of biological age, there is a classification on accelerants and retardants. Retardants should not be neglected because the selection itself always takes a longer period, and with it, their progress as well. In addition to this, we can also assume that better players are those who have better genetic predispositions.

As all the players in this research have approximately been training over the same period of time, based on the data we collected, we can conclude that players with greater explosive power are also faster, more coordinated and with less body fat and they should have an advantage when doing a selection for the team in this age group.

It is crucial to include other anthropological features in the following researches in order to obtain relevant information on the anthropological complexes of male baseball players in different quality and different playing positions. Thus, the explanations should be searched for in an athlete's integral potential, and not in the isolated anthropological characteristics which are undoubtedly the future researching directions.

References

1. Carda, R.D., Looney, M. (1994). Differences in physical characteristics in collegiate baseball players. A descriptive position by position analysis. *Sports Med Phys Fitness*, 34(4):370-6.
2. Carvajal, W., Ríos, A., Echevarría, I., Martínez, M., Miñoso, J., Rodríguez, D. (2009). Body Type and Performance of Elite Cuban Baseball Players. *MEDICC Review*, 11(2): 15-20.
3. Derenne, C., Ho, K. W. & Murphy, J.C.J. (2001). Effects of general, special, and specific resistance training on throwing velocity in baseball: a brief review. *Journal of Strength & Conditioning Research,* 15(1):148-56.
4. Escamilla, R.F., Fleisig, G.S., Yamashiro, K., Mikla, T., Dunning, R., Paulos, L. & Andrews, J. R. (2010). Effects of a 4-week youth baseball conditioning program on throwing velocity. *Journal of Strength & Conditioning Research*, 24(12):3247-54.
5. Gray, R.(2009). A Model of Motor Inhibition for a Complex Skill: Baseball Batting. *Journal of Experimental Psychology*, 15 (2):91-105.
6. Hoshina, K., Tagami, Y., Mimura, O., Edagawa, H., Matsubara, M., & Nakayama T. (2013). A study of static, kinetic, and dynamic visual acuity in 102 Japanese professional baseball players. *Clinical Ophthalmology*, 627-632.
7. Lachowetz, T., Evon, J. & Pastiglione, J. (1998). The Effect of an Upper Body Strength Program on Intercollegiate Baseball Throwing Velocity. *Journal of Strength & Conditioning Research*, 12(2):116-119.
8. Lin, W.B., Tung, I.W., Chen, M.J. & Chen, M.Y. (2011). An analysis of an optimal selection process for characteristics and technical performance of baseball pitchers. *Perceptual and Motor Skills,* 113(1):300-310.
9. Nakata, H., Nagami, T., Higuchi, T., Sakamoto, K. I Kanosue, K. (2013). Relationship between performance variables and baseball ability in youth baseball players. Journal of strength and conditioning research, 27(10): 2887-2897.
10. Tomašić, M., Čavala, M., & Katić, R. (2012). Differences in morphologic characteristic and motor abilities of young male baseball players in relation to player's quality. In *4th International scientific conference Contemporary Kinesiology.*
11. Tomašić, M., Čavala, M., & Katić, R. (2014). Differences in morphological and motorical abilities between juniors and seniors in baseball. In *7th International Scientific Conference on Kinesiology* (p. 642).

INDICATORS OF SITUATIONAL EFFICIENCY OF *PPD ZAGREB* AND *MVM VESZPREM* HANDBALL PLAYERS IN REGULAR 2015. / 2016. *SEHA* LEAGUE SEASON

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Abstract

The players' situational efficiency parameters are important for experts, trainers and the club's coaching staff because the obtained results show the real situation and can be compared with the modal values. This paper is an analysis of some situational efficiency indicators of shots on goal variables from *Zagreb* and *Veszprem* handball players, who performed in the regular 2015. / 2016. *SEHA* league season. Each team played 18 games in as many rounds. Situational efficiency of shots on goal was analyzed with 10 variables. A multivariate analysis of variance showed no statistically significant differences between clubs, as was to be expected given that *Veszprem*, at the end of the regular season, ranked at 1. position, and *Zagreb* at 3. position. This analysis included only some parameters of situational efficiency. Presumably a further analysis, which would have more variables from the phase of attack, and take into account other aspects of game, would show the differences between the two clubs.

Key words: *team handball, seniors, regional league, technical elements, performance, analysis*

Introduction

Handball game (HG) is marked by various typical and atypical situations, therefore, there is a need for an objective registration of certain situations in the game, respectively parameters of situational efficiency of each player in the competition and situational conditions. By conducting appropriate statistics, we can reach indicators of situation efficiency during the HG, as well as the parameters that belong to the tactical responsibility, involvement, behavior and other (Vuleta et al., 2003). Each HG offers many options for registering large amounts of data suitable for interpretation regarding types and action quality of individual players and the team. Statistical analysis application in the process of modern training and competition in handball and other sports is important in multiple ways and indispensable for achieving top results. In order to analyze the HG, it is necessary to monitor and define a repertoire of technical and tactical activities during the game and register events based on certain situations in which a player is usually located. During the HG it is possible to note every successful and unsuccessful move of the individual, such as the number of shots on goal, number of goals, shot on goal percentage of realization, turnovers, technical mistakes, penalties, successful and unsuccessful goalkeeper's defense from all positions, from fastbreak, from penalties and more. In that way, we can get objective indications of status, respectively the players' and team's effectiveness. Based on such indicators the coach may well assess the contribution of individual players, groups of players, and the entire team (Gruić, 2006; Ohnjec, 2006).

The top athlete's pursuit is only victory. These requirements are precisely what inspired numerous studies. We can apply above facts to HG as well, where a lot of research was made on factors that have an impact on performance, and therefore the ultimate sports achievement as well (De Rose, Jr., 2004; Taborsky, 2008). Previous HG efficiency analyses can be divided into 3 directions of research. The 1. group represents research where a descriptive approach was used to analyze the frequency of various events during the HG, and the performance of different technical and tactical elements was recorded and analyzed (Vuleta & Šimenc, 1989; Czerwinski, 2000). Determining the difference between handball teams according to different criteria (victory or defeat, better or worse placement in competition or any other criterion) is the main approach in the 2. direction of research (Rogulj, 2000). The 3. group of research focused on impact determination of various standard performance indicators according to different criteria (Vuleta, 1997; Vuleta et al., 2005).

The aim of this study was to determine the situational efficiency of Zagreb and Veszprem handball players during the regular part of SEHA League in season 2015. / 2016. As an extra aim, a results comparison between handball players of both teams was made.

Methods

Sample of respondents

The sample consisted of two handball team players who played in the regular *SEHA* league season 2015. / 2016. During this season *SEHA* (*South East - European Handball Association*) league consisted of 7 handball federations (Belarussian, Bosnian and Herzegovinian, Croatian, Hungarian, Macedonian, Serbian and Slovakian). 10 clubs competed in that league (*MVM Veszprem, Vardar, PPD Zagreb, Meshkov Brest, Tatran Presov, Nexe, Vojvodina, Borac m: tel, Spartak Vojput, Max Strumica*).

Total number of respondents was 47. The physical characteristics of the *Zagreb* players (n = 24) were 25,7 ± 4,85 years (group means ± standard deviations); 193,29 ± 7,7 cm and 89,75 ± 10,11 kg, compared to *Veszprem* players (n = 23) who were 27,3 ± 6,48 years; 191,65 ± 8,16 cm and 90,82 ± 12,49 kg.

Data were collected by experts who observed this two clubs in 36 games. Eeach team played 18 games in as many rounds.

Sample of variables

Sample of 10 variables in this study consisted of situational efficiency shots on goal variables: *FSS* - field shots sucessfull (from the backcourt positions); *FSU* - field shots unsucessfull (from the backcourt positions); *LSS* - line shots successful (from the pivot position); *LSU* - line shots uncucessfull (from the pivot position); *SSS* - side shots sucessfull (from the wings' position); *SSU* - side shots unsucessfull (from the wings' position); *FBS* - fastbreak sucessful; *FBU* - fastbreak unsucessful; *7MS* - 7 meters sucessfull; *7MU* - 7 meters unsucessfull.

Data processing methods

Descriptive statistics (M, SD, Σ, %) were calculated (Table 1). Normality of variables was determined with the Kolmogorov-Smirnov test. A multivariate analysis of variance (MANOVA) was conducted for determining statistical significance of differences between clubs in 10 variables. A univariate analysis of variance (ANOVA) was made for insight into the contribution of individual variables difference. The level of significance was set at $p < 0.05$. All results and processed data are available on the official *SEHA* league website (www.seha-liga.com). The statistical analysis was performed with the software package *Statistic for Windows 12.0.* (*StatSoft, Inc*., Tulsa, OK, USA).

Results

Table 1: Descriptive parameters (M, SD, Σ , %) and results of the Kolmogorov-Smirnov test of normality of distribution (Max D, K –S p) for shots on goal variables

	ZAGREB	VESZPREM	Max D	K – S p	ZAGREB		VESZPREM		
	M ± SD	M ± SD			Σ	%	Σ	%	
FSS	6,96 ± 8,49	8,09 ± 12,76	0,18	p > .10	177/368	48	186/331	56	**FS**
FSU	7,96 ± 9,69	6,61 ± 10,03	0,27	p > .10	169/217	78	193/256	75	**LS**
LSS	7,04 ± 8,86	8,57 ± 12,93	0,12	p > .10	57/90	63	93/142	65	**SS**
LSU	2,00 ± 3,02	2,91 ± 3,98	0,04	p > .10	94/107	88	99/117	85	**FB**
SSS	2,42 ± 4,17	4,04 ± 8,43	0,08	p > .10	52/65	80	60/66	91	**7M**
SSU	1,63 ± 2,73	2,09 ± 4,45	0,16	p > .10					
FBS	3,88 ± 4,98	4,30 ± 5,93	0,07	p > .10					
FBU	0,54 ± 1,06	0,78 ± 1,31	0,00	p > .10	**549/847**	**65**	**631/912**	**69**	
7MS	2,17 ± 5,00	2,57 ± 7,49	0,20	p > .10					
7MU	0,54 ± 0,98	0,26 ± 0,75	0,20	p > .10					

Legend: M – mean; SD – standard deviation; Max D – maximum difference between the cumulative frequency variable and cumulative frequency expected for a normal distribution; K – S p – the smallest error with which the deviation of the distribution variables of normal distribution can be declared statistically significant according to the Kolmogorov - Smirnov test; Σ – ratio of goals (score / attempt); % – percentage of Σ; FSS – field shots sucessfull; FSU – field shots unsucessfull; LSS – line shots successful; LSU – line shots uncucessfull; SSS - side shots sucessfull; SSU – side shots unsucessfull; FBS – fastbreak sucessful; FBU – fastbreak unsucessful; 7MS – 7 meters sucessfull; 7MU – 7 meters unsucessfull; FS – field shots; LS – line shots; SS – side shots; FB – fastbreak shots; 7M – 7 meters shoots.

By examination of Table 1. and through analysis of basic parameters (M, SD), as well as by indicators of normality distribution according to the Kolmogorov-Smirnov test (Max D, K – S p), it can be determined that there are no variables that deviate from the normal distribution, respectively all 10 variables are normally distributed.

Table 2: Playing position efficiency of analyzed handball teams

SHOOTS	PLAYING POSITION					
	WINGS		PIVOTS		BACKCOURT ATTACKERS	
	ZG.	VE.	ZG.	VE.	ZG.	VE.
FS	16/34	9/23	4/7	2/6	157/327	175/302
LS	28/31	24/29	60/86	103/133	81/100	66/94
SS	55/86	85/128	1/1	1/3	1/3	7/11
FB	61/72	56/66	14/15	22/25	19/20	21/26
7M	41/51	38/40	0/0	2/3	11/14	20/23
Σ	**201/274**	**212/286**	**79/109**	**130/170**	**269/464**	**289/456**
%	**73%**	**74%**	**72%**	**76%**	**58%**	**63%**

Legend: FS – field shots; LS – line shots; SS – side shots; FB – fastbreak shots; 7M – 7 meters shoots; Σ – ratio of goals (scored / attempt); % – percentage of Σ; ZG. – *Zagreb*; VE. – *Veszprem*.

Table 2. presents the results of shooting on goal (score / attempt) in various situations with the percentage of efficiency, systematic under certain playing positions.

Table 3: MANOVA - multivariate differences between two handball teams for shots on goal variables

Effect	Multivariate Tests of Significante			
	Test	Value	F	p
Intercept	Wilks	0,34	7,07	0,00
Klasif	Wilks	0,69	1,58	0,15

Legend: Intercept – the value of free coefficient; F – F value statistics, p – significance level

Results from Table 3. indicate that there is no statistically significant difference between *Zagreb* and *Veszprem* handball players (Wilks = 0.69; F = 1.58; p 0.15).

Table 4: ANOVA - univariate differences between the two handball teams in the shots on goal variables

Dependent Variable	Test of SS Whole Model vs. SS Residual			
	Multi R	Multi R2	F	p
FSS	0,53	0,03	0,13	0,72
FSU	0,70	0,05	0,22	0,64
LSS	0,07	0,05	0,22	0,64
LSU	0,13	0,17	0,79	0,38
SSS	0,12	0,15	0,71	0,40
SSU	0,64	0,04	0,19	0,67
FBS	0,04	0,02	0,07	0,79
FBU	0,10	0,01	0,48	0,49
7MS	0,03	0,00	0,05	0,83
7MU	0,16	0,26	1,21	0,28

Legend: Multi R-correlation coefficient (beta); Multi-R2 coefficient of determination; F-F value statistics; p-level of significance; FSS - field shots sucessfull (from the backcourt positions); FSU – field shots unsucessfull (from the backcourt positions); LSS – line shots successful (from the pivot position); LSU – line shots uncucessfull (from the pivot position); SSS – side shots sucessfull (from the wings' position); SSU – side shots unsucessfull (from the wings' position); FBS – fastbreak sucessful; FBU – fastbreak unsucessful; 7MS – 7 meters sucessfull; 7MU – 7 meters unsucessfull.

A univariate analysis of variance was made to display the content of each variable to a statistically significant difference. The difference was not found in any of the analyzed shots on goal variables (Table 4.) It is evident that these variables do not present statistically significant differences between two analyzed handball teams.

Discussion

As expected, Table 1. shows that most shots on goal were from the field positions – FS (363 goals from 699 attempts). It is understood that field players are good shooters from the ground and from jump; they have a very good running start to the ball and they are equally dangerous from all three field playing positions (Malić and Dvoršek, 2011). Consequently, it is logical and expected that they make most shots due to their positioning on the field, they have the longest control time, the longest contact with the ball and then they can operate at optimal spatial positions (the central part of the handball court). That opens for them the best overview and the greatest shooting angle in relation to the opponent's goal. It can be concluded that the effectiveness from external positions was at a good level (48% *Zagreb*, 56% *Veszprem*). The good and quality of a team's game largely depends on the greater distance shooting efficiency from field position (Štimac et al., 2015).

From line position – LS, players (pivots) sent a total of 473 shots and achieved 362 goals. It is obvious (Table 2.) that field players and pivots cooperated very well together (725 goals out of 1180 goals). We can conclude that both teams designed their finish from field positions, but also from the line positions, as evidenced by a large number of shots from this very position (473 shots out of 1759 shots).

Wing players – SS, from side positions reached a total of 150 goals. The percentage of realization from *Zagreb* players was 63%, and for *Veszprem* players 65%, suggesting that the wing attackers were on a high level of realization. We can note the number of attempts by *Zagreb* players (90 shoots, compared with 142 shoots from *Veszprem* players) was too small, which is certainly not a characteristic of modern, fast handball. The big difference in the number of shots and scored goals from wing positions in favor of *Veszprem* players, suggests that the game was conceived on the fast passing of the ball, fast field players crossing and on creating extra attackers on side positions. A prerequisite for such a game style are top wing players whose quality and constant is often crucial for the final outcome of match.

From fastbreak – FB, players had 224 shots. *Zagreb* players had 10 attempts less and 5 goals less then *Veszprem* players. Observing the situations where fastbreak developed, whether in individual, group or collective form, which includes the players' spatial temporal advantage, we can conclude that the efficiency of 85% from *Veszprem* players, and 88% from *Zagreb* players, was on a very high level.

Gruić et al. (2006) analyzed handball teams at the World Cup for men and displayed the same hierarchy of shots on goal variables (1. fastbreak shooting; 2. line shooting; 3. side shooting; 4. field shooting). A similar analysis was performed by Ohnjec et al. (2008), when they observed 60 matches at the World Handball Championship for women, and obtained similar results (1. fastbreak shooting; 2. line shooting; 3. side shooting; 4. field shooting).

Penalty shots realization – 7M, was also a segment with a very high level of success by both clubs. *Zagreb* players were observed to have more unrealized penalty shots (*Zagreb* 52/65 = 80%; *Veszprem* 60/66 = 91%), which certainly contributes to the outcome of an individual match, and the final ranking on the competition table.

There was no statistically significant difference between two clubs in the observed variables. Results indicate that both teams achieve the expected result and qualified for the final stage of competition. *Zagreb* took 3. place in the rankings with a total of 42 points won. *Veszprem* at the end of the regular season, took 1. place in the rankings with a total score of 50 points. Top players perform for both teams, most of whom are internationals. On most playing positions for both clubs, there was an adequate substitute, which certainly should be considered, because the clubs also participated in other competitions (National Championship, National Cup, Champions League).

Conclusion

This paper is an analysis of some situational efficiency indicators of shots on goal variables from *Zagreb* and *Veszprem* handball players, who performed in the regular 2015. / 2016. *SEHA* league season. Each team played 18 HG in as many rounds. Situational efficiency of shots on goal was analyzed with 10 variables. A multivariate analysis of variance showed no statistically significant differences between clubs, as was to be expected given that *Veszprem*, at the end of the regular season, ranked at 1. position, and *Zagreb* at 3. position. This analysis included only some parameters of situational efficiency. Presumably a further analysis, which would have more variables from the phase of attack, and take into account other aspects of game, would show the differences between the two clubs. The players' situational efficiency parameters are important for experts, trainers and the club's coaching staff because the obtained results show the real situation and can be compared with the modal values. In each team's result interpretations, it is necessary to respect the fact that interpretations are determined by various factors, while the model of situational effectiveness varies from team to team in each game at different levels of competition (Gruić, 2006).

References

1. Czerwinski, J. (2000). Statistical analysis and remarks on the game character based on the European Championship in Croatia. *EHF Periodical*, 2, 10-18.
2. De Rose Jr., D. (2004). Statistical analysis of basketball performance indicators according to home/away games and winning and losing teams. *Journal of Human Movement Studies*, 39 (2), 85-104.
3. Gruić, I. (2006). Situacijska efikasnost muških rukometnih ekipa na Svjetskom prvenstvu u Portugalu 2003 (magistarski rad). Zagreb: Kineziološki fakultet.
4. Gruić, I., Vuleta, D., Milanović, (2006). D. Performance indicators of teams at the 2003 Men's World Handball Championship in Portugal. // *Kinesiology* : international journal of fundamental and applied kinesiology. 38; 164-175.
5. Malić, Z., Dvoršek, B. (2011). Rukomet-pogled s klupe. 2 izdanje. Zagreb: Hrvatska olimpijska akademija.
6. Ohnjec, K. (2006). Situacijska efikasnost ženskih rukometnih ekipa na Svjetskom prvenstvu u Hrvatskoj 2003. (Magistarski rad). Zagreb: Kineziološki fakultet.
7. Ohnjec, K., Vuleta, D., Milanović, D., Gruić, I. (2008). Performance indicators of teams at the 2003 World Handball Championship for Women in Croatia. // *Kinesiology* : international journal of fundamental and applied kinesiology. 40, 1; 69-79.
8. Rogulj, N. (2000). Differences in situation-related indicators of the handball game in relation to the achieved competitive results of teams at 1999 World Championship in Egypt. *Kinesiology*, 32(2), 63-74.
9. Štimac, I., Vuleta, V., Milanović, M. (2015). Analiza pokazatelja situacijske efikasnosti mladih hrvatskih rukometaša na Europskom prvenstvu u Turskoj 2012. godine. U Igor Jukić i sur. (ur.), Kondicijska priprema sportaša. Zbornik radova, Zageb, 27. - 28. veljače 2015. godine (str. 319-393). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu
10. Taborsky, F. (2008). Cumulative indicators of team playing performance in handball (Olympic Games Tournaments 2008). *EHF Periodical*.
11. Vuleta, D. (1997). Kineziološka analiza tehničkotaktičkih sadržaja rukometne igre. (Doktorski rad), Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu.
12. Vuleta, D., & Šimenc, Z. (1989). Analiza nekaterih kazalcev učinkovitosti igre mladinske rokometne reprezentance na VII. svetovnom prvenstvu. [Analysis of certain performance indicators of the youth handball national team at the 7th World Championship. In Slovenian.] *Trener*, Rokomet 1, 25(3/582), 3-42.
13. Vuleta, D., Milanović, D., & Sertić, H. (2003). The relationship between variables of shooting on goal with the final result in handball match of the European Champ. in 2000 for men. *Kinesiology, 35*(2), 168-183.
14. Vuleta, D., Milanović, D., Gruić, I., & Ohnjec, K. (2005). Influence of the goals scored on final outcomes of matches of the 2003 World Handball Championships for Men in Portugal. In D. Milanović & F. Prot (Eds.), Proceedings Book of the 4th International Scientific Conference on Kinesiology "Science and Profession – Challenge for the Future", Opatija, Croatia, 7-11 September, 2005 (pp. 470-473). Zagreb: Faculty of Kinesiology, University of Zagreb.

SELECTED FACTORS INFLUENCING THE SUCCESSFULNESS OF SHOOTING IN WOMEN'S BASKETBALL

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Abstract

The aim of this study is to identify the factors which may affect the shooting efficiency under the natural game conditions. Ten female U19 basketball players, 1st division of this age category, participated in this research. Monitoring of the heart rate (HR) and the shooting performance was done during 4 competitive games. 206 total field goal attempts were evaluated. The relation between the dependent variable (field goal shooting performance) and the independent variables (intensity of load, defensive pressure, ball possession duration, distance from the basket, individual game periods) was expressed by binary logistic regression. Two regression coefficients in the final model—the independent variables, i.e. defensive pressure and shooting distance—were statistically significant. We recommend to take into account these findings when preparing a shooting practice.

Key words: *Field goal shooting, defensive pressure, shooting distance, binary logistic regression*

Introduction

Performance analysis allows to better understand the structure of a sport performance and its subsequent development (O'Donoghue, 2010). In basketball, the performance analysis works as a tool to define the performance indicators in hands of the coaches. Based on these indicators they can develop a more effective training process (Hughes & Barlett, 2002).

One of the most important performance indicators, which determine the outcome of the game, is the field goal shooting (Ibañez et al., 2009). As well as the other performance indicators may be determined by certain factors, so can be the shooting performance. Erčulj & Supej (2009) state that with the higher intensity of load and with cumulated fatigue, the kinematic parameters of shooting were altered and thus the shooting successfulness from 7.24 m (3-point line in NBA) decreased. Significant changes in shooting appeared in the release angles of the individual upper-arm segments. The difference in kinematic parameters of shooting with defender, when compared to the shooting without the defender, was noted in a study by Rojas et al. (2000)—the release angle of the ball increased along with the postural adjustment (increased angles at the knees and shoulders) and the flight time of the ball was reduced. Miller & Bartlett (1996) and Okazaki & Rodacki (2012) confirmed an assumption that with the increasing horizontal distance from the basket, the decrease in shooting successfulness is statistically significant. However, all these studies present the impact of the chosen factors on the shooting performance under artificially created conditions. The influence of defensive pressure on the shooting performance, under natural game conditions, was studied by Csataljay et al. (2013). More significant defensive pressure (reduced distance between the offensive and defensive player) led to the decrease in shooting effectiveness.

Álvarez et al. (2009) and Erčulj & Štrubmelj (2015) pointed out the importance of the other contextual factors (e.g. type of defense, offense time, etc.) which may influence the frequency and successfulness of shooting. Therefore, the aim of this study is to identify the factors which may affect the shooting efficiency under the natural game conditions.

Methods

Participants

Ten female U19 basketball players, 1st division of this age category, participated in this research. There were 3 forwards, 3 point guards and 4 centers. The average age of these players was 17.6 ± 1, the average height was 179.4 ± 6.2 cm and the average weight 62.9 ± 5.3 kg. Participants trained 4–6 times a week and every other weekend played 2 games in their age category. The research was carried out in accord with the Declaration of Helsinki and all participants (or their legal representatives) signed the informed consent.

Procedure

The participants ran the beep test (Léger et al., 1988) at the appointed maximal heart rate (HR_{max}). Monitoring of the heart rate (HR) and the shooting performance was done during 4 competitive games. All games were played under FIBA 2012/2013 rules and were recorded on digital camera HG10 (Canon Inc., Tokyo, Japan). For the notational analysis the software Dartfish TeamPro 6.0 (Dartfish, Fribourg, Switzerland) was used. To evaluate the shooting performance, the players had to be active for at least 10 minutes of the live time and in both game halves. The influence of the independent variables (intensity of load, defensive pressure, ball possession duration, distance from the basket, individual game periods) on the dependent variable (field goal shooting performance) was monitored in retrospection.

206 total field goal attempts were evaluated. The intensity of load was determined form the % of HR_{max}. Because of the intermittent nature of the intensity of load, each field goal attempt was assigned mean value of HR (from -5 to +10 seconds since the release of the ball). To monitor the HR the telemetric system Suunto Team was used and to process the data the software Suunto Training Manager (Suunto Oy, Vantaa, Finland) was employed. Subsequently, each field goal attempt was categorized to one of the 3 intensity of load zones (Ben Abdelkrim et al., 2010). The defensive pressure was set, based on Álvarez et al. (2009) and Gómez et al. (2015), to the low/none, moderate or high. The ball possession duration was divided into 3 parts: 0–8 s, 9–16 s, and 17–24 s. Furthermore, 3 horizontal distances from the basket were measured: <2.5 m, 2.5–6.75 m, and >6.75 m. Period in which individual field goal attempts were attempted was also noted. If the player was fouled in the shooting, the field goal attempt was considered effective (Gómez et al., 2015).

Statistical Analysis

The relation between the dependent variable (field goal shooting performance) and the independent variables (intensity of load, defensive pressure, ball possession duration, distance from the basket, individual game periods) was expressed by binary logistic regression (Landau & Everitt, 2004). It means that the dependent variable gained only two values, 0 or 1. In this case 0 represents successful shots and 1 unsuccessful shots. The regression coefficients were estimated utilizing the maximum likelihood estimation method. To interpret the parameters of the model of the logistic regression the odds ratios (OR) and their 95% confidence intervals were calculated. Backward stepwise selection, which describes the data better, was used to find the desired model of the logistic regression. The models of the logistic regression were compared employing the likelihood ratio test. The statistical significance of the regression coefficients was verified by Wald's test. Reference category was chosen as the first option in the succession of the independent variables. All statistical tests were evaluated on the level of statistical significance $\alpha = 0.05$. Statistical software IBM SPSS Statistics 24 (IBM Corp., New York, USA) was used to compute these tests.

Results and discussion

The distribution of the relative frequencies of the individual variables in all 4 games is presented in Tab. 1. The final model of the binary logistic regression was computed by backward stepwise selection method. Saturated model with all predictors was eliminated by nonsignificant predictor in each step. Statistical significance of each regression model was verified by likelihood ratio test. Saturated model with all five predictors was reduced by about 3 predictors in 4 steps. Wald's test showed statistical significance of two regression coefficients in the final model—the independent variables, i.e. defensive pressure and shooting distance. Standardized beta weights (B), standard error of the estimate (SE), values of Wald's test (Wald), statistical significance of regression coefficients (p value), and odds ratio (Exp(B)) and the 95% confidence intervals (CI) are presented in Tab. 2. If the shooting is performed under high defensive pressure the chance for field goal missed increases 4.085 times when compared to shooting under low defensive pressure, ceteris paribus. If the field goal is attempted from the middle range distance (2.5–6.75 m) then the chance for unsuccessful shot is 5.214 times higher than from short range distance (<2.75 m), ceteris paribus. If shooting from long range distance (>6.75), then the chance for unsuccessful shot is 4.493 times higher than from short range distance (<2.75 m), ceteris paribus.

Table 1: Frequencies of the individual variables

Variable	Description	Frequency [n]	Percent [%]
Dependent variable			
Shooting performance	Successful	99	48.1
	Unsuccessful	107	51.9
Independent variables			
Defensive pressure	Low	112	54.4
	Moderate	61	29.6
	High	33	16
Ball possession duration	0–8 s	105	51
	9–16 s	83	40.3
	17–24 s	18	8.7
Intensity of load	<85% of HR_{max}	25	12.1
	85-95% of HR_{max}	145	70.4
	>95% of HR_{max}	36	17.5
Shooting distance	<2.5 m	140	68
	2.5–6.75 m	43	20.9
	>6.75 m	23	11.2
Period	1st	61	29.6
	2nd	49	23.8
	3rd	53	25.7
	4th	43	20.9

Table 2: Variables in the final model

		B	SE	Wald	df	p value	Exp(B)	95% CI for Exp(B)	
								Lower	Upper
Step 4	Defensive pressure			20.106	2	0			
	Defensive pressure(1)	-0.694	0.415	2.797	1	0.094	0.5	0.222	1.127
	Defensive pressure(2)	1.57	0.5	9.848	1	0.002*	4.805	1.803	12.808
	Shooting distance			15.566	2	0.000*			
	Shooting distance(1)	1.651	0.459	12.941	1	0.000*	5.214	2,12	12.821
	Shooting distance(2)	1.503	0.558	7.254	1	0.007*	4.493	1,506	13.411
	Constant	-0.461	0.293	2.479	1	0.115	0.631		

* Statistically significant

As s in Okazaki & Rodacki (2012) and Miller & Bartlett (1996), we may also state that the shooting distance is a statistically significant predictor of shooting successfulness. These authors verified this statement under artificial conditions but in our case we demonstrated, as Gómez et al. (2015), that shooting distance was also a predictor in the actual game. This study, as Csataljay et al. (2013), confirms the influence of high defensive pressure on shooting successfulness. Ball possession duration, period and intensity of load are factors which do not affect the shooting performance. Vencurik (2015) also proves that the intensity of load is an insignificant factor. On the other hand, we believe that also other contextual factors are necessary to include for the analysis of shooting successfulness. Our recommendation, as in Erčulj & Štrumbelj (2015), is to include, e.g. the type of defense, score difference, loss or win, etc.

Conclusion

Based on this study, we recommend to practice shooting under high defensive pressure and from all horizontal distances to increase the shooting performance. Nevertheless, analysis of thousands of field goal attempts under the actual game conditions is needed to reach more generally applicable conclusions.

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References

1. Álvarez, A., Ortega Toro, E., Salado, J., & Gómez, M. Á. (2009). Study of the defensive performance indicators in peak performance basketball. *Revista de Psicología del Deporte*, *18*, 0379-384.
2. Ben Abdelkrim, N., Castagna, C., Jabri, I., Battikh, T., Fazaa, S.E. & Ati, J.E. (2010). Activity profile and physiological requirements of junior elite basketball players in relation to aerobic-anaerobic fitness. *Journal of Strength and Conditioning Research*, *24*(9), 2330-2342.
3. Csataljay, G., James, N., Hughes, M. & Dancs, H. (2013). Effects of defensive pressure on basketball shooting performance. *International Journal of Performance Analysis in Sport*, *13*(3), 594-601.
4. Erčulj, F. & Supej, M. (2009). Impact of Fatigue on the Position of the Release Arm and Shoulder Girdle over a Longer Shooing Distance for an Elite Basketball Player. In *Journal of Strength and Conditioning Research*, *23*(3), 1029-1036.
5. Erčulj, F., & Štrumbelj, E. (2015). Basketball Shot Types and Shot Success in Different Levels of Competitive Basketball: e0128885. *PLoS One*, *10*(6).
6. Gómez, M., Alarcón, F., & Ortega, E. (2015). Analysis of shooting effectiveness in elite basketball according to match status. *Revista de Psicologia del Deporte*, *24*(3), 37-41.
7. Hughes, M. D., & Bartlett, R. M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, *20*(10), 739-754.
8. Ibáñez, S.J., García, J., Feu, S., Lorenzo, A. & Sampaio, J. (2009). Effects of consecutive basketball games on the game-related statistics that discriminate winner and losing teams. In *Journal of Sports Science and Medicine*, *8*(3), 458-462.
9. Landau, S., & Everitt, B. (2004). *A handbook of statistical analyses using SPSS*. Boca Raton: Chapman & Hall/CRC.
10. Léger, L.A., Mercier, D., Gadoury, C. & Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences*, *6*, 93-101.
11. Miller, S. & Bartlett, R. (1996). The relationship between basketball shooting kinematics, distance and playing position. In *Journal of Sports Sciences*, *14*, 243-253.
12. Okazaki, V.H.A. & Rodacki, A.L.F. (2012). Increased distance of shooting on basketball jump shot. In *Journal of Sports Science and Medicine*, *11*, 231-237.
13. O'Donoghue, P. (2010). *Research methods for sports performance analysis*. London: Routledge.
14. Rojas, F. J., Cepero, M., Ona, A., & Gutierrez, M. (2000). Kinematic adjustments in the basketball jump shot against an opponent. *Ergonomics*, *43*(10), 1651-1660.
15. Vencurik, T. (2015). Can the intensity of game load affect the shooting performance in basketball? *Journal of Human Sport and Exercise*, *11*(Proc1), 201-206.

DIFFERENCES BETWEEN WINNING AND DEFEATED HANDBALL TEAMS IN COMPETITION PERFORMANCE INDICATORS

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Summary

The aim was to find out differences between the winning and defeated women and men's handball teams in game performance indicators. The sample of entities was comprised of 60 winning (30 men's and 30 women's) teams and 60 defeated (30 men's and 30 women's) teams participating in the preliminary round of the handball tournament at the London Olympic Games in 2012. Seventeen variables were occurrence frequencies of both the completed and unsuccessfully executed technical-tactical elements of finishing actions in attack and defence. Canonical discriminant analysis was used to establish the differences between the winning and defeated teams in game performance indicators. The significant differences were obtained in six variables. The winning teams scored significantly higher in the following variables: fast-break shot scored (p=.01), long range (9-line) shot scored (p=.02), short range (6m-line) shot scored (p=.04), and in one variable of play in defence: blocked balls/shots (p=.03), whereas the defeated teams scored higher in the breakthrough shot scored (p=.01) and long range (9-line) shot missed (p=.03). These differences contributed significantly to the match final outcome. The applied system of handball game performance indicators was proven good in explaining the differences between the winning and defeated men and women's handball teams and, consequently, in explaining the determinants of match final outcomes.

Key words: *handball, competition performance, men's handball, women's handball, canonical discriminant analysis, 2012 Olympic Games*

Introduction

Objective indicators of game performance or situation-related efficiency of players and teams provide optimal opportunities to rationally assess players' fitness and preparedness for the match played as well as their individual contribution in the certain phases of the game.

Within research of numerous technical-tactical (TE-TA) elements of handball game with winning and defeated men's teams (Czerwinski, 1998; Rogulj, et al., 2011., Foretić, i sur., 2011; Hianik, 2011; Skarbalius, 2011; Vuleta, et al., 2009, 2011, 2015) it has been established that the winning teams perform much more short-lasting attacks (fast-breaks and counter-attacks) against the not yet consolidated defence, which are usually finished by breakthroughs or open realization from the 6m-line. Contrary, the defeated teams perform more positional intermittent attacks against consolidated defence, due to which they are usually forced to overlong their TE-TA activities in attack.

Research of handball game with winning and defeated women's teams (Yamada, Aida, Fujimoto, & Nakagawa, 2014; Taborski, 2013; Varbanov, 2013; Ohnjec, et al., 2008; Hianik, 2007; Vurgun, Işik, Şahan, & Işik, 2014) has revealed statistical significance of the number of scored long range shots, performed by backcourt players, and of the number of short range shots (performed from the wing and pivot positions) for the match final outcome.

The aim of this research was specific since our goal was to determine the presupposed differences between the winning men and women's handball teams and defeated men and women's handball teams, the participants of the Olympic handball tournament in London in 2012, in the indicators of their game performance or situation-related efficiency. In this way we expected to provide an answer to the question which variables of game performance differentiated the most between the winning and defeated handball teams.

It was hypothesized that:

H1 – the statistically significant difference exists between the winning and defeated women and men's handball teams in game performance indicators;

H2 – the contribution of individual variables to either victory or defeat in handball matches is variable.

Methods

The sample of entities consisted of 30 men's and 30 women's handball matches (which gave a total of 60+60 opponents) played during the preliminary round (group phase) at the 2012 Olympic Games in London. By 12 national handball teams competed in the men's and women's parts of the handball tournament.

In our study we used data collected from altogether 60 handball matches played by 120 opposing team participants. The total number of 120 entities was big enough, under the established number of degrees of freedom, to allow for testing of the specified hypotheses.

The sample of variables consisted of occurrence frequencies of completed and attempted TE-TA elements of actions performed during handball games in the phases of defence and attack. These data were objective recordings of teams' situation-related efficiency indicators (notation analysis; game statistics). The data were compiled from the IHF official statistics data, published on the IHF official internet site at www.ihf.info/. Most variables (14 out of 17) were numerical indicators of game performance in attack, whereas the rest of three indicators of TE-TA activities referred to play in defence.

Canonical discriminat analysis was used to establish the differences between the winning and defeated men and women's handball teams in game performance variables. Statistical significance of global differences between the two groups of teams was tested using the Burttlet's χ^2-test. The level of statistical significance was set at p=.05.

Results

Table 1: Discriminant analysis of the winning and defeated teams' play as manifested in handball game performance (situation-related effectiveness) indicators

df	λ	Rc	Wilks' λ	χ^2	df	p
1	1.14	0.73	0.47	77.87	17	0.00

Note: DF – number of discriminant functions; λ – variance of the discriminant function; Rc – coefficient of canonical discrimination; Wilks' λ – Wilks' lambda; χ^2 test – Burttlet's Chi-square test; df – degrees of freedom; p – error of statistical inference.

The obtained canonical discriminat function (Table 1) differentiated between the groups of winning and defeated teams at the 0.01 (p<.01) significance level together with a high coefficient of canonical discrimination (Rc=.73). Such a high coefficient of thee Burttlet's χ^2-test of canonical discrimination suggests a globally significant difference between the analysed groups of handball teams in the game performance indicators. Victory in handball game depends on a specific structure of TE-TA actions in attack and defence which are finished by the performance of only limited number of TE-TA elements. Performance of these finishing actions can be expressed as situation-related efficiency or game performance indicators of play in defence and attack. A research question arises here: Which game performance indicators are we talking about here?

Table 2: Discriminant analysis of the differences between the winning and defeated men and women's handball teams in game performance indicators

	Mean WINN.	SD WINN.	MAX D WINN.	Mean DEFT.	SD DEFT.	MAX D DEFT.	F-remove (1,101)	p-value	FACT. STR.	STAND. COEFFIC. CAN. VAR.
ŠUT6MUS	5.20	2.51	0.14	4.68	2.62	0.15	4.48	***0.04****	0.28	**0.46**
ŠUT6MNE	2.30	1.63	0.24	1.73	1.67	0.17	1.27	0.26	-0.05	-0.18
ŠUTKRUS	4.03	2.04	0.20	3.83	1.96	0.16	2.42	0.12	0.19	0.26
ŠUTKRNE	3.35	1.39	0.19	2.95	1.71	0.20	1.62	0.21	-0.05	-0.20
ŠUT9MUS	7.73	3.03	0.09	6.70	3.10	0.13	5.43	***0.02****	0.15	**0.45**
ŠUT9MNE	11.67	5.53	0.14	11.95	4.26	0.10	4.87	***0.03****	-0.54	**-0.40**
ŠUT7MUS	2.47	1.52	0.16	2.73	1.93	0.15	0.05	0.83	0.06	-0.04
ŠUT7MNE	0.80	0.86	0.22	1.05	1.14	0.26	1.42	0.24	-0.20	-0.19
ŠUTKOUS	4.15	2.79	0.13	4.05	2.49	0.15	6.45	***0.01*****	0.46	**0.49**
ŠUTKONE	1.30	1.17	0.24	1.37	1.37	0.22	1.21	0.27	0.01	-0.17
ŠUTPRUS	2.63	1.68	0.15	3.17	2.04	0.18	6.40	***0.01*****	0.24	**0.41**
ŠUTPRNE	1.18	1.35	0.23	1.38	1.30	0.22	3.51	0.06	0.10	0.31
ASISTEN	13.52	5.24	0.10	12.62	3.98	0.15	0.30	0.59	0.41	-0.12
IZGULOP	12.58	4.04	0.08	15.88	5.08	0.13	0.06	0.80	-0.22	-0.05

OSVOLOP	4.00	2.14	0.16	4.62	2.31	0.13	2.60	0.11	0.26	0.26
BLOKLOP	2.87	2.65	0.14	2.52	1.73	0.21	4.71	***0.03****	0.25	**0.34**
2 MINISK	4.07	1.85	0.16	3.10	1.87	0.15	0.64	0.43	0.11	0.13

K-S test=0.17

Note: N – sample of entities, Mean – arithmetic mean, SD – standard deviations, K-S p – significance of the Kolmogorov-Smirnov's test of distribution normality, λ – variance of the discriminant function, p – error of statistical inference or F-remove – level of significance, FACT. STR. – factorial structure of significant discriminant functions, STAND. COEFFIC. CAN. VAR. – standardized coefficients of canonical variables. ŠUT6MUS – short range (6m-line) shot scored; ŠUT6MNE – short range (6m-line) shot missed; ŠUTKRUS – wing shot scored; ŠUTKRNE – wing shot missed; ŠUT9MUS – long range (9m-line) shot scored; ŠUT9MNE – long range (9m-line) shot missed; ŠUT7MUS – 7m-throw scored; ŠUT7MNE – 7m-throw missed; ŠUTKOUS – fast-break shot scored; ŠUTKONE – fast-break shot missed; ŠUTPRUS – breakthrough shot scored; ŠUTPRNE – breakthrough shot missed; ASISTEN – assists; IZGULOP – turnovers; , OSVOLOP – steals (ball won); BLOKLOP – blocked balls/shots; 2 MINISK – 2-minute suspensions.

Kolmogorov-Smirnov test revealed that most variables (more than 67% of them) met the criterion of distribution normality at the significance level of 95% (MaxD<Test).

Out of 17 variables utilized in this research, in six of them statistically significant differences were established between the winning and defeated women and men's handball teams in the game performance indicators. These were variables from play in attack: fast-break shot scored (p=.01), breakthrough shot scored (p=.01), long range (9-line) shot scored (p=.02), long range (9-line) shot missed (p=.03), short range (6m-line) shot scored (p=.04), and one variable of a defensive action: blocked balls/shots (p=.03).

Similar findings were presented in the study on the winning and defeated teams by Foretić and colleagues (2011) for the following variables: attack realization from the 6m-line, long range (9m) shooting efficiency, the number of the blocked shots/balls, 7m-throw efficiency, and turnovers.

Discussion

The winning teams are on average more successful in realizations from counter-attacks (ŠUTKOUS) (4.15) than the defeated teams (4.05), whereas the defeated teams are more successful in realizations from breakthroughs (ŠUTPRUS) (3.17) than the winning teams (2.63), both men and women. Also, the winners were more successful in the finishing long range shots (ŠUT9MUS) (7.73) than the defeated teams (6.70), whereas the latter had more unsuccessful long range shots (ŠUT9MNE) (11.95) than the former (11.67).

The results indicate that male and female winning teams attempt and score far more shots from fast-breaks/counter-attacks (ŠUTKOUS), meaning that counter-attacks should be considered a key, most often group, TE-TA activity of successful teams, that is, the winners. It is in accord with previous research which demonstrated an average of 6-7 successful counter-attacks, which was enough to ensure victory in a handball match. The number of scored both the long range (ŠUT9MUS) and short range shots (ŠUT6MUS) suggests that successful men and women's handball teams utilize appropriate tactical systems of play in attack and that they are good, from the aspect of tactics, in decision-making when to take long range shots as well as those from the 6m-line. It speaks in favour of tactical balance and cooperation between the line (pivot and wings) and backcourt players.

In contemporary handball, as obvious from the findings of the current research and previous analyses of various forms of tactical activities, a very high degree of efficient shooting on goal can be registered. This claim refers equally to fast-break shots (ŠUTKOUS), long range shots (ŠUT9MUS), and short range or line shots (ŠUT6MUS). Therefore, these three variables of situation-related efficiency appear to be the crucial factors in securing the positive outcome of a handball match.

The winning men and women's teams blocked more shots (BLOKLOP) than the defeated teams in the phase of defence. This indicates that the winners managed to select the most suitable defensive system and applied the best variant of play in defence, which allowed them to prevent potentially dangerous shots and deny the opponents from scoring. Also, in that way (BLOKLOP) the winners created favourable preconditions for the organization and performance of their fast-breaks and counter-attacks. The variables that describe play of the winning teams demonstrated, in the simplest way, how close are play in defence and play in attack interwoven in handball.

The defeated men and women's teams made significantly more successful shots from breakthroughs (ŠUTPRUS), but also executed more unsuccessful long range shots (ŠUT9MNE). The explanation for this lie in the lower capacity of their backcourt players (as demonstrated by a higher rate of unsuccessful long range shots) due to which less successful teams tend to finish their attacks by breakthroughs.

Finally, analyses of game performance of the winning and defeated men and women's handball teams indicate that play of winners is characterized predominantly by the variables of efficient play in attack in terms of quick, successful realizations from counter-attacks and successful closers of attack actions, in which a strict long-range shot selection is obvious as well as a higher number of assists to the line players. The winners are also superior in defence, as can be seen in the number of blocked shots, thus demonstrating importance of that defensive segment or TE-TA element of play.

Conclusions

On the sample of 30 men's and 30 women's matches, played at the 2012 Olympic Games' handball tournament, the statistically significant differences were established between the winning and defeated men and women's teams in the variables of game performance. The winning teams had a higher number of scored goals from counter-attacks (ŠUTKOUS), long range shots (ŠUT9MUS), and 6m-line shots (ŠUT6MUS). They also blocked more shots (BLOKLOP). The defeated teams performed more successful shots from breakthroughs (ŠUTPRUS) and more unsuccessful long range shots (ŠUT9MNE).

Evidently, the applied system of variables managed to explain the role of technical-tactical skills' performance in the differentiation between successful and not so successful handball teams, that is between the winning and defeated teams.

Literature

1. Czerwinski, J. (1998). Statistical analysis of the men's European Championship held in Italy in 1998. *European Handball*, 2, 10-18.
2. Foretić, N.; Rogulj, N.; Srhoj, V.; Burger, A., & Rajković, K. (2011) Differences in situation efficiency parameters between top men and women handball teams. In 2011 EHF Scientific Conference "*Science and Analytical Expertise in Handball*" (pp. 243-247). Vienna.
3. Hianik, J. (2011). The team match performance indicators and their evaluation in handball. In 2011 EHF Scientific Conference "*Science and Analytical Expertise in Handball*" (pp. 252-256). Vienna.
4. Ohnjec, K., Vuleta, D., Milanović, D., & Gruić, I. (2008). Performance indicators of teams at the 2003 World Handball Championship for women in Croatia. *Kinesiology*, *40*(1), 69-79.
5. Rogulj, N., Foretić, N., & Burger, A. (2011). Differences in the course of result between the winning and losing teams in top handball. *Homo Sporticus*, *13*(1), 28-33.
6. Skarbalius, A. (2011). Monitoring sport performance in handball. In 2011 EHF Scientific Conference "*Science and Analytical Expertise in Handball*" (pp. 325-330). Vienna.
7. Taborsky, F. (2013). The comparison of cumulative indicators of team playing performance between genders: Olympic Games handball tournaments 2008 and 2012. In Proceedings of the *2nd EHF Scientific Conference* "Women and Handball – Scientific and Practical Approaches", Vienna, 22nd-23rd November, 2013 (pp. 13-18). Vienna: European Handball Federation.
8. Varbanov, I. (2013). Tendencies in modern handball affecting women's teams after the Olympic Games in London and the European Championship 2012. In Proceedings of the *2nd EHF Scientific Conference* "Women and Handball – Scientific and Practical Approaches", Vienna, 22nd-23rd November, 2013 (pp. 288-294). Vienna: European Handball Federation.
9. Vuleta, D., Milanović, D., & Sporiš, G. (2015). Indicators of situational efficiency of winning and defeated male handball teams in matches of the Olympic tournament 2012. *Acta Kinesiologica*, *9*(1), 40-49.
10. Vurgun, H., Işik, T., Şahan, C., & Işik, O. (2014). Technical analysis of 2012 female Europe Championship and Olympiad Games – Handball performances. *The Online Journal of Recreation and Sport*, *3*(1), 41-47.
11. Yamada, E., Aida H., Fujimoto, H., & Nakagawa, A. (2014). Comparison of game performance among european national women's handball teams. *International Journal of Sport and Health Science*, *12*, 1-10.

ANALYSIS OF SITUATIONAL EFFECTIVENESS OF WINNING AND LOSING TEAMS AT THE 2014 VOLLEYBALL WORLD CHAMPIONSHIP

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Abstract

Purpose: The primary aim of the research is to analyze the situational effectiveness of volleyball teams at the World Championship in Poland 2014 and compare the winning and losing teams. The secondary aim of the research is to determine in which volleyball skills the winning and losing teams differ and which singular skills have the greatest effect on the outcome of the game in matches played in three, four or five sets.

Methods*:* For the purpose of this study 103 matches were analyzed. The first group of participants, in this case matches, are 46 matches that ended in 3:0 while the second group are 35 matches that ended in 3:1 and 22 matches that ended in 3:2. The results were analyzed using the variables of situational effectiveness and the data were downloaded from the website fivb.org. The Wilcoxon signed-rank test, which is appropriate for comparing two related samples, was used for determining the statistical significance of the difference between the winning and losing team based on the indicators of situational effectiveness. In addition to the analysis of statistical significance, an analysis was conducted on the effect size of the yielded differences using the ratio of the z-factor and square root of the number of observations.

Results: The differences in the indicators of situational effectiveness between the winning and the losing teams in the matches that ended in 3:0 and 3:1 are statistically significant in almost all variables, which suggests a difference in the qualitative relationship between the two teams, while in the matches that ended in 3:2 there is a statistically significant difference in the variable KB − the victory block, and variable SERVE TOT − the total number of serves.

Conclusion: From the aforementioned it can be concluded that in the matches ending in 3:2 the teams are pretty equal in their performance and situational effectiveness. However, the main distinguishing variable between the teams is KB − the victory block − and it has the greatest influence on the outcome of the game, winning or losing.

Key words: *situational effectiveness, differences, volleyball skills, success*

Introduction

The observation and collection of information during the match on the performance of technical - tactical elements and their impact on winning the points at the end of action is extremely important to the coach on which basis he creates the current tactical solution and reaches the organization's strategy of attack or defense in the game (Lobietti et al., 2010, Marcelino and al., 2010, Miskin et al., 2010, Palao and al., 2005, Zetou et al., 2007). The success of the team results in winning and depends on situational effectiveness of technical - tactical elements of volleyball, (Đurković, et al., 2009, Costa et al., 2012). Based on data collected coach may plan and program the training to improve the performance of individual elements or increase situational efficiency during the game, (Peña, Guerra, Buscà and Serra, 2013). The structure of volleyball can be divided into two complexes in which a particular technical - tactical elements of the game dominate. ***Complex 1*** includes game in which the team receives a service, after successful reception follows the rise for the smash in the attack and the complex ends by smash in the attack. ***Complex 2*** contains other elements: serve, block, field defense, lifting for the smash in the counterattack and smash in the counterattack (Selinger, 1986, Marelić, 1998, Rešetar, 2011). Since winning the points is a prerequisite for winning, there are no defense tactics in volleyball (Janković and Marelić, 1995), therefore, the technical elements and their performance in complex 1 and 2 are equally important (Eom and Schuttz, 1992), actually the efficiency in one complex depends on the quality of performance in the previous (Bergeles et al., 2010). For successful planning and programming of training in order to increase situational efficiency and to perfect performance of technical - tactical elements of volleyball, it is necessary to analyze the best teams and their performances in major competitions on which basis it can be established a model of the game that can be an important predictor of success. That is why this study analyzed matches of the World Volleyball Championships for men in Poland in 2014. Data processing included all matches in the competition, a total of 103 matches with a final score of 3:0, 3:1 and 3:2. It is expected that there are differences in performance between winning and losing teams, but the question is in which skills winning and losing team are different in matches that end with a win in three, four or five sets, and what is the main differentiator variable, a skill that has the highest impact on the prediction of success in the game. Based on the results opponents and their game can be analyzed and set tactical solutions and strategy of game based on the quality of performance of technical elements (Janković and Marelić, 1995). However, some studies (Bergeles et al., 2009, Buscà and Febrer, 2012) proved that with the top players and teams, the error in some skills may indicate a higher level of risk taken in the game than the bad technical performed volleyball skills.

Methods

Examinees sample

For the purpose of research, the present study analyzed 103 matches from the World Volleyball Championships for men in Poland in 2014. This paper specially analyzed the games with different outcome in the number of sets played, 46 games with a final score of 3:0, 35 games with a final score of 3:1 and 22 games played in five sets and the final score of 3:2. The number of samples with respect to the number of matches in the first group with 46 matches has 92 samples because two teams played in one game, the winning and the losing and so were analyzed. In the second group with 35 matches a sample is consisted of 70 examinees or teams and the third group with 22 games and 44 examinees, which provides a total number of 206 examinees or teams throughout the study.

Variables sample

Data on situational efficiency of teams in the World Volleyball Championships for men in Poland in 2014 are taken from the official website of the World Volleyball Federation, FIVB. For the study 12 basic variables were used that describe the situational efficiency in the game and 4 auxiliary or control variables. The basic variables on which the data processing is based are: S - smash, which won points for the team that smashes, SF - smash fault in which the team loses a point, S TOT - total number of smashes in the match, KB - winning block in which the team wins the point, BF - fault of block in which the team loses a point, AS - a service where a team wins the point by service, SERVE F – fault of service and a direct loss of points, SERVE H - successful service in the field of opponents, D - a successful defense with prerequisites of success in the organization of counterattack, DF – fault in the defense and the loss of point, ER - excellent reception of service with good preconditions of organization attacks, FR - fault at reception and loss of point. The variables are additionally marked with a 0 for losing teams and with 1 for the winning teams so to differ S1 - smash, which won points for the team that smashes, winning, and S0 - smash, which won points for the team that smashes, defeated in this study. Auxiliary or control variables in the study are BLOCK TOT - total block attempts, SERVE TOT - total number of services, DIG TOT - total number of balls played in defense and REC TOT - total number of service receptions.

Statistical data processing

Statistical analysis was performed using the computer program Excel and SPSS 20. Determining the statistical significance of the difference between the winning and losing team on indicators of situational efficiency was conducted by Wilcoxon signed-rank test that is appropriate to compare two dependent groups of results. With the analysis of statistical significance (which depends among other things on the number of observations), effect size analysis of obtained differences by method of the ratio of the z-value and the square root of the number of observations is also carried out (Field and Hole, 2003).

Results and discussion

The results of the winning and losing teams vary according to the expected pattern and the result at the end of the game. The winning teams have achieved better results in all variables of situational efficiency except in variable SERVE F - fault of service. The study (Bergeles et al., 2009, Buscà and Febrer, 2012) proved that for the top players and teams, the fault in some skills may indicate a higher level of risk taken in the game than the bad learned and implemented volleyball skills. The winning teams have achieved higher number of successful smashes and fewer mistakes in smashing which is associated with excellent reception of service for the setter (Nishijima et al., 1987). A good grip allows faster and more diversified attack to defense, which is not well-set (Đurković, et al., 2009), and the winning teams had more successful receptions and fewer faults in reception. With this in mind we can say that a better and more accurate reception allows more different tactical variations that are directly related to the success of the smasher. Successful smash as final shot is influenced by a series of technical - tactical factors (Jankovic and Marelić, 1995). High situational efficiency, quality of smash performance and reception of services are factors that lead to winning (Marelić et al., 2004). In this case the setter has several options of attack combinations which increases the success of smashing, while reducing the possibilities of successful implementation of the winning bloc and successful defense of the opposing team. The winning teams achieved better results in the implementation of blocking the opponent's attack which wins a point, and a small number of faults in blocks which lose points. The success of blocking the attack depends on the quality of service. Good service can slow down and anticipate the opponent's attack which increases the performance of blocking. The high number of points scored after the block indicates that the losing teams have worse reception of service while the winning teams have a successful service, as evidenced by the results of our research. Previous researches have shown that the number of the winning blocks is the factor that strongly differentiates the winning and the defeated teams, but also points to the large number of faults for teams of lower quality (Hayrinen and al. 2004). The difference between winning and losing teams decreases with increasing the number of sets played. When the game ends in a score of 3:0 or 3:1 it is expected that the teams have significantly different qualitative values and that the winning team is superior in almost all elements of volleyball while in matches that end in a score 3:2 teams are of very similar performance. A more detailed analysis of the differences was carried out after the standardization and testing the significance of differences.

Standardization of results

With the aim of comparison of performance indicators, the transformation of the results of all indicators of situational efficiency on a standardized scale of z-values is made. The differences in averages (*Mpob-Mpor*) are shown in *Table 1.* A positive value indicates that the winning team had a higher score, and a negative value had a lower score than the losing team. The same procedure was repeated separately for the matches that were played with a different number of sets, in order to identify any changes in the pattern of obtained differences in the matches with different number of sets.

Table 1: Descriptive analysis of the differences in standardized performance indicators

	z- difference winners - defeated			
	total (N=103)	3 sets (N=46)	4 sets (N=35)	5 sets (N=22)
ZS	0,547	0,753	0,582	0,059
ZSF	-0,752	-0,986	-0,687	-0,364
ZSTOT	-0,084	-0,066	-0,108	-0,084
ZKB	0,710	0,840	0,603	0,606
ZBF	-0,350	-0,422	-0,397	-0,126
ZBLOK TOT	-0,053	-0,024	-0,144	0,032
ZAS	0,962	1,207	1,068	0,280
ZSERVE F	0,067	0,047	0,150	-0,022
ZSERVE H	0,551	0,784	0,474	0,188
ZSERVE TOT	0,629	0,858	0,602	0,197
ZD	0,238	0,390	0,222	-0,053
ZDF	-0,152	-0,301	-0,113	0,099
ZDIG TOT	0,038	0,040	0,065	-0,007
ZER	0,054	-0,096	0,067	0,346
ZFR	-0,932	-1,206	-0,977	-0,287
ZRREC TOT	-0,650	-0,939	-0,536	-0,225

The data show the expected results with specific changes in the patterns of results in matches with different number of sets. When we observe all the matches together, it is evident that the largest standardized average positive difference between winning and losing teams obtained with the indicator ZAS is slightly lower on indicators ZKB and ZS as confirmed in researches by Eom and Schutz (1992) who found that the block and a smash in the offensive phase and in the phase of counterattack were very important factors that contribute to success in volleyball. Results obtained in the study clearly indicate that winning teams have a greater number of successful services and aces compared to the losing teams. It is likely that the aggressive service was directly related to the organization of counterattack because the opponent's team had bad reception and the bad organization of the attacks, which allowed the serving team easier game in defense, setting up blocks, organization of counterattacks and winning a point. Because the teams are balanced, at the end of the match, the service can be associated with winning. Our results confirm the observations of Zetou et al. 2007, who stated that ace service, directly conquered point, is a prerequisite for winning in high-quality teams. According to Marelić et al. (2004), teams with more service points in the set and a small number of service faults have better prerequisites for a positive outcome. Research on the results of the Summer Olympics in Beijing in 2008 (Patsiaouras et al., 2011) confirm that the winning teams have more service points and better service reception while losing teams have a greater number of smash faults that actually end up in the block of the opponent. These results indicate the importance of successful service, improving block of opponent's attack as well as a small number of faults in service reception (Silva et al., 2014). The maximum standardized negative difference was obtained in indicator ZFR. As for the faults in the service reception, the results show that this factor, as would be expected, can be related to the defeat. Several studies have proved a positive correlation between the effectiveness of the reception and the final result of the match (João et al., 2006, Laios and Kountouris 2005, Maia and Mesquita, 2006).

The statistical significance of the difference between the winning and losing team

To determine in which indicators of situational efficiency there are statistically significant differences between the winning and losing team, Wilcoxon signed-rank test is conducted with calculating the size of the effect. Of all the differences shown in *Table 2*, it was found that all were statistically significant at the level p <0.001 except the difference in indicators STOT, BLOK TOT, SERVE F, DIG TOT and ER which are not statistically significant. When the analysis is carried out separately for the games with a different number of sets, we see that matches with 3 sets have the same pattern of results. In matches with 4 sets level of significance differences in D decreases at p <0.01, and the difference in DF ceases to be significant. The biggest change can be seen at the matches with 5 sets in which no difference was statistically significant except for the difference in KB and SERVE TOT, which remains significant at the level of 0.05. According to Palao (2008) successful blocking is a good prerequisite for winning. In addition, the block is the first defensive action from the opposing attack and can lead to direct winning point. Given that the statistical significance of differences is affected by the number of observations, these results may reflect the smaller number of observations with matches played in 5 sets. Therefore, indicators of effect size are additionally calculated which consistently show smaller size of effects in matches with 5 sets (average effect size was r = -0.147) than in matches with 4 sets (average effect size was r = -0.319) or 3 sets (average size effect is r = -0.375).

Table 2: Testing the statistical significance of the difference between successful and unsuccessful teams and the size of the effec

	N=103		3 sets (N=46)		4 sets (N=35)		5 sets (N=22)	
	Z	effect (r)	Z	effect (r)	Z	effect (r)	Z	effect (r)
S0 - S1	-6,406***	-0,446	-5,688***	-0,593	-3,656***	-0,437	-0,505	-0,076
SF0 - SF1	-6,05***	-0,422	-4,808***	-0,501	-3,248***	-0,388	-1,814	-0,273
STOT0 - STOT1	-1,667	-0,116	-0,955	-0,100	-1,163	-0,139	-0,608	-0,092
KB0 - KB1	-5,468***	-0,381	-4,21***	-0,439	-2,761***	-0,330	-2,109*	-0,318
BF0 - BF1	-5,532***	-0,385	-4,399***	-0,459	-3,528***	-0,422	-1,062	-0,160
BLOK TOT 0 – BLOK TOT1	-0,934	-0,065	-0,164	-0,017	-1,226	-0,147	-0,081	-0,012
AS0 - AS1	-6,626***	-0,462	-5,093***	-0,531	-4,191***	-0,501	-0,831	-0,125
SERVEF0 - SERVEF1	-0,585	-0,041	-0,453	-0,047	-0,421	-0,050	-0,07	-0,011
SERVEH0 - SERVEH1	-7,162***	-0,499	-5,823***	-0,607	-4,167***	-0,498	-1,168	-0,176
SERVE TOT 0 – SERVE TOT1	-8,451***	-0,589	-5,909***	-0,616	-5,073***	-0,606	-2,282*	-0,344
D0 - D1	-4,200***	-0,293	-4,415***	-0,460	-2,569**	-0,307	-0,522	-0,079
DF0 - DF1	-2,862***	-0,199	-3,451***	-0,360	-1,518	-0,181	-0,843	-0,127
DIG TOT 0 – DIG TOT1	-0,555	-0,039	-0,481	-0,050	-0,505	-0,060	-0,318	-0,048
ER0 - ER1	-0,248	-0,017	-0,841	-0,088	-0,539	-0,064	-1,061	-0,160
FR0 - FR1	-6,356***	-0,443	-4,911***	-0,512	-3,94***	-0,471	-0,919	-0,139
REC TOT 0 – REC TOT1	-7,513***	-0,523	-5,893***	-0,614	-4,237***	-0,506	-1,403	-0,212

***p<0,001; **p<0,01; *p<0,05; r effect size: the ratio of z-value and the square root of the total number of observations (N*2)

Conclusion

In conclusion, the success of the competition depends on situational effectiveness of technical - tactical elements of volleyball. Some skills are more important than others but to succeed it is necessary to know which technical tactical elements of volleyball influence the outcome of the match. To improve efficiency, the coaches have to train certain tactics of the game based on the abilities and skills of players, assess the opponent, focus on the skills that can discriminate in favor of winning and improve those skills that can be the reason of failure. Analyzing situational efficiency of volleyball players at the World Volleyball Championship in Poland in 2014 through 12 variables or elements of volleyball with the aim of comparison between winning and losing teams in the games ending by score of 3:0 and 3:1 it can be established that the teams differ significantly in almost all variables, especially in the variable S, SERVE H and AS while in matches that ended with 3:2 statistically significant differences were found only in the variable winning block - KB and the total number of services - SERVE TOT. This is the result of the tie teams and only some technical-tactical elements and their performance differ top teams and can affect the outcome of the match. Therefore, in analyzing of opponents and preparing for the game it would be desirable to practice game in defense thus creating the prerequisites for playing a successful counterattack and winning points, and a first stage of the game in defense is game in the block play and winning the points by block which confirm the results of this research.

References

1. Bergeles N, Barzouka K, Nikolaidou EM. Performance of male and female setters and attackers on Olympic-level. International Journal of Performance Analysis of Sport, 2009; 9: 141-148
2. Buscà B, Febrer J. Temporal fight between the middle blocker and the setter in high level volleyball. Rev. int. med. cienc. act. fís. deporte, 2012; 12(46): 313-327
3. Costa G, Alfonso J, Brant E, Mesquita I. Differences in game patterns between male and female youth volleyball. Kinesiology, 2012; 44(1): 60-66
4. Đurković T, Marelić N, Rešetar T. Rotation analysis of teams' performances at 2003 youth European volleyball championship. Kinesiology, 2009; 41(1): 60-66
5. Eom HJ, Schuttz RW. Statistical Analyses of Volleyball Team Performance. Quarterly research for Exercise and Sport, 1992; 63: 11-18
6. Field, A., Hole, G. 2003. How to Design and Report Experiments. London: Sage Publications.
7. Hayrinen M, Hoivala T, Blomqvist M (2004). Differences between winning and losing teams in men's European top-level volleyball. Retrieved October 21, 2013 from: http:// www.kihu.jyu.fi/tuotostiedostot/julkinen/2004_hay_difference_10001.pdf
8. Janković V, Marelić N (1995). Odbojka. Zagreb: Fakultet za fizičku kulturu. [Volleyball. Faculty of Physical Education].
9. João P, Mesquita I, Sampaio J, Moutinho C. Comparative analysis between libero and priority receivers on the offensive organization, from the serve reception on the volleyball game. Rev Port Cien Desp, 2006; 6(3): 318-322
10. Laios Y, Koutouris P. Evolution in men's volleyball skills and tactics as evidenced in the Athens 2004 Olympic Games. Int J Perform Anal Sport, 2005; 5(2): 1-8
11. Lobietti R, Coleman S, Pizzichillo E, Merni F. Landing techniques in volleyball. J Sport Sci, 2010; 28(13), 14691476
12. Maia N, Mesquita I. Study of zones and efficacy of the reception according the receiver player in female senior volleyball. Rev. bras. educ. fís. esporte, 2006; 20(4): 257-270
13. Marcelino R, Mesquita I, Sampaio J, Moraes J. Study of performance indicators in male volleyball according to the set results. Rev. bras. educ. fís. esporte, 2010; 24 (1): 69-78
14. Marelić, N. (1998). Kineziološka analiza karakteristika ekipne igre odbojkaša juniora. Doktorska disertacija. Zagreb: Fakultet za fizičku kulturu, Sveučilište u Zagrebu (Physical analysis of the characteristics of the team's games of junior volleyball players. Doctoral thesis. Zagreb: Faculty of Physical Education, University of Zagreb)
15. Marelić N, Rešetar T, Janković V. Discriminant analysis of the sets won and the sets lost by one team in A1 Italian volleyball league – a case study. Kinesiology, 2004; 36(1): 75-82
16. Miskin M, Fellingham G, Florence L. Skill Importance in Women's Volleyball. J. Quant. Anal. Sports, 2010; 6 (2): 5, 1-12
17. Nishijima T, Ohsawa S, Matsuura Y. The relationship between the game performance and group skill in volleyball. International Journal of Physical Education, 1987; 24(4): 20-26
18. Palao J, Santos J, Ureña A. Effect of setter's position on the smash in volleyball. J hum movement stud, 2005; 48(1): 25-40
19. Palao J. Options for analysis of the volleyball score sheet. Int J Perform Anal Sport, 2008; 8(2): 26-43
20. Patsiaouras A, Moustakidis A, Charitonidis K, Kokaridis D. Technical Skills Leading in Winning or Losing Volleyball Matches During Beijing Olympic Games. Journal of Physical Education and Sport, 2011;11(2); 149-152
21. Peña J, Guerra, J.R. Buscà, B., & Serra, N. (2013). Which skills and factors better predict winning and losing in high–level men's volleyball. Journal of strength and conditioning research, 27(9), 2487-2493
22. Rešetar, T. (2011). Situacijska efikasnost odbojkašica različitih dobnih skupina. Doktorska disertacija. Zagreb: Kineziološki fakultet, Sveučilište u Zagrebu. (Situational efficiency of volleyball players of different age groups. Doctoral thesis. Zagreb: Faculty of Kinesiology, University of Zagreb)
23. Selinger, A. (1986). Arie Selingers power volleyball. New York: St. Martin s press.
24. Silva M, Lacerda D, João P.V. Game-Related Volleyball Skills that Influence Victory, Journal of Human Kinetics volume 41/2014, 173-179
25. Zetou E, Moustakidis A, Tsigilis N, Komninakidou A. Does Effectiveness of Skill in Complex I Predict Win in Men's Olympic Volleyball Games? J. Quant. Anal. Sports, 2007; 3(4): 1559-1570

STATIC STRETCHING WARM-UP DOES NOT PROVIDE ANY ADDED BENEFIT TO DYNAMIC STRETCHING IN REPEATED SPRINT ABILITY IN FEMALE HANDBALL PLAYERS

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Purpose: Cross-over randomized study was aimed to examine the effect of typical static vs dynamic stretching warm-up protocols on repeated sprint ability (RSA).

Method: Thirteen healthy, uninjured females (mean ± SD: age = 22.1 ± 3.2; height = 1.71 ± 6.5 m; body mass = 68.5 ± 10.4 kg) were required to perform a standardized 5-min aerobic warm-up supplemented with one of three stretching protocol followed by the RSA performance test (5 x 6 s) on three occasions. Stretching protocols consisted of 6-min exercises for lower limbs, administrated randomly: static starching (SS), dynamic-balistic stretching (DS) and no stretching (CON). Before and after warm-up protocols range of movement was measured by sit-and-reach test. Mixed linear models were used to analyze effects of stretching protocol and interpreted using magnitude-based inferences.

Results: Between athlete differences in mean peak power in RSA was 9.7, ±3.8% (90% CL), while individual differences in fatigue over 5 sprints was 6.7, ±3.3% (large). Within-athlete stretching-protocol-to-stretching-protocol variability and sprint-to-sprint random error (residual error) were moderate (3.1, ±1.0% and 3.5, ±0.4%, respectively). DS and SS protocol increased range of movement (ROM) by 12.7 and 19.2% (small effects, possible and very likely,respectively), while increase of ROM with CON was trivial (possible). DS induced greater improvements on mean peak power in RSA test than SS and CON (3.3% and 3.0%, effects were small,likely and small, possible, respectively) and on peak power in 1st sprint (1stSp), 5th sprint and power drop in RSA when compared to CON (2.0%, 4.1% and 2.1%; trivial to small, possible, small likely and small, possible respectively). The SS condition resulted in significantly worse performance than DS (-3.9%; small, likely) and CON (-2.0; trivial to small, possible) in 1stSp and power drop in RSA, when compared to CON (3.5%; small, likely), but did not impair RSA performance when compared to CON.

Conlusions: It was shown that 6-min of dynamic stretching after 5-min aerobic exercise of the lower limbs has a likelihood of augmenting sprint and repeated sprint performance, where the same portion of static stretching exercise in warm-up impairs performance.

Reference

1. De Oliveira, F. C. L., & Rama, L. M. P. L. (2016). Static Stretching Does Not Reduce Variability, Jump and Speed Performance. *International Journal of Sports Physical Therapy*, *11*(2), 237-46
2. Gharbi, Z., Dardouri, W., Haj-Sassi, R., Chamari, K., & Souissi, N. (2015). Aerobic and anaerobic determinants of repeated sprint ability in team sports athletes. *Biology of Sport*, *32*(3), 207-12.
3. Amiri-Khorasani, M., Sahebozamani, M., Tabrizi, K. G., & Yusof, A. B. (2010). Acute Effect of Different Stretching Methods on Illinois Agility Test in Soccer Players. *Journal of Strength and Conditioning Research*, *24*(10), 2698-2704.

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THE CHALLENGES FACING SPORT IN THE NEXT DECADE

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Introduction

Sport is big business. The IOC's TOP sponsorship programme raised over £1billon for the 2013-2016 quadrennial. UK pay-TV broadcaster BT Sport acquired exclusive UK rights for UEFA Champions League and Europa League from 2015/16 for £299 million per season. Tennis player Li Na earned £11 million in endorsements in 2012, sportswear giant Adidas signed a six year sponsorship deal with Italian football club, Juventus for £145.5 million and FC Barcelona have announced that they will spend nearly £500 million on the renovation of their iconic Nou Camp stadium. The top 10 sports rights deals in 2013 were worth £5.3 billion and PwC (2011) have predicted that the global sports market will have revenues of approximately £88 billion by 2015.

Sport is also a global phenomenon and perhaps more importantly, has become a global 'entertainment' phenomenon, driven by the ongoing commercialism of the industry, an ever increasing appetite for sport 'spectacles' and increasing investment on behalf of owners, sponsors and governments in achieving success. The Olympic Games is a clear example of this. The opening ceremony of London 2012 drew an estimated global TV audience of 900 million people (Ormsby, 2012), TV coverage of London 2012 exceeded that of Beijing 2008 by more than 40,000 hours, teenage viewership (the hardest to build) increased by 29% over Beijing and NBC paid 32% more to broadcast London 2012 than it did for the 2008 games. There were over 21000 accredited media at the Games, more than 6000 people were employed to work on the Games and the UK government spent £264 million on elite sport in order to win 65 medals.

However, there are a number of challenges facing our industry that sport managers will need to be concerned with if the industry is to continue to grow. The two key issues sport managers will need to deal with in the next few years are outlined below and responding to these will require innovative and strategic thinking, careful management of staff and resources and a commitment to stakeholders and quality.

The popularity of sport and engaging young people

Despite the global and entertaining nature of sport, the business of sport is highly competitive and many sports are facing significant challenges. Luker (2000, p. 48), in his analysis of the sports industry, stated that

> 'a changing marketplace, new technology and fresh competition for the public leisure time and dollars means that old assumptions have to be challenged ... It's no longer about getting people to say yes to your sport – it's about getting people not to say no.'

This becomes an even greater challenge when considering that levels of participation in sport are, in many countries, stagnant or declining (Sport England, 2013). In addition, in terms of spectating, both live and by media, it is often a small range of sports, sometimes one, such as football, that attracts the significant proportion of spectators. For example, a football game was the most watched sport event in 2013 in France, Germany, Italy, Japan, South Africa and Spain.

Sport, in particular many traditional and regulated sports, is simply not popular with many individuals, particularly young people who want their sport on their 'own terms'. Consequently, sport disciplines and even events within codes are being increasingly subjected to public scrutiny as new sports appear on the scene or alternative activities that are more attractive to the younger person result in a reduction of participation in regular or formal sporting activities. The current debate surrounding the viability of Test Cricket (Hughes, 2013) or even the 50 over format is a cause of great concern for traditional cricket administrators in the face of public preference for the Twenty20 version of the Game. Young people's tastes in sport change and will continue to change and therefore the task of promoting and popularising a sport becomes a very important priority for many sport services. For example, the IOC has responded to the growing concern that its product is losing popularity by introducing the Youth Olympic Games, with modified events such as 3-a-side basketball, while the Winter Olympic Games now include events such as Skeleton, Snow Board and freestyle skiing to attract greater viewing interest. Even within the Summer Games programme there is pressure to remove some of the older traditional sport events in favour of the more popular modern versions, which has led to the inclusion of rugby 7s in the 2016 Olympic Games.

There are a number of factors involved in whether a sport is popular or not:

- *Olympic status.* Those sports that have Olympic programme status will, in most countries, be more likely to receive state funding and sponsorship support than sports not on the Olympic programme. This will not, necessarily, be the case in countries such as the UK and Australia where funding is focused on target sports, however, being part of the Olympic programme makes funding more likely. Funding then makes it possible to promote and develop the sport and to develop elite athletes which are able to compete on the world stage.
- *The televising of the sport.* Sport that is seen on television is more likely to popular for two reasons. First, seeing a new sport may encourage people to participate. Sports that make exciting television promote, in young people, the desire to participate. In addition, sports that make exciting television are more likely to be identified by broadcasters as being appropriate for broadcasting. Those sports that do not present well on television, or are technically difficult to follow make far less impact. Although advances in broadcasting technology have popularised some sports that have been hard to follow, such as sailing, long distance running and sychronised swimming, this is a challenge for many sports with some changing aspects of their sport in order to appeal to television audiences and the requirements of broadcasters. Second, sports on television are popular as broadcasters 'play it safe' and allocate television hours on those sports they now will attract an audience and thus sponsorship. This becomes a virtuous (or vicious) cycle, where a popular sport becomes more popular as it is seen on television, which in turn increases its popularity.
- *Access to facilities and equipment.* The availability of these can hamper the development of sports. Lacrosse almost died out as a sport after the two World Wars due to the lack of hickory for making the sticks. Even the events within a sport such as athletics can be impacted by lack of equipment e.g. pole vaulting in various countries in the developing world is hardly practised because the expense and availability of the poles and the landing mats makes the event difficult to organise. Sports that require expensive equipment, such as bobsleigh or sailing face an even greater challenge to become or remain popular.
- *The duration of the event.* There is a growing interest in sport competitions that can be packaged up and delivered for the 'fast-food' sport market. Beach volleyball and rugby 7s are examples of modified versions of traditional sports that are threatening to become more popular and significant than the traditional version of the sport. People appear to be less interested in participating or watching events that take a long time to complete.
- *The cost.* The cost of either watching an event or taking part in sport will be a significant factor in the future that managers will have to deal with. Traditionally sport was a cheap or even free form of activity. However, as business principles evolve and there is an increase in pressure to package sport in a more entertaining way, so the cost of participating in sport, and spectating of sport events also increases. This puts sport in a position where the consumer market, the spectators and participants may be attracted to the idea of spending their money elsewhere.
- *The competition.* Increasingly, there are more and more alternatives for people seeking a sport experience. Non competitive, recreational activities in particular appear to becoming more popular amongst young people, along with participation in events that are organised outside of the mainstream of traditional sports, such as 'wild swimming'. Olympic sport organisations are therefore threatened by the introduction of new activities that appear more attractive than what they offer and also by organisations that are not membership based and therefore do not require a commitment or sustained effort from participants.

It is not unreasonable to assume that some sports will recede in popularity and other new sports will emerge and take centre stage. Managers of sport organisations will need to monitor the interest in their product, the levels of participation and be innovative in their attempts to attract new participants and spectators.

The dark side of the business of sport: corruption in sport

Transparency International (2008, p. 5) stated that "It appears that corruption can be found in almost any imaginable areas of sport." They went on to identify the main areas of corruption as match fixing, embezzlement or misusing of sport funds, corruption in the hosting of games, corruption in changing sport results, corruption in transfers of players and corrupted elections in sporting bodies. The table below sets out a typology of sport corruption, with instances of when this has occurred in sport.

Table 1: Corruption in sport

Type of corruption	Form it takes in sport	Examples of sports affected
Systemic corruption	Vote rigging Bribery Gifts and hospitality Organised crime	Awarding of the Olympic Games to Salt Lake City Figure skating FIFA - football
Gambling corruption	Match fixing Sport fixing	Cricket, Football, Tennis, Basketball, Snooker
Competition corruption	Use of illegal drugs Cheating	Cycling – Tour de France Rugby – Heineken Cup

(Source: Adapted from Transparency International, 2011)

Brooks, Aleem and Button (2013) have carried out an extensive analysis of fraud, corruption and sport and highlighted how as sport has become more popular with a truly global audience in recent years, it appears to have become much more of a target for individuals and groups of people wanting to take advantage of the lucrative nature of the industry. Although most corruption in sport is due to doping (Gorse and Chadwick, 2011) much of this activity has also been focused around sport gambling.

Betting on sporting events has grown in popularity as sports broadcasting and new interactive technologies have become more readily available and this has exacerbated the potential for corruption in sport. The opportunity for on-line betting during the process of sporting competition, on a growing range of outcomes (spot betting), has led to the fixing of results of competitions, or indeed elements within a game, match or race. Examples of this type of activity have been found in a range of sports such as cricket, rugby, baseball, football and sumo wrestling. The sports betting market, originally developed out of a passion for horse racing, has expanded in recent years to take account of a growing demand for the opportunity to gamble on the outcome of a wide range of sports events. In recent years, the online betting market has taken off and in 2012 the UK's online gambling sector was worth £2 billion. The online revolution began with Gibraltar-based Victor Chandler's betting operation in May 1999, and in 2000, William Hill, UK bookmakers, became the first major player to offer duty-free betting. Also in 2000, the first dedicated worldwide football betting Internet service was launched. VIPsoccer.com offered tax-free betting and accepted bets from anywhere in the world on games in leagues across the world. In the UK, the Hilton Group committed £100m to provide betting on the Internet, through interactive television and mobile telephones. The US betting company Autotote aligned themselves with Arena Leisure, operators of six UK racecourses, to create an international web-based betting business founded on horse racing.

Online betting was able to gain market share quickly, by offering tax-free or reduced tax betting to punters, as operators either absorbed the cost of the tax deduction or based their operations offshore. In response to this, the UK government abolished betting tax, replacing it with the requirement for bookmakers to pay 15% of their gross profits directly to the government. Sports gambling has always been justified on the basis of the revenue it supplies to governments through taxation and in the UK; the betting levy raised more than £75 million in 2009/10. It is, however, impossible to ignore the ethical issues surrounding sports betting, with the following being key concerns:

Sports betting is likely to:

- increase attempts by players and coaches to influence the outcome of scores;
- create suspicion by fans who feel that the outcome was influenced;
- increase costs spent on monitoring and policing the league to preclude game fixing and point shaving;
- change the nature of sport, focusing not on the beauty of competition, but on the 'points spread';
- encourage and promote gambling;
- increase personal health problems associated with gambling. (Davis, 1994)

Although all of these concerns are clearly important, it is the first two that are of greatest concern to those who run the business of sport as they lead to a perception of a corrupt business. Marco Pantani, 1998 winner of the Tour de France was, in 2000, the first sportsperson to be found guilty under civil law of trying to manipulate the result of a sporting event by the use of banned drugs. In the UK, the government has established the Independent Football Commission and then the Independent Football Ombudsman to watch over the game.

The reason why sport is so susceptible to corruption is to do with its very nature. The unpredictability of sport and sporting outcomes means that it is possible that a result obtained by corrupt practice may potentially have been obtained naturally. For example, players drop catches, goalies fail to save goals and often the underdog beats the favourite. This makes it extremely hard for spectators and officials to detect a corrupt result from a non-corrupt result. Sport is also self-governing and has many structural problems that facilitate corruption, such as power and vested interests that oppose change, myopia or naivety about the 'cleanliness' of their sport and a belief that codes of conduct prevent fraud and corruption (Brooks et al, 2013). Sport is not subject to the laws of the countries within which it operates and this provides a chance for corrupt practice to be hidden or to be dealt with less severely than it would be by a formal legal process. Perhaps more importantly, however, is that sport is virtually powerless to prevent corruption “with their actions resting more on persuasion, rather than the imposition of sanctions” (Brooks et al, 2013, p. 170).

Although corruption is not widespread, it has a significant impact on the business of sport. Corruption undermines the integrity of sport and leads to decisions regarding the bidding for events, team selection and even sporting outcomes open to doubt. In some sports, such as cycling there is an ingrained cynicism about some events and outcomes. It can also damage the commercialism of a sport, when in the face of a loss of integrity a sport sponsor may take their support elsewhere. However, it is also possible to argue that the impact of corruption may not be a significant as one might think. Despite well publicised episodes of fraud and corruption, people still watch the Tour de France, watch cricket and bet on horses.

Conclusions

The management of sport organisations cannot operate in a vacuum and managers need to take into account and respond to developments in the external environment. This in turn requires managers to be aware of what is happening around them and to respond to these developments positively and logically, using best practice sport management practices. The potential contribution of sport to improved health, the pride of the nation, opportunities for life long learning and better social cohesion, requires managers to demonstrate efficiency and effectiveness in the allocation of resources, management of staff and quality of service delivery. Failure to do this will lead to sport being marginalized in societies that are ever increasingly concerned with sport spectating and home based activities.

References

1. Brooks, G.; Aleem, A. & Button, M (2013). *Fraud, Corruptions and Sport*. Basingstoke: UK
2. Davis, K.A. (1994). *Sport Management: Successful Private Sector Business Strategies*. Madison, WI: Brown & Benchmark.
3. Gorse, S. and Chadwick, S. (2011) *The prevalence of corruption in international sport* Coventry: CIBS.
4. Hughes, A. (2013). ‘Test cricket and the bitter truth’. *Cricinfo.com*. www.cricinfo.com, Accessed 07/01/14.
5. Luker, R. (2000). ‘US sports sector slips from the summit’, *SportBusiness*, March: 48-9.
6. Ormsby, A. (2012). ‘Opening ceremony draws 900 million viewers’ *Reuters*, www.reuters.com, access 07/01/2014.
7. PwC (2011) *Changing the game: Outlook for the global sports market to 2015*. London: PwC
8. Sport England (2013). *Active People survey,* http://www.sportengland.org/research/who-plays-sport/national-picture/, accessed 15/01/14
9. Transparency International (2008). *Why sport is not immune to corruption*. Transparency International: Czech Republic.
10. Transparency International (2011). *Corruption in the UK*. Transparency International: Czech Republic.

BARRIERS OF ENTRY FOR YOUNG SPORT ATHLETES INTO ORGANIZED PROCESS IN SELECTED SPORTS

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Abstract

Statistics of the Czech Sport Union (ČUS) show on long term basis significant decrease in participation of youth in organized sport activities in particular sport´s clubs.

Main aim of specific research that took place at Faculty of Sports Studies at Masaryk´s University in 2016 was to specify particular barriers that prevent young athletes from entering into organized processes in various sport clubs in the Czech Republic.

Football, Ice Hockey, Swimming, Floorball, cycling and Volleyball have been selected sports for this research.

Selection has been based not only on popularity and development of particular sport in the Czech Republic but also from the point if chosen sport is individual or collective.

After selecting particular barriers of entry our study has been divided into two parts: Phase one use quality survey such as interviews with sport club representatives and interviews with coaches. Phase two is based on quantity survey. The survey indicates that we have received 1 167 responses from parents of these children.

Survey proves that in more than a half of cases important role are different interests of a child, school duties or mere laziness. Survey proves that one of possible barriers is selection of one sport as priority.

Key words: *organized sport, family budget, attendance*

Introduction

Statistics of the Czech Sport Union (ČUS) show on long term basis significant decrease in participation of youth in organized sport activities in particular sport´s clubs (Rektořík & Hobza, 2006).

According to data provided by members of ESEA (European Sport Economics Associations) this trend has been recorded in Western Europe at the beginning of 80´s and currently Czech Republic is also included. However, this trend has been stopped in past two years.

Change of social conditions after 1990 has offered plenty of possible activities for youth that do not have any connection with organized sport process (e.g. be participant of training, competitions or just be registered at selected sport club) whatsoever. Another aspect is development of new sports and disciplines (Mäkinen, Kestilä, Borodulin, & Martelin, 2009; Novotný, 2011).

We assume that one of the main reasons for low number of youths that actually participate in sport is that youths have become idle.

Most children/youths these days do not have a will to prove that they are better than others.

Short-term participations of these children exists in particular sport but later on this participations given up for something less demanding.

More and more common reason is also not enough time of parents that are driving their children to the trainings or competitions. Due to the lack of spare time caused by other activities of parents (parents own sport club or other activity) in many cases physical education of children is not supported at all. In some cases, child's trainings are for some parents used only as a place where their children can spend time before they are picked up by parents but weekend competitions and matches are not attended (Dmitruk, Popławska, Górniak, & Hołub, 2014).

In general, the main reason for not supporting children/youths in sport is financial issue meaning that many sport activities are costly. However only minimum of these cases have been proven to be truthful (Kantomaa, Tammelin, Näyhä & Taanila, 2010; Novotný, 2012).

Main aim of this project was to determine real barriers of entry of youths to organized sport process in various sport clubs in the Czech Republic. Football, Ice Hockey, Swimming, Floorball, Cycling and Volleyball have been among selected sports.

Households with children aged 6 to 18 have been targeted group for this project.

Methodology of work

- Following methods have been used:
- processing of literary searches with similar topics,
- interview with functionary of sports and coaches,
- questionnaires,
- descriptive methods of data from questionnaires,
- method of synthesis of findings,
- method of deduction for conclusion findings.

For determination of particular barriers, survey has been divided into 2 parts/phases.

Phase one used qualitative survey interviewing sport officials from individual unions and clubs as well as coaches of selected sports. These interviews gave us important information for our quantitative survey.

As most common obstacles have been determined competition of different sport branches, sport activities of parents and their business during whole week and mostly during weekends, insufficient equipment, and bad financial support from Ministry of Education as well as doping issues in various sports.

Data obtained from these interviews helped to issue questionnaire that has been distributed to Grammar and Secondary Schools kids that passed them onto their parents.

Phase two consisted of filling up questionnaire. 575 families participated which brought results about 1 167 children.

The results of this questionnaire are obvious: different sport branches, other interests of a child (non-sport activities), school duty of a child, no sport area nearby, lack of talent or laziness of children.

Results

575 families have participated in the survey bringing results of 1 167 children. 80% of all cases of the questionnaire it has been filled up by the mother. Often these families live in cities between 2 000 to 4 999 inhabitants. However, in total comparison to 10 000 inhabitants and over 10 000 inhabitants is ratio almost even (44% vs. 56%).

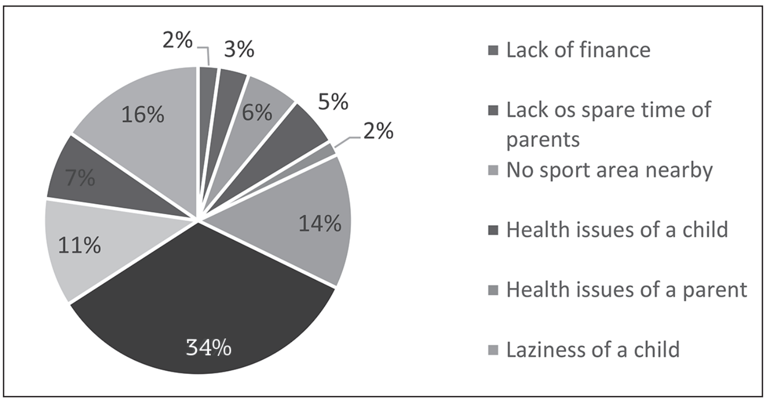
Three quarters of children are from married families, remaining one quarter has divorced or single parents. Most often parents have completed Secondary School Education (44%), University Education has been completed by a third. A fifth of respondents have completed an Apprenticeship.

More than half of families has four members, one quarter has five members. At least three family members has 14% of these families. Average monthly family income is 1 500 EUR.

In 43% of families has sport history the Mother as well as Father. One of the parents has been active in sport in 36% of all cases. 21% of replies state no sport history at all. 72% of parents consider sport a great importance.

In total sum up the results are about 608 girls and 559 boys that have been obtained. Average age has been 13 years for both, girls and boys. 60% of children participate in at least one sport on top of Physical Education at school, 40% does not spend any time on sport activity. On contrary, 68 children out of this study, are active in more than one sport.

As visible on the graph 1 below, most common barriers for all children are different interest – in almost one third. Substantial is also laziness of a child (14%) and school duties mentioned in 11% cases. In 7% parents have marked lack of talent of a child for selected sport. Notable is only 2% for lack of finance.



Graph 1: Barriers of entry

Management of Sport

In following chart are processed sports with selected criteria. Significant result is that majority of barriers has been mentioned only in minimum cases. This means if a child participates in their favorite sport almost nothing can stop them.

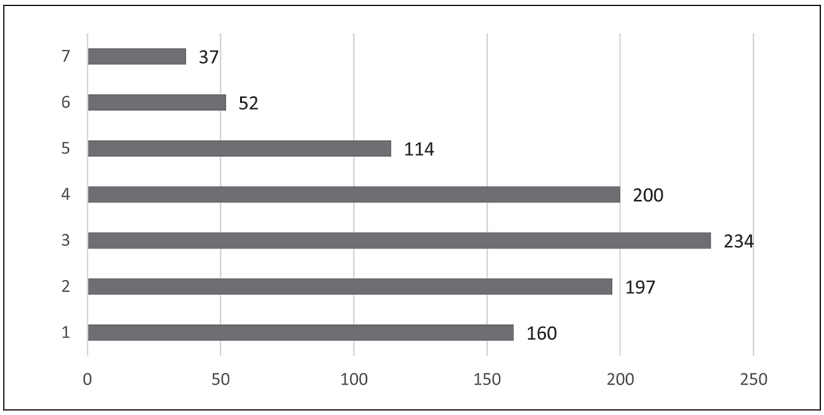
In most cases in mentioned sport branches both parents spend their time with their children (70%). In cases where only one parent spends time, it is mostly the father (65%).

Table 1: Results for selected sports

	Number of children preferring this sport	Weekly attendance (in hrs)	Weekly attendance of parents (in hrs)	Monthly costs (in EUR)	Most common obstacles
Football	104	6,5	9,5	90	Unknown
Ice Hockey	18	8	9,5	90	Unknown
Swimming	30	3,5	5	35	Health issues, laziness, other interests
Floorball	55	4	5	25	School duties, health issues
Cycling	29	7	6,5	75	Lack of finance, no sport area nerby, other interests, school duties
Volleyball	28	5,5	3,3	15	Unknown

For absolute majority of parents it is important to know the opinion of their child on his/her activities – this option has been selected by 909 respondents. 202 respondents then shows contradiction between child's opinion and its own. Only 56 respondents do not care about child´s opinion.

80% of families claim that sport of children does not oppress them, 20% claims that a sport of children is a burden on a family budget.



Graph 2: Total burden of family budget (Lickert scale – 1 the smallest, 7 the biggest)

Conclusion

Even though that in 2015 the decrease of sporting activities of youths in the Czech Republic had stopped, this topic is still current and due to the different circumstances active youths are turning to different non-sporting hobbies.

Survey proves that in more than a half of cases important role are different interests of a child, school duties or mere laziness.

Survey proves that one of possible barriers is selection of one sport as priority.

Offer of different sport sis quite large. 50 different sports have been appointed in the questionnaire by parents as sports that children do.

In case of prioritization of specific sport are barriers as itself minimal for sports selected by us.

Resources

1. Dmitruk, A., Popławska, H., Górniak, K., & Hołub, W. *The participation of girls and boys in structured sports and extra-curricular activities in the aspect of social and economic conditions* [online]. 2014. Accessed from http://econpapers.repec.org/article/vrsspotou/v_3a21_3ay_3a2015_3ai_3a4_3ap_3a240-246_3an_3a5.htm (retrieved October 29, 2016).
2. Kantomaa, M., Tammelin, T., Näyhä, S., & Taanila, A. *Adolescents' physical activity in relation to family income and parents' education* [online]. 2010. Accessed from http://www.pubfacts.com/fulltext/17335890/Adolescentsphysical-activity-in-relation-to-family-income-and-parents-education (retrieved October 29, 2016).
3. Mäkinen, T., Kestilä, L., Borodulin, K., & Martelin, T. *Effects of childhood socio-economic conditions on educational differences in leisure-time physical aktivity* [online]. 2009. Accessed from http://eurpub.oxfordjournals.org/content/20/3/346.full (retrieved October 29, 2016).
4. Novotný, J. (2012). *Ekonomická náročnost přípravy mladých talentovaných sportovců v* České *republice na příkladech ledního hokeje a volejbal*. In Sborník recenzovaných příspěvků z 1. mezinárodní vědecké konference Ekonomika a řízení podniku ve 21. století. Ostrava: VŠB-TU Ostrava, Ekonomická fakulta, katedra podnikohospodářská a katedra managementu.
5. Novotný, J. (2011). *Sport v ekonomice*. Praha: Wolters Kluwer.
6. Rektořík, J., & Hobza, V. (2006). *Základy ekonomie sportu*. Praha: Ekopress.

USE AND FREQUENCY OF CONTRASTIVE DISCOURSE MARKERS: ANALYSIS OF SCIENTIFIC PAPERS ON SPORTS MANAGEMENT

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Abstract

Sports management is a relatively young research discipline with its own set of discourse patterns which are used in scientific papers in this field of research. The aim of this research was to analyse the use and frequency of three contrastive discourse markers in sports management papers. The analysis has shown that their use and frequency follow certain previously determined discourse patterns found in theoretical studies on discourse markers.

Key words: *discourse analysis, sports management, contrastive discourse markers, but, however, on the other hand*

Introduction

The term *discourse* implies different meanings when used in numerous different contexts, however, in many cases, underlying the word *discourse* is the general idea that language is structured according to different patterns that people's utterances follow when they take part in different domains of social life (Jørgenesen & Phillips, 2002, p. 12). Further, in keeping with this definition – *discourse analysis* refers to the analysis of the mentioned patterns which includes a series of interdisciplinary approaches that can be used to explore many different social domains in many different types of study. Gee (2014, p. 17) defines discourse as the sequence of sentences and the way in which sentences connect and relate to each other across time in speech and writing. Accordingly, the term *discourse analysis* is then used by linguists to refer to the study of the connections among and across sentences as they follow one after the other. However, in order for such a sequence of sentences to be interpreted as a coherent unit, a certain type of relationship must be indicated between the sentences.

One of the first to mention discourse markers as a group which requires studying was Levingston (1983) in saying that "there are many words and phrases in English, and no doubt most languages, that indicate a relationship between an utterance and the prior discourse" (Fraser, 1988, p. 19). Heeman and Allen (1999, p. 5) consider discourse markers to relate utterance to discourse context. Among other researchers who studied discourse markers, Aijmer (2002) stressed their contextual specificity, Schiffrin (1987) analysed their role for the progression of information, and Bondi (2004) dealt with the discourse function of contrastive connectors in academic abstracts.

Until today, there have been numerous studies on discourse markers where different researchers used a series of other terms, such as cue phrases, discourse connectives, discourse operators, discourse particles, discourse signalling devices, phatic connectives, pragmatic connectives, pragmatic expressions, pragmatic formatives, pragmatic markers, pragmatic operators, pragmatic particles, semantic conjuncts, sentence connectives, etc. Among the several most commonly used theories on discourse markers is certainly that of Bruce Fraser (1998, p. 302) who defines them as lexical expressions drawn primarily from the syntactic classes of conjunctions, adverbials and prepositional phrases which do not play the role that their classes would suggest, but are separate from the propositional content of the sentence and function to signal the relationship between the segment of discourse they introduce, S2, and the prior segment of discourse, S1. Fraser (1998, p. 302) also elaborates that "their meaning is not conceptual, but procedural, with each discourse marker providing information on how to interpret the message conveyed by S2 vis-à-vis the interpretation of S1.

According to most researchers, discourse markers can be classified into three classes – contrastive (*but, however, instead, etc.*), elaborative (*and, furthermore, in addition, etc.*) and inferential (*so, thus, as a result, etc.*). According to Jucker and Ziv (1999), in his analysis of the contrastive discourse markers of English, Fraser further classifies them into three different classes where the largest class signals that the speaker intends the explicit message conveyed by the following discourse unit to contrast with an explicit or indirect message conveyed by the preceding discourse unit. The second class of contrastive discourse markers signals that the speaker intends the explicit message conveyed by the following unit to correct a message conveyed by the preceding unit, while the third class signals that the explicit message conveyed by the following discourse unit is to be perceived as correct, whereas the message conveyed the preceding unit is to be taken as false. The contrastive discourse markers *but*, *however* and *on the other hand* are all part of the first and largest class, where the marker *but* has the widest semantic application and it subsumes the semantic range of *however*, which, in turn, subsumes the marker *on the other hand.* There are also authors who classified discourse markers into interpersonal, referential, structural and cognitive (Fung & Carter, 2007). According to this classification, for example, the discourse marker *but* belongs to the referential set expressing contrast. The terminology regarding discourse markers is not unified and attempts have been made by researchers such as Yang (2011) to try to clarify the confusion regarding the terminology, but also in the analytical method occurring due to different research perspectives.

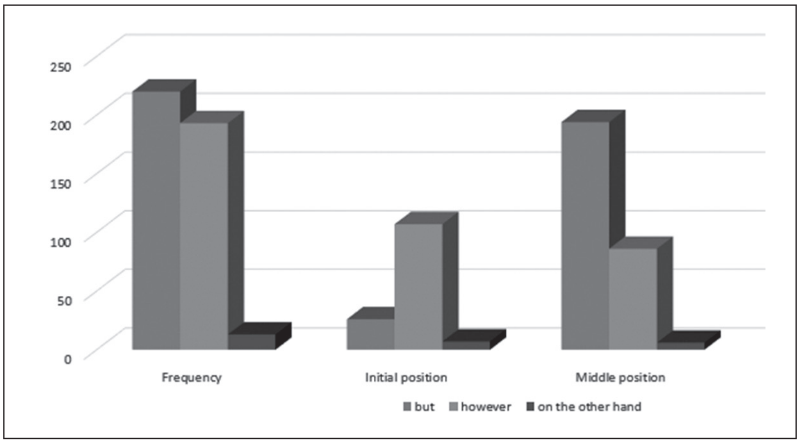
The aim of this article was to analyse the use and frequency of the three mentioned contrastive discourse markers in scientific papers on sports management to infer about the notion of testing various points of views expressed in the analysed papers, and to do so by contrasting the messages conveyed by various authors. As the academic community is still discussing on where to position sports management within science, and as it is a relatively young research discipline which is often differently classified and housed within study programmes of different universities (Nova, 2014), there has been no extensive research on discourse markers in terms of the most common discourse patterns in which they are used within the field of sports management. Also, even though discourse markers have no conceptual, but only a procedural meaning, they are sometimes indispensable in terms of coherence and the precise communication of a desired utterance.

Methods

For the purpose of this research, 20 randomly selected scientific papers on sports management published in the period between 2007 and 2017 were analysed by using the freeware corpus analysis toolkit for concordance and text analysis, AntConc by Lawrence Anthony (Windows 3.4.4 version). The mentioned randomly selected papers on sports management were taken from a variety of journals such as Sport Management Review, Journal of Physical Education and Sport Management, International Journal on Sport Management and Marketing, Journal of Sport Management, European Sport Management Quarterly, Transformations in Business and Economics and others. The use and frequency of the contrastive discourse markers *but*, *however* and *on the other hand* was analysed in relation to Fraser's classification and description (1998).

Results

As it is presented in Graph 1, *but* is the most frequently used contrastive discourse marker (220) among the three analysed markers. *However* is slightly less frequently used (193), whereas *on the other hand* (13) is used substantially less frequently in scientific papers on sports management. Interestingly, in terms of frequency of use depending on the position in the sentence, *but* is mostly used in the middle position, whereas *however* and *on the other hand* are almost equally used in both positions.



Graph 1: Frequency and position of ***but*****,** ***however*** *and* ***on the other hand***

Discussion and conclusion

The aim of this analysis was to determine the use and frequency of three contrastive discourse markers in scientific papers on sports management in order to verify Fraser's classification and interpretation of the mentioned discourse markers and to arrive to conclusions on the role and tone of contrastive discourse markers in the field of sports management. As *but* is described by Fraser (1998, p. 312) as a basic contrastive marker which in all cases signals that S2 is to stand in contrast to a message conveyed by S1 and where all refinement of this simple contrast comes from the context and the messages involved (not from an ambiguity of the core meaning of *but* functioning as a contrastive discourse marker), the presented results demonstrating *but* as the most commonly used contrastive marker are in keeping with the above-mentioned utterances.

*The Games are held every four years (summer editions only) under the auspices of the Pan American Sports Organisation (PASO), a continental governing body, **but** the Games are ultimately the property of the International Olympic Committee.*

S1, but (=contrast) + S2

Fraser (1998, p. 313) further argues that *however* only slightly differs from *but* in the fact that the core meaning of *however* signals that S1 is being emphasized and places the S2 message in a more subordinate role. He further continues that this difference is difficult to show as *but* can occur in all *however* contexts and can be interpreted as emphasizing S2 when it does so. The results yielded in this analysis on scientific papers on sports management indicate that *however* is indeed only slightly less frequent than *but*, which does support the idea that these two contrastive markers do not differ very much.

*Research related to major sport events has notably included marketing, sponsorship, and brand studies; image and identity studies, and economic impact and tourism studies. **However**, few studies have truly examined organizational and managerial processes within major sport events, which is essential for the successful (efficient and effective) hosting of major sport events.*

S1. However, (=emphasis of S1) + S2 (in a more subordinate role)

In case we replace *however* in the above-mentioned example with the "superordinate" marker *but*, it is clear why Fraser argues that the two contrastive markers are very similar and that the difference between them is quite difficult to explain and demonstrate. However, it can be said that *however* does bring a certain additional tone of subordination in relation to S2.

The core meaning of the contrastive marker *on the other hand* is more specific than *however* as it signals that the contrasting S2 message must be an alternative to the direct S1 message around a specific topic. Fraser (1998, p. 314) also indicates that the sense of alternatives becomes more apparent when S1 is introduced by *on the one hand*.

*Researchers have also found that competencies expected of sport managers comprise strong communicative and social aspects with an emphasis on the importance of interpersonal communication, public relations, advertising and techniques of personal management. **On the other hand**, Quarterman et al. stated that a combination of personal, human, conceptual, technical and conjoined skills is necessary when working as a sport manager.*

S1. On the other hand, S2 (as an alternative to the S1 message)

Arguably, the conclusion made by Fraser (1998, pp. 313-314) that in the case of *but* and all its subclasses, the upper, more general contrastive discourse marker can "replace" a lower contrastive discourse marker and take on the more restrictive contrastive interpretation, also implies that certain changes must be made in the actual sentences in order for this to be applicable, primarily in relation to the position of the mentioned discourse markers within the sentence. The results of this analysis suggest that *but* is generally used in the middle position (88%), whereas *however* and *on the other hand* occur nearly equally in both positions and are only slightly more often used in the utterance-initial position (55%). Further detailed analysis should be conducted concerning the mentioned "replacement" of more restrictive contrastive discourse markers by upper and more general ones in relation to their occurrence in a particular position in the sentence.

In his study on discourse markers, Holker (1991, pp. 78-79) mentions four basic features, among which he argues that "they do not affect the truth conditions of an utterance" and that "they have an emotive, expressive function rather than a referential, denotative, or cognitive function". The above-mentioned functions of discourse markers, therefore also of *but, however* and *on the other hand*, accurately demonstrate the role of contrastive discourse markers in sports management papers. Although the above-mentioned examples would convey the identical information if uttered without the contrastive discourse markers *but, however* and *on the other hand*, the precise message conveyed by the various authors would by no means remain the same as the uttered markers add a certain tone, as well as a certain "attitude" in relation to S1 and S2.

In conclusion, different scientific papers, as well as various scientific disciplines they are part of, tend to research and analyse a fundamental thesis which is the subject matter of a research. While doing so, comparisons are made in relation to the existing knowledge in order to determine the relevance of the researched topic. The analysis has shown that in scientific papers on sports management, among the three studied contrastive discourse markers, *but and however* are most frequently used, however *but* mostly in the middle position, while *however* is almost equally used both in the middle and the utterance-initial position. *On the other hand* is used substantially less frequently, which is expected as it has a specific meaning which requires an utterance signalling not only contrast, but also providing an alternative. The result of the analysis also suggest that further research should be conducted on the possibilities of "replacement" of more restrictive contrastive discourse markers by general ones in relation to their occurrence in a particular position in the sentence.

References

1. Aijmer, K. (2002). *English discourse particles. Evidence from a corpus*. Amsterdam: John Benjamins.
2. Bondi, M. (2004). The discourse function of contrastive connectors in academic abstracts. In K. Aijmer & A.-B. Stenström (Eds.), *Discourse Patterns in Spoken and Written Corpora* (pp. 139-156). Amsterdam: John Benjamins.
3. Fraser, B. (1988). Types of English discourse markers. *Acta Linguistica Hungarica*, *38*(1-4), 19-33.
4. Fraser, B. (1998). *Contrastive discourse markers in English*. Discourse Makers: Description and Theory, pp. 301-326.
5. Fraser, B. (1999). What are discourse markers? *Journal of Pragmatics*, *31*, 931-953.
6. Fung, L., & Carter, R. (2007). Discourse markers and spoken English: Native and learner use in pedagogical settings. *Applied Linguistics*, *28*(3), 410-439.
7. Gee, J. P. (2014). *An introduction to discourse analysis: Theory and method*. London: Routledge.
8. Heeman, P.A., & Allen, J.F. (1999). Speech repairs, intonational phrases and discourse markers: Modeling speakers' utterances in spoken dialogue. *Computational Linguistics*, *25*(4), 1-45.
9. H**ö**lker, K. (1991). Franz**ö**sisch: Partikelforschung. *Lexikon der Romanistischen Linguistik,* vol V. 1.
10. Juncker, A. H. & Ziv Y. (Eds.), *Discourse Markers: Description and theory* (pp. 301-326). Amsterdam/Philadelphia: John Benjamins Publishing Company.
11. Nova, J. (2014). *Sport management as an integral part of kinanthropology. 7th International Scoentific Conference on Kinesiology: Fundamental and Applied Kinesiology – Steps Forward*. Proceedings, 447-450.
12. Jørgenesen, M., & Phillips, L. (2002). *Discourse analysis as theory and method*. London: Sage Publications.
13. Schiffrin, D. (1987). *Discourse markers*. Cambridge: Cambridge University Press.
14. Yang, S. (2011). Investigating discourse markers in pedagogical settings: A literature review. *ARECLS*, *8*, 95-108.

ASSESSING THE IMPACT OF EUROPEAN UNION FUNDING FOR SPORT FACILITIES AT LOCAL LEVEL

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Abstract

The cohesion policy and European funds and operational programmes at regional level in the Czech Republic in the programme period 2007- 2013 allowed the financial support of various projects aimed at the development and reconstruction of sports facilities. Therefore, the objective of this study was to identify the extent of this targeted funding in the Czech regions and to explore how it is viewed by beneficiaries, sports associations, and sports clubs with regard to the impact on participation in sport and elite sport. The results from three subsequent surveys were complemented by a Eurobarometer survey and a representative sample of the Czech population survey. The main reason for which the beneficiaries were applying for support from EU funds for the construction of new or the revitalization of sports in their town/city was to increase sport participation and to create the conditions for talent development, which is the cornerstone of elite sport. As the Eurobarometer results showed, the percentage of those who exercise or play sport regularly in the Czech Republic remained the same in 2014 as it was in 2010 , but there is increase in those who are exercising or playing sport with some regularity or seldom. This study also showed that the different target groups in three different surveys share the same opinion about the extent to which the EU funding used for the development of facilities can contribute to elite sport success in the Czech Republic. Representative sample survey in 2016 though confirmed the decline in the membership base in sports clubs in the Czech Republic. Thus, the study makes a contribution towards the understanding of EU funding as one of the possible facilitators for sports development purposes.

Key words: *EU funding, sport infrastructure, sport participation, club membership, impact*

Introduction

The sport policy in the Czech Republic over the last three decades has emphasized participation in sport as well as support for elite sport. The cohesion policy and the *European funds* used as a tool for its implementation have a significant impact on the economy of the Czech Republic. Operational programs at a regional level in the program period 2007-2013 allowed the support of various projects in the 7 regions (the so-called Cohesion Regions NUTSII). Many of them were aimed at the development and reconstruction of sport facilities. The situation with regard to EU funds utilization for the provision of sporting facilities and opportunities for the masses resembles the situation in Finland as described by Green and Collins (2008). But the question remains how to evaluate the effect of the EU funds in sport and how it affects participation in sport as one of the critical factors of the third pillar model SPLISS (De Bosscher et al., 2008). Although participation in sport is one of the critical factors, at the same time De Bosscher et al. (2013) also emphasise that the claims made by policymakers that elite sport and mass participation benefit one another is a complex issue and elite sport cannot be regarded as a simple extension of mass participation. In addition, in club based sport culture there is an assumption that increased mainstream participation and club membership will have a positive effect on elite sport success and vice versa. The theoretical model developed by Van Bottenburg (2002) called the 'double pyramid theory' presents a two-way assumed relationship between mainstream and elite sports. A supply function from mainstream sports to elite sports, and an inspirational function from elite sports to mainstream sports are at the core of this model. But the research evidence about how this two-way relationship in sports is facilitated by EU funding is lacking. The aim of this study is therefore to determine the ways to identify and measure the relationships between EU funding and participation rates in sport in the Czech Republic in the long term, and assess the impact of EU funding on club membership and development of talent for elite sport.

Methods

The extent of financial support from Regional Operational Programme schemes for the development of sports facilities in the 7 regions of the Czech Republic in the period of 2007 up to 2015 was explored. Profound content analysis of relevant documents on EU fund spending and an examination of the lists of beneficiaries in each region were conducted. This hard data has been supplemented by a mail survey which was held among the EU fund beneficiaries (n= 251, response rate 38%), and representatives of selected sports associations (n = 46, response rate 36%) at a regional level about the expected impact of EU funding. To assess the impact on sports clubs (n=318) a questionnaire was created containing descriptive questions about the perceived impact of EU funding participation. The results from the Eurobarometer surveys from the years 2010 and 2014 with regard to the Czech Republic have been taken into consideration as well, as far as the surveys have been conducted in the period where increased participation/club membership should be recognizable as result of the EU funding. The last data set was created in the form of a questionnaire survey conducted by the agency Focus using the face-to-face method. Overall, 1,050 respondents participated in the survey. A gender balanced sample was a representative sample of the Czech population.

Results

As of July 2015 in 7 regions, the total amount allocated for Regional Operational Programmes was €4.995 billion. Analysing the structure of beneficiaries, there were 971 sport-related projects out of 6728 supported. The amount allocated for projects related to sport and the development of sport infrastructure reached almost 12% (€598.9 million) out of the overall allocated amount for regional development. The detailed analysis of all 7 regions showed that the majority of supported projects were aimed at the development or reconstruction of cycle paths, multi-purpose and special-purpose sports fields, public sports fields, running tracks, swimming pools, sports centres and leisure facilities for disabled sports. The selected results from the mail survey among EU fund beneficiaries are presented in Table 1; results from the survey among representatives of sports associations at a regional level are presented in Table 2.

Table 1: The expected impact of EU funding in sport infrastructure - opinions of EU fund beneficiaries (2015)

Q 1: What was **the main reason for which you're applying for support from EU funds** for the construction of new or the revitalization of sports in your town/city?
Increasing the participation of inhabitants of the region in sports – 55%; Creating conditions for the development of young talent- 12%; Support for the development of a particular sport- 5.2%; another reason – 27.5%.
Q 2: Has participation in sport increased, according to your view, thanks to the new / redeveloped number of sports venues in your town/city? If so, approximately how many percent?
Not increased at all –3.2%; **Don't know** – 23.1% **Less than 5%** – 9.6%; **(5% - 9%)** – 15.1%; **(10% - 19%)** – 24.7%; **(20% - 49%)** – 15.9%; **(50% - 79%)** – 4.8%; **(80% - 100%)** – 2%; **More than 100%** – 1.6%
Q 3: Does the new/redeveloped sports facility contribute in your town/city for the development of talent for elite sport?
Yes – 49.4%; **No** – 50.6%

Table 2: The expected impact of EU funding in sport infrastructure - opinions of regional sport association representatives' (2015)

Questions and answers
Q 1: What was, in your opinion, **the main reason for which municipalities in your region asked for support from EU funds** for the construction of new or revitalization of existing sports facilities?
Increased participation of inhabitants in sport activities –32.6%; **The creation of conditions for the development of young talent** – 23.9%; **The support of a particular sport – 23.9%; Another reason** – 19.6%
Q 2: Has the participation in sport increased, according to your view, thanks to the new/revitalized sports in villages and towns in your area? **If so, by approximately how many percent?**
No – 21.7%; **Don't know** – 32.6% ***Expected increase of between:*** **(5-9%)** – 15.2%; **less than 5%** –10.9%; **(10-19%)** – 6.5%; (**20-49%)** – 6.5%; **(50-79%)** – 4.3%; **more than 100%** – 2.2%
Q 3: In which categories of athletes in your sport has the participation increased as a result of new/revitalized sports in villages and towns in your region?
Younger school age (6 – 11 years) – 43.5%; Older school age **(11-15 years)** – 8.7%; **Teenagers (15-18 years)** – 0% **Men** – 4.3%; **Women** – 2.2%
Q 4: In which categories of athletes do you expect their development at an elite level, as a result of new/revitalized sports in villages and towns in your region?
Younger school age (6 – 11 years) – 15.2%; **Older school age (11-15 years)** – 17.4%; **Teenagers (15-18 years)** – 15.2%; **Men** – 2.2%; **Women** – 4.3%
Q 5: Do the new/redeveloped sports in villages and towns in the region contribute to the d**evelopment of young talent for elite sport?**
Yes – 50%; **No** – 50%
Q 6: Do you assume that the new/revitalized sports in villages and towns in your region will result in an **increase in the number of medallists at Olympic Games and world and European championships**
Probably No – 50%; **Probably Yes** – 15.2%; **Definitely No** – 8.7%; **Definitely Yes** – 2.2%; **DK** – 23.9%

When assessing the impact of EU funding on sport infrastructure, the results from the Eurobarometer survey (EC, 2010, 2014) can also be used. For the purpose of this paper, only the questions and results relevant to the general participation in physical activities and opportunities that exist in local areas for physical activity, participation in physical activities in sports clubs, and club membership have been selected. The results are presented in Table 3.

Table 3: Eurobarometer survey results 2010, 2014 – selected results

Year	2010		2014	
How often do you exercise or play sport?	**EU%**	**CZ%**	**EU%**	**CZ%**
Regularly (at least 5 times a week)	9	5	8	5
With some regularity (3 to 4 or 1 to 2 times a week)	31	23	33	31
Seldom (1 to 3 times a month or less often)	21	35	17	29
Never	39	37	42	35
	2010		**2014**	
Where do you engage in sport or physical activities?	**EU %**	**CZ %**	**EU %**	**CZ %**
In a club (Q in 2010) *In a sports club (Q in 2014)*	11	6	12	11
Are you a member of a sports club?	n/a	n/a	11	11
The area where I live offers me many opportunities to be physically active (Q in 2010/2014) **Local sports clubs or local providers offer many opportunities to be physically active (Q in 2014)**	**EU % 2010/2014**	**CZ % 2010/2014**	**EU %**	**CZ %**
Totally agree	37/39	19/24	36	23
Tend to agree	38/37	42/49	38	46
Tend to disagree	13/13	24/19	12	21
Strongly disagree	7/7	11/4	7	5
Don’t know	5/4	4/4	7	5

The results from the survey conducted in sports clubs in the form of questionnaires are presented in Table 4

Table 4: The perceived impact of EU funding by sports clubs (2016)

Number of respondents (sports clubs N=318) 102 sports clubs have participated as an organization in the preparation of an application for project financial support, 135 have not, 80 did not answer; 65 sports clubs (n=238) 20, 44% have been the only recipient of funds over that period
Q 1: Was any construction or reconstruction of sports facilities carried out in your municipality in the period of 2007-2015?
Yes – with EU funding – 32; Yes- with other than EU funding – 133 (mostly from municipality and regional resources) Both – 23; No – 87; Yes – not sure about resources – 3 **19.7% EU funding; 56, 17% other sources** N=278
The type of sports infrastructure that was built the most over that period
N=181 Multifunctional playgrounds, gyms and parks (46) – 25.41%; Reconstruction (58) – 32% Football pitches (15) – 8.28%; Ice hockey rinks (11) – 6.07%
Q 2: What effect have you recognized as a result of EU and other funding in your sport facilities?
14 The sports club created new sports sections in these sports Athletics, swimming, fitness, table tennis, self-defence, workout, (football, aerobics) golf, football, beach volleyball, slow-pitch, tennis, floorball, ice hockey; **The estimated increase in the number of members of sports clubs** (80 clubs out of 318) the number of new members of sports clubs – 1952, on average 24 members per club; **Expanded numbers in particular age groups in the sports club** – (62 sports clubs out of 318) 40 of them expanded the numbers in the kids age group, 6 for all age groups, the rest – expanded the seniors, adults, juniors and women age groups; **Improved sports training for members and also towards the elite sport concept** – (83 clubs out of 318) in these clubs, the current number of athletes in preparation for elite sport is 3847.
Estimated increased interest of the citizens in PA from sports clubs community as a result of the change in sport infrastructure
Just 78 sport clubs were able to answer this Q **and 46 (58.97%) of them estimated that the participation of citizens in sport increased between 10 - 20%.**

The last data set used in the analysis was created in the form of a questionnaire survey conducted in autumn 2016 by the agency Focus using the face-to-face method. Overall, 1,050 respondents participated in the survey. The average age of respondents was 46.45 years old. The gender representation was 501 (47.7%) men and 549 (52.3%) women. This survey showed that 61.04% of respondents are doing sport recreationally while 29.04% respondents are not involved in sport activities at all. It also showed that 91.5% of respondents are not members of a sport club while 8.5% are.

Discussion

In this study, the assumed relationship between EU funding and sport participation in the Czech Republic was assessed using four subsequent surveys. The first one was conducted in 2015 among the EU beneficiaries who obtained EU funding for the building and reconstruction of sport facilities and among the regional sports associations representatives' assessing the impacts of EU funds in terms of sport participation and potential for elite sport development. The second one, the Eurobarometer, presents the reality in 2014 in comparison to 2010 with regard to sport participation, conditions for sport and physical activities, and sport club membership. The third one presents the opinions of sports clubs with regard to the impact of EU funding in sporting facilities and was conducted in 2016 as along with the representative survey among the Czech population. Analysis of the results showed the trends in sport participation, club membership increase and their relationship to elite sport in the Czech Republic. The main reason for which the beneficiaries were applying for support from EU funds for the construction of new or the revitalization of sports in their town/city was to increase sport participation (55%) and to create the conditions for talent development, which is the cornerstone of elite sport (12%). According to the view of sports associations, the main reasons were the same, but they assigned a different importance to these areas (sport participation increase – 32.6% and condition for talent – 23.9%). The estimation of the increase in sport participation thanks to new/redeveloped sports venues varies. While the 24.7% of beneficiaries believe that the participation increased from 10% - 19%, just 6.6% of representatives from sports associations believe this. Just 78 sport clubs were able to answer this question and 46 (58.97%) of them estimated that the participation of citizens in sport due to the new sport facilities increased between 10-20%. As the Eurobarometer results showed, the percentage of those who exercise or play sport regularly in the Czech Republic remained the same in 2014 as it was in 2010 i.e. 5%, but there is 2% increase in those who are exercising or playing sport with some regularity or seldom. The percentage of those who are not involved in sport activities at all has decreased - by Eurobarometer from 37% in 2010 to 35% in 2014, and our representative survey in 2016 confirmed this trend identifying the number of people who never do any sport at just 29.04%. Thus in our view, the assessment of targeted EU funding into sport facilities in the long term can be conducted as a comparison of the results from four different surveys in the Czech Republic that estimate an increase in participation in sport and this can be confirmed by the Eurobarometer surveys and our own survey from a representative population sample, although there are another factors present that might be a reason for sport participation as well. However, the importance of appropriate, available, and accessible sport infrastructure can be seen in the Eurobarometer survey results. Comparing the figures from 2010 to 2014 there is a positive change in the assessment of opportunities to be physically active (see Table 3) that might be the result of newly built or renovated sport infrastructure from EU funds. This study also showed that the different target groups in three different surveys share the same opinion about the extent to which the EU funding used for the development of facilities can contribute to elite sport success in the Czech Republic. Half of them believe that new/redeveloped sports facilities in villages and towns will contribute to the development of talent for elite sport and to an improvement in the number of medallists at Olympic Games and world and European championships. The question regarding the membership in sports clubs was a new item introduced in the Eurobarometer survey from 2014 and the figure gathered in 2013 (11%) is higher than the figure from our representative sample survey in 2016 (8.5%) and it confirms the decline in the membership base in sports clubs in the Czech Republic. The results from the survey among the sports clubs indicate that there is an increase in the number of members of sports clubs but just 80 clubs out of 318 confirmed the number of new members of sports clubs.

Conclusion

The European Union supports participation in sport in its key documents (European Commission, 2007, 2014) and encourages EU member states to implement all measures (including EU funding schemes) to increase it. But little is known about how to measure and evaluate the impact of this targeted funding in the long term with regard to the expected rise in participation level and the success in elite sport as well. Therefore, on the basis of the country case study, this paper emphasises the inevitability of adopting the appropriate measuring mechanism in terms of the effectiveness and efficiency of EU funding in sport, which is fully in the hands of the national and regional authorities. This would also allow the identification of links between participation and elite-focused policies and thus suggest the appropriate policy instruments which will be in tune with them.

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References

1. De Bosscher, V., Bingham, J., Shibli, S., Van Bottenburg, M. &De Knop, P. (2008). A global Sporting Arms Race. An international comparative study on sports policy factors leading to international sporting success. Aachen: Meyer & Meyer.
2. De Bosscher,V., Sotiriadou, P. & Van Bottenburg, M. (2013). Scrutinizing the sport pyramid metaphor: an examination of the relationship between elite success and mass participation in Flanders. *International Journal of Sport Policy* 11/2013; 5(3):319-339. DOI:10.1080/19406940.2013.806340.
3. Bottenburg, M. van (2002). Sport for all and elite sport: do they benefit one another? Paper for the IX World Sport for All Congress, Papendal, the Netherlands, 27-30, October.
4. European Commission (2010) Eurobarometer 72.3 (2009). TNS Opinion & Social, Brussels. GESIS Data Archive, Cologne. ZA4977, data file version 2.0.0, doi:10.4232/1.11140.
5. European Commission (2014) Eurobarometer 80.2 (2013). TNS Opinion, GESIS Data Archive, Cologne. ZA5877 Data file Version 1.0.0, doi:10.4232/1.12010
6. Green, M. &Collins, S. (2008). Policy, Politics and Path Dependency: Sport Development in Australia and Finland. *Sport Management Review*. Vol.11, pp. 225- 251.
7. Resolution of the Council and of the Representatives of the Governments of the Member States, meeting within the Council, of 21 May 2014 on the European Union Work Plan for Sport (2014-2017). *Official Journal of the European Union*. C 183/12.

SPORTS TOURISM AND TEXTILE INDUSTRY

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Abstract

This paper focuses on detection and description of the role and importance of the textile industry for the tourism industry i.e. its specific form of selective tourism - sports tourism. It is widely known that nowadays textiles can be designed in different ways and in accordance with our needs e.g. sports. These types of textile materials, have their place in the field of technical textiles, as a specific part, so-called sports textiles i.e. sporttech. With the development of society and technology, sports and recreation it was possible to put for this paper hypothesis that textile industry has, with all its resources, a comprehensive applicability in the business of sport and, as a consequence, in sports tourism. It produces significant economic, sociological, psychological, intrinsic and other unmentioned effects. Different trends of understandings of life and ways of life, favor to the growth of consumption in the segment of sports tourism, and thus in the area of supply and demand for sports textiles. In support of hypothesis, are given examples of unquestionable connection between the textile industry and services and production activities relevant to the development of sports tourism, which are in the function of their numerous impacts and in order to meet the needs of consumers.

Key words: *sports tourism, textile industry, technical textiles, sports textiles, sports textiles impacts*

Introduction

The 21st century gives us a new paradigm for textiles. Textiles are not associated any more only with clothes that covers our body and protect it from harsh environmental conditions, but also with materials that can be designed according to the specific requirements in use like e.g. breathable (water repellent and at the same time vapor permeable) fulfilling our needs from medical to sports (Figure 1). These kinds of textiles have different structures and characteristics depending on the specific requirements and needs. Such unconventional textiles are known as technical textiles (Figure 2) and today, with the respected value market represents the major profitable niche in textiles production. The reasons for such success can be contributed to the fact that textile science and technology through different textile fibers, structures and constructions provide solutions that help modern engineers to accomplish different temptations and expectations posed on them at the present time like e.g. light construction and low weight, air-permeable, ultra breathable, optimum heat and moisture regulation, temperature control, rapid drying or wicking, low water absorption and water vapor permeability, biodegradable, non-flammable, dimensionally stable in different weather condition, bullet resistant, windproof and waterproof etc. Usage of such ***technical textiles in sports activities*** is no exception - quite the contrary.

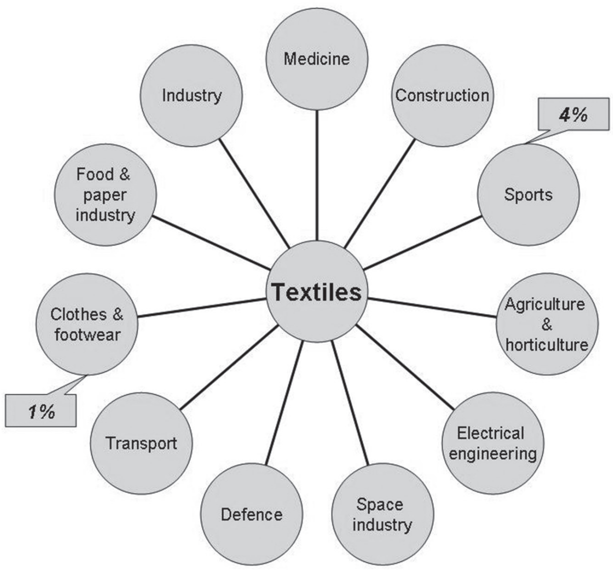

Figure 1: Areas of textiles application

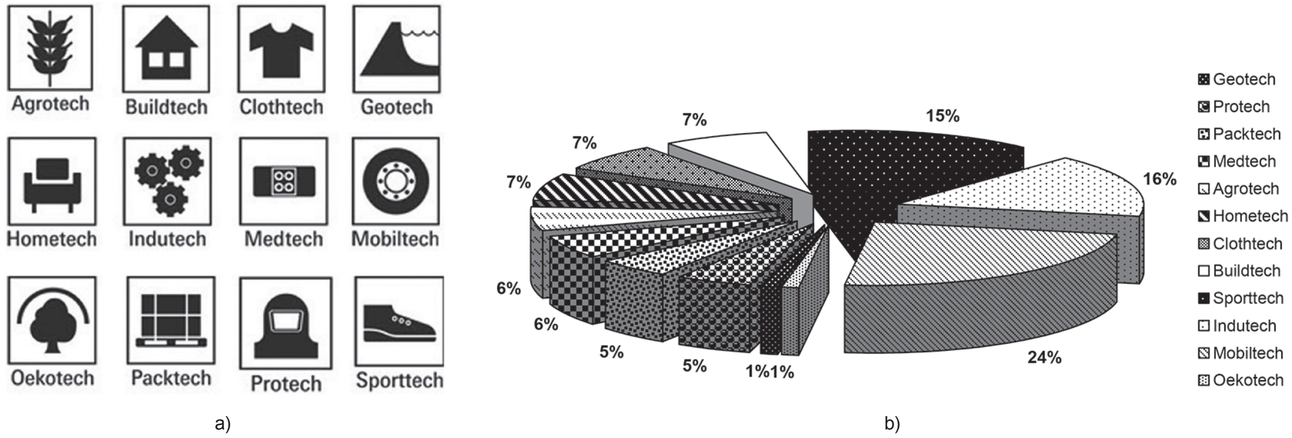

Figure 2: Technical textiles; a) classification according to the Techtextil Messe Frankfurt Exhibition GmbH and b) share by category (Horrocks, R., Anand, S. 2000)

Methods

In this paper, general methods of scientific research were used: desk research of primary, secondary and tertiary sources, systematic observation, description method, causal method, deductive and inductive methods and methods of analysis and synthesis. On such collected data, the qualitative explanatory case study method (Baxter, Jack 2008) was made. *So, "this type of explanatory case study would be used if the goal is to seek the answer for a question that sought to explain the presumed causal links in real-life that are too complex for the survey or experimental strategies" (Yin, 2003; Baxter & Jack, 2008:547). In this case, of evaluation, the explanations would link to effects.*

Hypothesis

Hypothesis: Textile industry has a comprehensive applicability in the business of sport and as a consequence in sports tourism.

Discussion

Since sport is perhaps the most dominant social influence in the world today by penetrating into every aspects of our life (O`Mahony, Braddock, 2002), sports textiles i.e. sporttech become more and more important not only for top athletes but also for ordinary humans. Sports textiles are one of the segments of technical textiles, which include:

- Textile materials used as sportswear (aerobic clothing, athletic clothing, football clothing, sweatshirts, swimwear etc.) with several function, providing not only body protection but also comfort, recognition and aesthetic design and sometimes even outstanding results.
- Textile fibers and materials used in sports equipment and accessories (sails, trampolines, camping gear, leisure bags, bikes, rackets, artificial grass, etc.) enabling e.g. faster sailing, safer climbing or simply easier handling and usage.
- Textile materials that is used in sports footwear (athletic shoes, football boots, gym shoes, tennis shoes, walking boots etc.).

The sports textiles business is technically oriented, using highly functional textiles for specialized performances in different sports, e.g. good thermal properties for cold-weather sport, aero-dynamic properties for downhill skiing and swimming, breathable waterproofing for outdoor pursuits, strength and durability for sails, less effort and fatigue of athletes due to the lightweight rackets and bats, safety in fencing because of cut and puncture resistant clothing and so on. *With the introduction of intelligent textiles and wearable technology, innovative solutions have become the name of the game for the sportswear businesses* (Sisho, 2005).

Since the hypothesis of this paper is claim, that textile industry has a comprehensive applicability in the business of sport and as a consequence in sports tourism, several (to this study available) studies were analyzed in order to confirm the claim (Table 1).

Table 1: Comparative analysis of previously conducted studies /parts connected with topic/

Published Study	Study goal(s)	Researchers outcomes
Developing sports tourism (Ross, 2001)	What is sport tourism? What are the impacts of sport tourism? What are the characteristics of sport tourists?	The tourism industry has started to recognize sport tourism, i.e. the experience of travel to engage in or view sport-related activities, as an important market etc.
Sport Tourism – Interrelationships, Impacts and Issues (Ritchie & Adair 2004).	Interdisciplinary perspective is a key to understanding of sport tourism applying different concepts or models in order to examine interrelationships, impacts and issues associated with sport and tourism.	Diversification in the industry; year round operations; resident attitude; security issue; future development determine by technology, innovations and personal factors; national strategies related to sport tourism; economic impacts etc.
An introduction to Sports Tourism and Event Management (Saayman, 2012).	Comprehensive approach to sports tourism.	Growing opportunity; economic, environmental and socio-cultural impacts, etc.
Report on THE SPORTS TOURISM INDUSTRY (NASC, 2015)	The sports tourism industry consists of many different forms of individual and team travel.	Visitor Spending in 2014 $8.96 billion, Growth Since 2013 3%, Sports Visitors in 2014 25.65 million, etc.
Textiles in Sportswear. (Shishoo, 2015).	To describe the developments in textile materials with specific reference to their use in sportswear.	Global sportswear market in 2012 exceeded $244 billion, etc.
Technical Textiles Market: Functionality over Aesthetics: Global Industry Analysis and Opportunity Assessment, 2015-2020. (FMI, 2016)	Share of the global textile revenues.	Fastest compound annual growth rate (CAGR) in terms of revenues were Oecotech 7.1%, Geotech 6.0% and Sportech 5.5%, etc.

What does sports tourism stand for? According to different researchers, (Gammon & Robinson, 1997, Ross, 2001, Saayman, 2012, etc.) sport(s) tourism refers to similar, but in final content, different issue. “Sport tourism refers to the experience of travel to engage in or view sport-related activities. It is generally recognized that there are three types of sport tourism: Sport Event Tourism, Active Sport Tourism, and Nostalgia Sport Tourism.” (Ross, S.D., 2001, p. 3). Sport Event Tourism includes visit to different sport events. Active Sport Tourism describes active participation in sports activities of individuals who travels. Nostalgia Sport Tourism is travelling to famous sport-related attractions (Ross, S.D., 2001). On the other hand, Gammon and Robinson (1997) describe relation between sport and tourism as “Sport tourism” and “Tourism sport”. Sport tourism involved passive and active participants at a competitive sporting event, while “Tourism sport” involves visitors who engage in some minor form of sport or leisure (Saayman, 2012). Therefore, it is obvious that sports tourism integrates into tourism product sports activities. Since sport involves very wide range of activities it is necessary to explain the areas of sports activities – these subareas are areas of competitive sport, recreational sport, education and science in sports, physical training and sports of disabled and other business sporting activities (Novak, 2001).

“What are general benefits of sport tourism? Sports are an investment in the tourism industry; Creates economic growth through filled hotels, restaurants and retail establishments; Creates exposure and enhances a positive image for your community; Creates new product, a new tourism destination; Maximizes facility use in your community; Builds community relationships and strengthens corporate support; Creates youth opportunity/entertainment; Attract high-yield visitors, especially repeaters; Generate favorable image for the destination; Develop new infrastructure; Use the media to extend the normal communications reach; Generate increased rate of tourism growth or a higher demand plateau; Improve the organizational, marketing, and bidding capability of the community; Secure a financial legacy for management of new sport facilities; Increase community support for sport and sport-events” (Ross, S.D., 2001, p. 7). Tourism provides one of 11 job worldwide (UN World Tourism Organization, 2017). Market for sporttech according to David Rigby associates consumption of sports apparel was 195 Kilo Tones in 1995 it increased to 395 KT in 2005 (Halder, P., 2013). Also, “global sportswear market in 2012 exceeded $244 billion” (Shishoo, R., 2015:3) and the market has trend to grow each year.

Example: “It is estimated that golf tourism currently generates around £220 million for the Scottish economy. This output represents Gross Value Added of £120 million and supports 4,400 jobs…This increase in demand for tourism services creates further economic activity through ‘multiplier’ effects. These businesses will need to purchase more inputs (i.e. goods and services) and this generates additional demand for suppliers…” (SQW Consulting, 2009, p. 51, 7). *How many jobs and how many other different economic effects generate textile industry within those effects?*

Since, the uses of sport(s) during vacation and/or travel with sports purpose necessarily inclose apparel i.e. textile items or equipment that implies that every with active participated and sport motivated travel is connected with direct or indirect expenditure for textile items. In that sense, how many jobs provides sports tourism and textile industry for sport tourism within this one of 11 jobs and / or for all of above mentioned impacts of sport tourism? On this questions is very difficult to answer, but is obvious that there are some significant impacts. It is common knowledge that sport has influence i.e. makes contribution to the GDP in semi and developed countries - around 1 to 2%. Tourism participate with 4 to 6% (Ritchie., B.W., Adair, D., 2004, p. 2). „International tourist arrivals grew by 3.9% to reach a total of 1.235

million, according to the data analyzed in this issue of the UNWTO World Tourism Barometer. Some 46 million more tourists (overnight visitors) travelled internationally last year compared to 2015“ (UNWTO Barometer, 2017:1). Therefore, many visitors obviously have to participate in sport tourism as well. Sports visitors in 2014 in USA participate with 25.65 million arrivals (NASC, 2015). In Croatia in 2014 visitors make 11.6 million arrivals with 10.1 billion US$ expenditure (UN statistical Yearbook, 2016). But only 2.75% on sport and leisure (Institute for Tourism, 2015).

Because of previously mentioned economic impacts and wide range of subareas of sport, sports tourism has opportunity to offer wide range of textile products within tourism products. Those products can be, and they are, connected with different type of facilities, equipments and nature for which are technical textile in sport (sporttech) specially designed. Having in mind different kind of sports tourism it is obvious that sporttech present a significant part in its realization:

- For competitive sport – institutional or not institutional competitive activity that involves highly skilled physical efforts with goal to achieve competitive results and/or joy of wining for which they need to use various types of technically advanced sportswear.
- For recreation tourism - to be able to escape the routine of daily life as in camping or going to a beach, solid, water resistant air-permeable tent is imperative while UV protective, fast drying swimsuit is essential. For active tourism like e.g. climbing on a mountain, thermo regulating, comfort clothing and light equipment are needed. In sports tourism as sky holidays or recreation sailing fiber reinforced fast and light skis or sail are wanted. For adventure tourism, super strength ropes in rock climbing or anti-slippery footwear during tracking through rainforest can save a life. In wilderness tourism cur resistant clothes and shoes might help in surviving. For ecotourism biodegradable, multifunctional accessories are in accordance with sustainable living.
- For health/medical and / or physical training (kinesitherapy) textiles breathable and antimicrobial clothes in exercising can be contributing factor as well as clothes and / or equipment that provides safe exercising.
- For sports of disabled persons there are many special apparels technically advanced for special purpose and other equipment based on fiber reinforced composites.
- For education and science in sports there are items that provide lecturing or exercising possible as well as different scientific activities.

Conclusion

According to shown facts and arguments, it is possible to conclude that given hypothesis: Textile industry has a comprehensive applicability in the business of sport and as a consequence in sports tourism is confirmed. Sports textile industry has significant impact on most of economies on supply side through production or through consumption for sports activities, which are part of sports tourism as well. That makes this conclusion possible.

References

1. Baxter, P., Jack, S. (2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. Fort Lauderdale, FL: The Qualitative Report
2. Future Market Insights (2016). Technical Textiles Market: Functionality over Aesthetics: Global Industry Analysis and Opportunity Assessment, 2015-2020. [online] Available at: http://www.futuremarketinsights.com/reports/technical-textiles-market
3. Global Industry Analysts Inc., (2015). Technical textiles – A global strategic business report. [online] Available at: http://www.strategyr.com/pressMCP-7090.asp
4. Halder, P. (2013). Textile in sports and material structure and application. [online] Available at: https://www.slideshare.net/ttkbal/textile-in-sports-and-its-material-structure-and-applicationn published 2013
5. Horrocks, R. and Anand, S. (2000). Handbook of technical textiles. Boca Raton: CRC Press
6. Institute for tourism. (2015). Tomas research Summer 2014. Zagreb: IT. [online] Available at: www.iztzg.hr/UserFiles/Pdf/Tomas/Tomas-Ljeto-2014-Sazetak-iz-knjige.pdf
7. Novak, I. (2001). The concept of sports marketing in the valuation of the economic impact of sport as an integral part of the economy. Dissertation. Zagreb: Faculty of economy and business.
8. O`Mahony, M. and Braddock, S. (2002). Sportstech – Revolutionary fabric, fashion & design. London: Thames & Hudson Ltd.
9. Ritchie., B.W., Adair, D. (2004). Sport Tourism – Interrelationships, Impacts and Issues. Clevedon-Buffalo-Toronto: Channel view publication.
10. Saayman, M. (2012). An introduction to Sports Tourism and Evant Management. Potchefstroom; African Sun Media Metro. [online] Available at: https://books.google.hr/books?id=y7gaB99c0UgC&pg=PA21&lpg=PA21&dq=competitive+sport+as+sports+tourism&source=bl&ots=M_h8LvZXaC&sig=BNY7gaOF2AngqlFZf9B_n_NXIiE&hl=hr&sa=X&ved=0ahUKEwjSzY6Gq4bTAhUrLcAKHYXuDsgQ6AEIRDAF#v=onepage&q=competitive%20sport%20as%20sports%20tourism&f=false
11. Schumacher, D.G., NASC (National Association of Sports Commission), (2015). Report on sports tourism industry. NASC/George Washington University Study 2014. [online] Available at: https://www.sportscommissions.org/Portals/sportscommissions/Documents/About/STI_ report_Oct_15.pdf

12. Shishoo, R. (2015). Textiles for Sportswear. Cambridge; Woodhead Publishing Limited.
13. United Nations. (2016). Statistical Yearbook 2016 Edition, 59th edition, New York: UN Department of economic and social affairs. [online] Available at: https://unstats.un.org/unsd/publications/statistical-yearbook/files/syb59/syb59.pdf
14. UNWTO – United nations World Tourism organization. (2016). [online] Available at: http://www2.unwto.org/en
15. Yin, R. K. (2003). Case study research: Design and methods (3rd ed.). Thousand Oaks, CA: Sage.

FINANCING OF RECREATIONAL SPORTS PROGRAMMES FROM THE STATE BUDGET OF THE REPUBLIC OF CROATIA

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Abstract

Republic of Croatia recognizes the benefits of recreational sports programmes and they are valued as a public necessity at state level. Therefore, funds are granted from the State Budget of the Republic of Croatia each year for their administration. However, only 10 per cent of Croatian citizens actively participate in recreational sports programmes, which is below the European average of between 13 and 72 per cent of active participants, relative to the population. Considering that it is scientifically proven that recreation has a positive effect on one's health, quality of life and workforce productivity, along with the fact that regular exercise prevents long-term sick leave, mental symptoms and poor health in working population, the aim of this article Is to indicate the need for more funds for recreational sports programmes from the State Budget and active participation of more Croatian citizens in the above-mentioned programmes.

Key words: *people's satisfaction, quality of life, a more productive population*

Introduction

The term *recreation* comes from a Latin word *recreare*, which means to re-create, renew, refresh, divert, have fun. Recreation is a spontaneous reflection of one's aspiration to satisfy his or her needs and appetites through preferred activities, all with the purpose of a more eventful use of free time (Relac, 1975). Recreation is an overall human activity outside of professional work, with positive effects, chosen according to one's preferences (Andrijašević, 1996).

Recreational sports are a part of recreation which encompasses different content of sports activities with the purpose of one's recreation (Andrijašević, 2006). People who participate in recreational sports programmes acquire healthy habits, such as having a healthy diet, not smoking, less alcohol consumption, etc., more easily (National institute of Health, 2003). Recreation has a positive effect on one's health through the improvement of their anthropological status, preventing typical illnesses of a modern man and increasing the level of people's satisfaction and quality of life (Vuori, 2004).

Every society should include recreational sports as an important factor at determining the quality of life, health and workforce productivity of its members, which strongly affects the nation as a whole. Awareness about the importance of health and workforce productivity should be an investment incentive for development and performance quality in the area of recreational sports (Andrijašević and Sirić, 2015).

Regular exercise prevents long-term sick leave, mental symptoms and poor health in working population and is a remedy for the dominant public health issues (Bemaards and associates, 2006, Houtman and associates, 2002, Vouri, 2004).

Republic of Croatia recognizes the benefits of recreational sports programmes and they are valued as a public necessity at state level, therefore funds are granted from the State Budget of the Republic of Croatia each year for their administration (Sports Act, 2006). The funds are planned for a distribution by the national sports authority and are allocated to the Croatian Olympic Committee (hereinafter referred to as COC) which is the umbrella sports organization in Croatia responsible for the distribution of funds for public needs in sport such as promotion of sports, especially for children, teens, university students and people with disabilities, funding of top athletes, national sports federations' activity, etc. Funds for recreational sports programmes are planned with purpose, and their administration is under the authority of the Croatian Federation for Sports Recreation "Sport for all" (CFSR). CFSR is a national organization which involves all structures and citizens of all age groups, who want recreational content to be a part of their life and an everyday habit, in recreational sports. The aims of CFSR's programme are for citizens to acquire useful knowledge, skills and habits while being a part of different types of physical activity, and an increase in the number of active participants from the current minimum of 10 per cent to the European level of between 13 and 72 per cent of active participants, relative to the population (Statut CFSR, 2015).

Methods

For the purpose of this article, we collected financial data about COC's overall income and expenditure for the period between years 2006 and 2015 and the annual amount and CFSR's expenditure proportion in COC's total expenditure, funded from the State Budget of the Republic of Croatia. For data analysis we used the Percentage Frequency Distribution method to calculate percentage. Study results are visually represented in following table and graph.

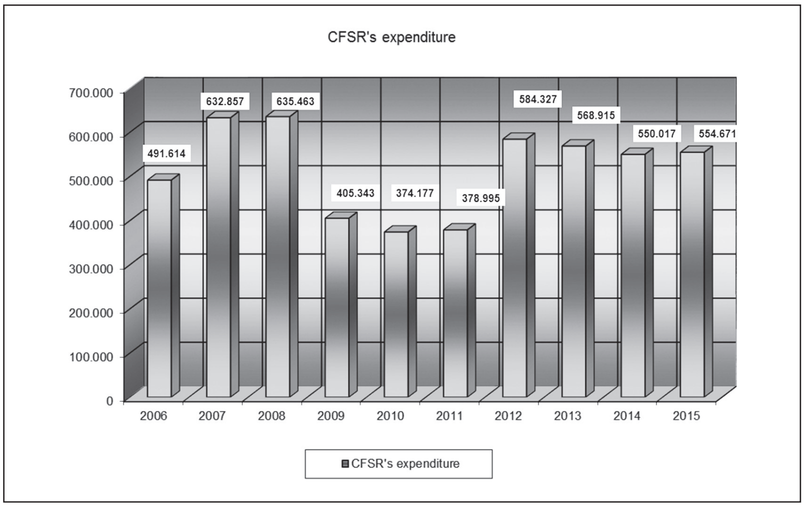
Results

Table 1 shows COC's total income and expenditure for the period 2006 - 2015 and annual expenditure for the recreational sports programmes as a percentage of COO's total expenditure (Financial reports COC' s 2006 - 2015).

Table 1: Total incomes and expenditures of COC for the period 2006 - 2015. and annual amount and percentage of expenditures for sport recreation programmes.

Year	COC's total income	COC's total expenditure	CFSR's expenditure	CFSR's expenditure - percemtage (4/3)
1	2	3	4	5
2006	127.979.913	107.496.623	491.614	0,46
2007	151.747.227	137.726.959	632.857	0,46
2008	151.747.227	147.100.762	635.463	0,43
2009	121.058.781	120.285.754	405.343	0,34
2010	120.415.831	114.424.764	374.177	0,33
2011	125.330.869	120.207.851	378.995	0,32
2012	131.440.193	138.974.636	584.327	0,42
2013	115.667.741	109.538.152	568.915	0,52
2014	108.941.778	107.863.384	550.017	0,51
2015	120.810.535	117.130.630	554.671	0,47
Total	1.275.140.095	1.220.749.515	5.176.379	0,42

Source: COC' s financial reports



Graph 1: CFSR's total expenditure from COC's funds for the period 2006 - 2015.

According to the regulations of the Sports Act, the majority of COC's expenditure (shown in the third column of Table 1) relates to the funding of top athletes and national sports teams competing in major international competitions (Olympic games, World Championship, European Championship, World Cup, European Cup, etc.)

The majority of recreational sports programmes have been administered for a number of years. The most significant programmes administered in 2015 were: 40th Women's March Cup (265 participants), 22nd Festival of Croatian recreational sports (200 participants), 22nd Recreational Tennis Festival (42 participants), 10th Festival of Recreational Cycling (800 participants), 21st Festival of recreational sports in rural areas (600 participants), 11th Croatian festival of recreational sports for women (320 participants), etc.

To administer recreational sports programmes, COC funds expenditure relating to administrative fees (salaries) of CFSR's employees, experts hired as recreational programme coaches, venues rented to administer the programmes, material expenses of CFSR, membership fees for European and world sports organizations, conferences organized by European sports associations, etc. The above-mentioned recreational sports programmes are organized by CFSR's employees as a part of the expenditure planned in COC's financial plan for each programme separately, while recreational sports programme participants cover their own expenses.

Discussion

Table 1 and its corresponding graph clearly show that the funds awarded to recreational sports programmes were slightly above 0,50 per cent of COC's total expenditure only in 2013 and 2014 (0,51 and 0,52 per cent respectively), while that percentage was under 0,50 per cent for the rest of the period, with it being the lowest during the years of recession (2009-2011), when the funds made up for an average of 0,33 per cent of COC's total expenditure. The percentage of funds awarded to recreational sports programmes was the highest in the pre-recession years (2007 and 2008), when COC's income and expenditure were also the highest comparing to the rest of the period between 2006 and 2015.

Funds annually awarded to CFSR's programmes from the State Budget are not significant (Table 1, column 4), but the fact that recreational sports programmes administered in 2015 included around 3000 participants shows that even with limited funds, significant results are achieved. According to CFSR's data, in the last five years these programmes included approximately 3215 participants per year.

According to the annual report from the Croatian Health Insurance Fund (CHIF) for 2015, the majority of total benefits paid in 2015 were sick leave and disability benefits which totalled 994.526.135 HRK, which is an increase of 6,63 per cent, or 61.880.381 HRK comparing to 2014 when they totalled 932.645.754 HRK. Moreover, 44.390 workers are absent from work daily in Croatia due to short-term disability (sick leave), which is 3,03 per cent of all policy holders (Business Report CHIF, 2015). Therefore, in 2015 Republic of Croatia has spent 994,526,135.00 HRK on sick leave and disability benefits (61 per cent or 606.355.122 HRK out of the above-mentioned amount was spent on benefits of paid sick leave), while spending only 554.671 HRK on recreational sports programmes, which is 1.793 times less than the amount spent on benefits of paid sick leave and disability benefits.

Conclusion

It is scientifically proven that recreation has a positive effect on one's health, quality of life and workforce productivity, while regular exercise prevents long-term sick leave, mental symptoms and poor health in working population and it is considered to be a remedy for the dominant public health issues. However, exercise is mostly a part of the private sphere of one's life. It is therefore essential that each country, including the Republic of Croatia, awards a more significant amount of funds for the administration of recreational sports programmes in their strategic annual plans, which will contribute to the growth of a healthy, happy and productive population.

References

1. Andrijašević, M. (1996). Sportska rekreacija u mjestu rada i stanovanja. Zagreb: Fakultet za fizičku kulturu.
2. Andrijašević, M. (2006). Kineziološka rekreacija (Skripra). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
3. Andrijašević, M. i Širić, V. (2015). Sportska rekreacija u razvitku hrvatskog društva. Zbornik radova 25. ljetne škole kineziologije. str. 51-58.
4. Bernaards, CM. Jans, MP. van den Heuvel, SG. Hendriksen, IJ. Houtman, IL. Bongers, PM. (2006), Occup Environ Med; 63(1): 10-6.
5. Financijska izvješća Hrvatskog olimpijskog odbora od 2006. do 2015. godine, www.hoo.hr i arhiva COO-a.
6. Houtman, ILD. Schoenmaker, CG. Blatter, BM. et al. (2002) Psychological complaints, interventions and return to work. The prognosis study INVENT [in Dutch]. Hoofddorp: TNO Work and Employment.
7. Izvješće o poslovanju Hrvatskog zavoda za zdravstveno osiguranje za 2015. godinu www.hzzo.hr
8. National Institut of Health (2003). Reducing nationwide obesity start sin neighborhoods/on-line/.
9. Relac, M. (1975). Rekreacija tjelesnim vježbanjem u procesu rada. Zagreb: Sportska tribina.
10. Statut Hrvatskog saveza sportske rekreacije „Sport za sve“, Skupština CFSR (2015), www.hssr.hr
11. Vuori, I. (2004) Physical inactivity is a cause and physical activity is a remedy for major public health problems. Kinesiology; 36(2), 123-153.
12. Zakon o sportu (Narodne novine 71/06, 150/08,124/10, 124/11, 86/12, 94/13, 85/15, 19/16-ispravak), www.nn.hr

THE IMPORTANCE OF KNOWLEDGE OF FOREIGN LANGUAGES IN SPORT MANAGEMENT

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Abstract

The aim of this research was to analyse the points of view of kinesiology students regarding the importance of foreign languages for ten possible jobs within the domain of management in sport, as well as to analyse the students' points of view regarding the importance of four communication-related aspects: the knowledge of terminology specific for sport and tourism, being able to discuss matters in a business situation in a foreign language, being acquainted with the issues in non-verbal communication and possessing intercultural communication competence. The sample was comprised of 70 subjects (men=44; women=26), between 21 and 32 years of age, students attending the Faculty of Kinesiology at the University of Zagreb. Factor analysis, done for ten variables addressing the importance of the knowledge of foreign languages for working as a sport manager in ten different jobs in Croatia, has extracted three factors. A series of regression analyses was then done to find out which of the communication variables best predicted the importance of the command of foreign languages for a sport manager in a certain set of possible jobs. The results point to the fact that tourism and organization of international sports events are domains in which the knowledge of foreign languages is an indispensable competence of sport managers. Attention should also be paid to intercultural communicative competence and the capacity to discuss business-related matters in a foreign language.

Key words: *foreign languages, sport management, jobs, terminology, communication*

Introduction

The importance of the knowledge of foreign languages in business matters is nowadays recognized in most areas of the world, and research has shown that the knowledge of foreign languages is a frequent requirement for many positions in a labour market (Martínek & Hanzlík, 2014). Sport, a global social phenomenon, has developed an array of domains in which experts of various areas of expertise work and pursue careers that contribute to this continuously growing phenomenon. Management in all those areas of expertise significantly affects the lines of their progress, and has become a subject matter of scientific inquiry. This has resulted in education demands for experts employed in sport management. Research has shown that communication skills (Chen, Adams-Blair, & Miller, 2013, p. 134), language skills in general (Thitthongkam & Walsh, 2010) and foreign language skills (Çiftçi & Mirzeoğlu, 2014) are among desirable knowledge-related requirements. Tourism is one of the business areas in which the knowledge of foreign languages, English occupying by far the most important place, goes without saying, and is a *must* worldwide for being competitive in a labour market and for pursuing a tourism-related career, e.g. in Thailand (Prachanant, 2012), Latvia (Dambe & Atstaja, 2013), Japan (Zhang & McCornac, 2014), Sri Lanka (Menike & Pathmalatha, 2015) and in Croatia (Kostic Bobanovic & Grzinic, 2011). Although the importance of the knowledge of foreign languages is unquestionable for many, some analyses have shown that there are cases when this knowledge is not regarded to be among the most important competences (cf. Atali, 2015).

Deliberation on the matter of foreign language proficiency has gone far beyond the issue of developing four traditional skills, i.e. writing, reading, listening and speaking, their development being a point of view omnipresent in research in the second half of the last century. Still, there were proponents of a different point of view according to which language skills are not a part of language ability at all, but are "contextualized realization of the ability to use language in the performance of specific language use tasks" (Bachman & Palmer, 2004, pp. 75-76).

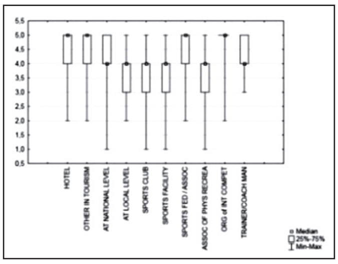
In the context of the previously said, the aim of this research was two-fold. The first aim was to analyse the points of view of kinesiology students regarding the importance of foreign languages for ten possible jobs within the domain of management in sport, as well as the importance of the four communication-related aspects: knowledge of terminology specific for sport and tourism, being able to discuss matters in a business situation in a foreign language, being acquainted with the issues in non-verbal communication and possessing intercultural communication competence. The second research aim was to identify the factor structure of the assessment tool, and to find out which of the communication variables best predicted the importance of the command of foreign languages for a sport manager in a certain set of possible jobs.

Methods

The sample was comprised of 70 subjects (men=44; women=26), between 21 and 32 years of age, students attending the Faculty of Kinesiology at the University of Zagreb. All subjects were at the stage of their study when they have already decided on their specialization in kinesiology, i.e. they were well acquainted with possible prospects both in pursuing a career in kinesiology in general and in pursuing a career in an area of expertise, management in sport-related sphere being one of them. The assessment tool was a questionnaire consisting of 14 statements – ten assessing the importance of the knowledge of foreign languages for working as a sport manager in ten different jobs in Croatia (*managing sports and physical recreation offer in a hotel; managing any other accompanying service connected with sports and physical recreation in tourism; managing the development of sports in institutions at national level; managing the development of sports in institutions at local level; managing a sports club; managing a sports facility; managing a sports federation/association; managing an association of physical recreation; managing the organization of an international sports event (event manager); and coach/trainer manager*), one assessing the importance of knowledge of terminology, and three assessing a selected set of communication-related variables (knowledge of non-verbal communication, e.g. gestures, facial expression, eye contact, etc.; being able to discuss business matters in a foreign language; and the knowledge of intercultural communication, e.g. being acquainted with the customs and principles of communication in different cultural surroundings). The subjects were asked to assess their agreement with each statement on a 5-degree Likert-type scale anchored between 1 (not important at all) and 5 (highly important). Nonparametric descriptive statistics of variables has been calculated. Factor analysis has been done for ten variables addressing the importance of knowledge of foreign languages for working as a sport manager in ten different jobs in Croatia. A series of regression analyses was then done to find out which of the communication variables best predicted the importance of the command of foreign languages for a sport manager in a certain set of possible jobs.

Results

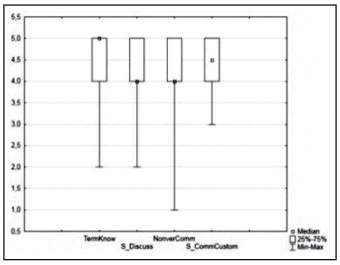
The survey of medians (Figure 1) has shown that although the subjects have assessed the importance of the knowledge of foreign languages to be high for all jobs under consideration, certain differences could be noted.



Legend: C – count; % – percent; HOTEL – managing sports and physical recreation offer in a hotel ; OTHER IN TOURISM – managing any other accompanying service connected with sports and physical recreation in tourism; AT NATIONAL LEVEL – managing the development of sports in institutions at national level; AT LOCAL LEVEL – managing the development of sports in institutions at local level; SPORTS CLUB – managing a sports club; SPORTS FACILITY – managing a sports facility; SPORTS FED / ASSOC – managing a sports federation/association; ASSOC of PHYS RECREA – managing an association of physical recreation; ORG of INT COMPET – managing the organization of an international sports event (event manager); TRAINER/COACH MAN – coach/trainer manager

Figure 1: Box and whiskers plot for the variables addressing the importance of the knowledge of foreign languages for working as a sport manager in ten different domains in Croatia

The variables *working as a sport manager in tourism*, *managing a sports federation/association* and *managing the organization of an international sports event* stood out as regards the significance of command of foreign languages that a sport manager should possess. Moreover, organization of an international sports event seemed to be the most demanding in this respect. The distributions of results regarding the variables addressing the knowledge of terminology and three communication-related aspects were also negatively asymmetric, the knowledge of terminology being rated as the most important (Figure 2).



Legend: TermKnow – knowledge of terminology; NonverComm – knowledge of non-verbal communication (gestures, facial expression, eye contact, etc.); S_CommCusto – knowledge of intercultural communication (customs, principles)

Figure 2. Box and whiskers plot for the variables addressing the four communication-related aspects

"Factor analysis is often carried out on variables which are highly skewed and/or kurtotic" (Muthén & Kaplan, 1985, p. 171), which was also the case in our research, so that subsequently the factor analysis (Kaiser criterion; Varimax normalized) has been performed for the set of these ten variables, and has yielded three factors (Table 1) that explained 67.5% of the total variance. Cronbach α of this part of the questionnaire was 0.775.

Based on the survey of factor loadings, the first of the three extracted factors could be defined as the *factor of managing more locally bound sport-related matters*, i.e. managing sports federations/associations, a sports facility and a sports club, or being a trainer/coach manager (Sports fed & clu), the second as the *factor of working as a sport manager in tourism* (Tourism & ISEO) and the third one as the *factor of managing the development of sports in institutions either at national or at a local level* (Nat & loc level). The third factor has been defined by the variables *managing the development of sports in institutions at national level* and *managing the development of sports in institutions at local level*, loading at 0.705 and 0.813, respectively.

Table 1: Factor loadings

VARIABLE	F 1	F 2	F 3
IN A HOTEL	0.009	**0.907**	0.008
OTHER IN TOURISM	0.039	**0.883**	0.059
AT NATIONAL LEVEL	0.150	0.472	**0.705**
AT LOCAL LEVEL	0.164	-0.279	**0.813**
SPORTS CLUB	**0.843**	0.188	0.092
SPORTS FACILITY	**0.825**	0.067	0.211
SPORTS FEDERATION/ ASSOCIATION	**0.766**	0.163	0.235
ASSOCIATION OF PHYSICAL RECREATION	**0.785**	-0.146	0.029
INTERNATIONAL COMPETITION ORGANIZATION	0.188	**0.613**	-0.062
TRAINER/COACH MANAGER	**0.519**	0.363	-0.176
Explained variance	2.951	2.496	1.305
Total proportion of the explained variance	0.295	0.250	0.130

The results of the regression analyses have shown a statistically significant coefficient of multiple correlation (R^2=0.282; F(4,65)=6.375; p<0.000) between the set of communication variables and the second factor, i.e. the factor of working as a sport manager both in tourism and in the organization of a sport event. Beta coefficients have shown that being able to discuss business matters in a foreign language (Beta=0.352; t(65)=2.977; p<0.004) and the knowledge of intercultural communication (Beta=0.290; t(65)=2.289; p<0.025), e.g. being acquainted with the customs and principles of communication in different cultural surroundings, strongly predicted the importance of the knowledge of foreign languages for a sport manager working in tourism in general, as well as for sport managers who participate in the organization of an international sport event.

Discussion

The factorial structure of ten variables addressing various jobs of a sport manager consisted of two dimensions whose common denominator was an array of duties that a sport manager could have when managing sports federations, sports facilities, sports clubs as well as associations of physical recreation. These duties might be more locally bound and intra-organizational. Hence, the knowledge of foreign languages, although important, does not seem to be critical. The second factor, as already said, was defined by tourism-related variables. Since "sport events have always been leveraged as a chance to boost tourism" (Zhang & McCornac, 2014, p. 114) and since the knowledge of foreign languages is an indispensable communication tool in both domains, their positioning on the same factor was not surprising. To develop a sport in institutions either at national or at local level requires a systematic approach in which the sources of knowledge play a crucial role. In the today's globalized world no development is possible without gaining a deeper insight into experience and knowledge of experts from the whole world, thus being possible only if one is able to understand expert literature written in a foreign language. It goes without saying that the foreign language most frequently learned and used in business communication is English.

Further, the obtained results have pointed to the fact that kinesiology students perceived the importance of being able to discuss business matters in a foreign language and the importance of their knowledge of intercultural communicative competence with regard to the jobs of sport managers both in the domain of tourism and in the organization of international sport events. These results are in compliance with contemporary trends in tourism, i.e. in international tourism. According to the World Tourism Organization (UNWTO, 2016, p. 4), international tourist arrivals reached 1,186 million in 2015, which means that more than 1.8 billion people travelled internationally. This consequently means that international tourism implies intercultural communication. Hence, intercultural communication competence is of extreme importance in contemporary tourism trends (Bedeković, Bosnić, & Jaković, 2014). Intercultural communication competence, also termed *intercultural competence*, is regarded as "the ability to understand cultures, including your own, and use this understanding to communicate with people from other cultures successfully" (British Council, 2017). Bayram (1997), one of the proponents of intercultural communicative competence approach to foreign language learning, emphasizes the intercultural speaker as a key target of the teaching/learning process. Such a speaker is conceptualized as „one who can effectively and appropriately mediate between world of origin and world of encountered difference" (Young & Sachdev, 2011, p. 83). Consequently, ICC refers, among many other aspects, to the use of particular culture-bound phrases, speech style, voice tone, etc. The importance of the ability to discuss business matters in a foreign language pointed to the role of a manager in both domains, i.e. tourism and organization of international sport events alike. Needless to say, international sport events, in one of their aspects, are also tourism-bound. Negotiations, an aspect of business communication, are a key aspect in the plethora of manager's roles. In his famous book *The Practice of Management* Drucker (1954) listed five functions that managers must execute to realize their goal of making people productive: set objectives; be a good organizer; motivate employees and communicate with them; set the goals and design ways of how to measure results; and strive to develop employees. Communication with employees, with business associates, prospective clients, etc. continues to be a key aspect constantly elaborated and modified.

Conclusion

The results of this research have shown that tourism and organization of international sports events, which could also have tourism-related significance, are perceived as domains in which the knowledge of foreign languages is an indispensable competence of experts. Additionally, according to the opinion of students, the capacity to discuss business matters in a foreign language and intercultural communicative competence seem to be indispensable aspects that sport managers need for their successful work. Consequently, further research could address other foreign language-related skills that sport managers would need to be more efficient and more competitive in the labour market.

References

1. Atali, L. (2015). Determining positions and desired applicant characteristics in sports job ads. *Educational Research and* Reviews, *10*(2), 198-201. doi: 10.5897/ERR2014.1913
2. Bachman, L.F., & Palmer, A.S. (1996). *Language testing in practice: Designing and developing useful language tests*. Oxford: Oxford University Press.
3. Bedeković, V., Bosnić, I., & Jaković, B. (2014). An intercultural personnel competence in cultural tourism. In J. Perić (Ed.) *22nd Biennial International Congress: Tourism & Hospitality Industry 2014 - Trends in Tourism and Hospitality Management* (pp. 471-481). Opatija: Faculty of Tourism and Hospitality Management.
4. British Council. (2017). Intercultural communicative competence. Retrieved February 12, 2017 from https://www.teachingenglish.org.uk/article/intercultural-communicative-competence
5. Byram, M. (1997). *Teaching and assessing intercultural communicative competence*. Clevedon: Multilingual Matters.
6. Chen, S., Adams-Blair, H., & Miller, A. (2013). Professional expectations of sport management students as related to academic curricular alignment support and preparation. *Universal Journal of Management*, *1*(3), 132-137.
7. Çiftçi, S., & Mirzeoğlu, N. (2014). The research of qualifications of sport manager. *Procedia - Social and Behavioral Sciences*, 152, 740-745. doi: 10.1016/j.sbspro.2014.09.313
8. Dambe, G., & Atstaja, D. (2013). Knowledge, skills and attitude in tourism industry: Case study of Latvia. *European Integration Studies*, 7, 177-184.

9. Drucker, P. (1954). *The practice of management*. New York: Harper & Row.
10. Hall, J.A., & Coats, E.J. (2005). Nonverbal behavior and the vertical dimension of social relations: A meta-analysis. *Psychological Bulletin*, *131*(6), 898-924.
11. Kostic Bobanovic, M., & Grzinic, J. (2011). The importance of English language skills in the tourism sector: A comparative study of students/employees perceptions in Croatia. *Almatourism*, *2*(4), 10-23. doi: 10.6092/issn.2036-5195/2476
12. Martínek, T., & Hanzlík, P. (2014). Analysis of the structure of job offers on the Czech labour market. *Review of Economic Perspectives*, *14*(3), 287-306.
13. Muthén, B., & Kaplan, D. (1985). A comparison of some methodologies for the factor analysis of non-normal Likert variables. *British Journal of Mathematical and Statistical Psychology*, *38*, 171-189.
14. Menike, H.J.M.Y.S., & Pathmalatha, K.M. (2015). Developing foreign language competencies of tourism industry oriented undergraduates in Sri Lanka. *Tourism, Leisure and Global Change*, *2*, TOC-74. Papers from the 7th Tourism Outlook Conference/ Tropical Tourism Outlook Conference, 8-10 August 2014, Dambulla – Kandalama, Sri Lanka.
15. Prachanant, N. (2012). Needs analysis on English language use in tourism industry. *Procedia - Social and Behavioral Sciences*, *66*, 117-125. *8th International Language for Specific Purposes (LSP) Seminar - Aligning Theoretical Knowledge with Professional Practice*. doi: 10.1016/j.sbspro.2012.11.253
16. Thitthongkam, Th., & Walsh, J. (2010). Roles of language in tourism organisational management. *Asian Journal of Management Research*, *2*(1), 184-199. Retrieved February 20, 2017 from http://www.ejournalofbusiness.org/archive/vol2no1/vol2no1_9.pdf
17. UNWTO. (2016). UNWTO Tourism Highlights. Retrieved February 23, 2017 from http://www.e-unwto.org/doi/pdf/10.18111/9789284418145
18. Young, T.J., & Sachdev, I. (2011). Intercultural communicative competence: Exploring English language teachers' beliefs and practices. *20*(2), 81-98.
19. Zhang, R., & McCornac, D.C. (2014). Challenges for the international tourism industry in Japan – An agent for economic recovery and development. *Almatourism*, *5*(10), 109-124.

THE PROFILE AND MOTIVATIONS OF ACTIVE SPORT TOURISTS – AN INVESTIGATION OF TRAIL RUNNING, SPORT FISHING AND CYCLING EVENTS

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Abstract

The aim of this paper is to present the profile of active-sport-event tourists who participated in trail running, sport fishing and mountain bike sport events. A self-administered questionnaire was developed and this paper focuses on three of its sections: motivation, travel party and frequency of travel, and socio-economic and demographic data. Descriptive analysis was applied to explore the sample profile of the study. Based on 334 responses gathered from 12 small-scale sport events, findings suggest that participants are mainly highly educated married men with children, who travel to events with their friends several times per year. Factor analysis reduced 28 motives to seven factors (Enjoyment, Socializing, Appearance, Competition, Skills, Physical and psychological condition, and Nature). However, it seems natural settings and a desire to experience fun and joy are major motivations for participants in all three sports. The findings can be used by sport events managers and organisers to help them better serve sports and tourism needs in the destination.

Key words: *business strategy, participation motivation, sport experiences*

Introduction

Understanding the profiles and behavioural aspects of active sport tourism is crucial for sport tourism practitioners when designing adequate business and marketing strategies. Keeping this in mind, motivation is one of the key variables for understanding tourism and leisure behaviour (Gibson, 2004; Alexandris et al., 2009). Moreover, literature notes different motivations for sport participation such as competition/ego, physical and psychological condition, appearance, affiliation, mastery, enjoyment, charity (Ryan et al., 1997; Morris & Rogers, 2004; Buning & Gibson, 2015) and motivation-based segmentation is used in many studies as a driver for segmenting sport tourists (e.g. Alexandris et al., 2009; Hallmann et al., 2012; Hodeck & Hovemann, 2016). As argued by Perić et al. (2017), motivation in combination with other contextual factors contributes also to sport tourists' experiences, and different business model elements are needed to provide different types of sport experiences. Indeed, motivation research can help in creating tourist profiles and in designing and positioning appropriate services that can satisfy sport tourists' needs.

This paper is part of a major research project SPORTBIZMODEL that is focused on issues related to sport experiences and sport events and business models. The purpose of the project is to learn more about the dependence of business model elements on different sport participation experiences and motivations. Since the project is still ongoing (see: http://fthm.uniri.hr/index.php/sportbizmodel), this paper presents the interim results of the research activities conducted so far. In other words, the aim of this paper is to present the profile of active-sport-event tourists who participated in small-scale trail running, sport fishing, and mountain bike sport events.

Methods

For Project SPORTBIZMODEL, a self-administered questionnaire was developed based on previous work in the field of leisure and sport motivations, business models, and sport expenditures. The questionnaire contains eight parts altogether, only three of which are the focus of this study: motivation, travel party and frequency of travel, and socio-economic and demographic data. Motivation for sport participation was measured with 28 items. The majority of items were selected from the Physical Activity and Leisure Motivation Scale (PALMS) originally developed by Morris and Rogers (2004). A few other items, deemed to be characteristic of the nature of the sporting events, were also added. Items regarding charity and prizes were added based on the work of Getz and McConnell (2011) and Buning and Gibson (2015), while findings from Kaplanidou and Vogt (2010), Kulczycki and Halpenny (2014), and Pomfret and Bramwell (2016) contributed to the development of the items regarding natural settings. Participants answered the questionnaire on a 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). The section investigating travel party and frequency of travel was constructed based on Dixon et al. (2012) and Medina Muñoz and Medina Muñoz (2012). Moreover, socio-economic and demographic data of the respondents was gathered (age, gender, education, income). The questionnaire was prepared in printed and online version in four languages (Croatian, Slovenian, English, and Italian).

A survey was conducted from July to November 2016 in Croatia and Slovenia. Respondents were active participants of 12 small-scale sport events in three different sports (see Table 1): trail running (three events), sport fishing (three events), and mountain biking (six events). Two different ways of collecting data were used, on-site or online, as agreed upon with the events' organisers. Altogether 397 responses were collected, of which 334 were acceptable in this study. Descriptive analysis was applied to explore the sample profile of the study. Exploratory factor analysis with direct oblimin rotation was used to reduce the 28 motives to a smaller number of factors.

Table 1: Events' portfolio in chronological order

Events	Sport	Date	Place	Number of participants
Risnjak Trail	Trail running	9 July 2016	Crni Lug, National Park Risnjak, Croatia	399
Gorski kotar Bike Tour 2016	MTB/Cycling	15-17 July 2016	Gorski kotar, Croatia	30
Black Hole Marathon	MTB/Cycling	23 July 2016	Črna na Koroškem, Slovenia	145
Kamenjak Mountain Bike Tour	MTB/Cycling	5-7 August 2016	Tršće, Gorski kotar, Croatia	26
Rekreatur 2016	MTB/Cycling	25-28 August 2016	Savinja and Šalek Valley, Kranj, Slovenia	100
Fužine2Sea	MTB/Cycling	28 August 2016	Fužine – Crikvenica, Croatia	248
38th Assault on Vršič	MTB/Cycling	3 September 2016	Kranjska Gora, Slovenia	672
Ogulin Trail 2016	Trail running	17 September 2016	Ogulin, Croatia	178
3rd Sakura UL Cup	Sport fishing	18 September 2016	Mrzla vodica, Lokve, Croatia	40
Dalmacija Ultra Trail	Trail running	21-23 October 2016	Omiš, Croatia	349
Pike Masters II	Sport fishing	29 October 2016	Orešje, Zagreb, Croatia	40 (20 teams)
3rd Prologic "Carp Challenge Mrežnica 2016."	Sport fishing	25-27 November 2016	Duga Resa, Croatia	20 (10 teams)

Results

The sample profile of the study for each sporting activity is presented in Table 2. Descriptive analysis showed that the events are male dominated, with sport fishing being a completely male sporting activity. Mountain bike participants are slightly older when compared with trail and sport fishing participants and in more cases they are married and have children. The majority of trail running and mountain bike participants have university degrees, while sport fishing participants usually have secondary school qualifications. Most of the respondents have a monthly net income between 500 and 1,500 euro. Regarding traveling companions, more than half of the participants travel with their friends. Respondents involved in trail running travel and participate in events more frequently than respondents involved in sport fishing and mountain biking.

Table 2: Sample profile

	Trail running		Sport fishing		Mountain biking	
	Freq.	%	*Freq.*	%	*Freq.*	%
GENDER	N=137		N=67		N=121	
M	88	64.2	67	100.0	65	53.7
F	49	35.8	0	0.0	56	46.3
MARITAL STATUS	N=137		N=66		N=121	
Single	69	50.4	29	43.9	42	34.7
Married	68	49.6	37	56.1	79	65,3
HAVING CHILDREN	N=133		N=67		N=121	
No	73	54.9	27	40.3	40	33.1
Yes	60	45.1	40	59.7	81	66.9
EDUCATION	N=136		N=67		N=119	
No education	1	0.7	0	0.0	0	0.0
Elementary	0	0.0	1	1.5	3	2.5
Secondary	27	19.9	47	70.1	33	27.7
University	89	65.4	16	23.9	66	55.5
Postgraduate	19	14.0	3	4.5	17	14.3

MONTHLY (PERSONAL) NET INCOME	N=132		N=63		N=110	
0-500 EUR	13	9.8	10	15.9	10	9.1
500-1000 EUR	52	39.4	33	52.4	46	41.8
1000-1500 EUR	33	25.0	17	27.0	33	30.0
1500-2000 EUR	20	15.2	1	1,6	14	12.7
2000-3000 EUR	6	4.5	2	3.2	5	4.5
3000-4000	5	3.8	0	0.0	1	0.9
>4000 EUR	3	2.3	0	0.0	1	0.9
TRAVEL PARTY	N=137		N=68		N=122	
Alone	23	16.8	3	4.4	12	9,8
With my family	18	13.1	2	2.9	17	13.9
With a partner only	13	9.5	14	20.6	22	18.0
With my friends	83	60.6	49	72.1	71	58.2
FREQUENCY OF TRAVEL	N=136		N=68		N=123	
1 – 6 times per year	45	33.1	39	57.4	84	68.3
6 – 12 times per year	52	38.2	22	32.4	25	20.3
> 12 times per year	39	28.7	7	10.3	14	11.4
AGE	N=128	years	N=66	years	N=121	years
Average age		37.8		37.8		42.3

Exploratory factor analysis was performed on the motivation scale. The analysis revealed a conceptually clear factor structure (Table 3). Seven factors emerged (Enjoyment, Socializing, Appearance, Competition, Skills, Physical and psychological condition, and Nature) which accounted for 72.6% of the variance. Two items were dropped ("To raise money for charity" and "To get away from pressures of everyday life" because their factor loadings were below 0.3 on all factors).

Individuals who scored high in the dimension of Enjoyment (four items) were driven by fun and happiness. Individuals who scored high in the dimension of Socializing (three items) were driven by spending time with their friends. Individuals who scored high in the dimension of Appearance (three items) were driven by aesthetic aspect of their bodies. Individuals who scored high in the dimension of Competition (four items) were driven by competition with others and the possibility to get prizes. Individuals who scored high in the dimension of Skills developing (four items) were driven by obtaining, maintaining or improving skills. Individuals who scored high in the dimension of Physical and psychological condition (three items) were driven by fitness and health. Items oriented on relaxation and coping with stress have rather weak factor loadings on all factors, with highest values of factor loadings on the factor of Physical and psychological condition. It implicates that these items might be related also to other motive categories. Individuals who scored high in the dimension of Natural setting (four items) were driven by the wish to enjoy in nature and beautiful surroundings.

Table 3: Results of the exploratory factor analysis

Variables	Factor 1 Enjoyment	Factor 2 Appearance	Factor 3 Competition	Factor 4 Socializing	Factor 5 Skills	Factor 6 Condition	Factor 7 Nature
Because it is fun	.905						
Because it makes me happy	.856						
Because it is interesting	.628				-.207		
Because I enjoy doing this sport	.588		.141				-.188
To improve my body shape		-.916					
To improve my appearance		-.881					
To maintain a trim, toned body	-.120	-.721				.167	
To be the best in a group			.882				
To compete with others around me			.775				
To be fitter than others		-.124	.725				
For the prize(s)			.687			-.108	
To enjoy spending time with others				.895			

To do the activity with others				.843			
To be with friends				.763			
To obtain new skills/activities					-.922		
To improve existing skills					-.767		
To maintain a current skill level					-.446		
To maintain my health						.835	
To improve cardiovascular fitness		-.113				.748	
To be physically fit		-.232		-.147		.577	
To help me relax	.200	.154		.189		.356	
To better cope with stress	.152			.149	-.176	.301	
To enjoy beautiful surroundings							-.849
Because I seek an unpolluted environment (clean air and/or water)					-.101		-.765
Because I want to connect with nature							-.693
Because I want to be in nature (outdoors)	.433				.119		-,467

Extraction Method: Maximum Likelihood.
Rotation Method: Oblimin with Kaiser Normalization.

Participants in all three sports are mostly motivated by the fun and happiness these sports offer to them and by the possibility to be in nature and enjoy the outdoors (Table 4). Socializing is also an important motivation but with lower mean values. Improving appearance and other items regarding physical condition are less important motivations for all participants. It is interesting to note that sport fishing participants are more motivated by prizes and the possibility to obtain and/or improve skills than participants in the other two sports.

Concluding remarks

This paper reveals some differences in socio-economic and demographic profile and motivation between trail running, sport fishing and mountain bike active-event participants. Regarding motives, seven factors emerged but mean scores suggest Enjoyment and Nature were the most important dimensions in all three sports. People indeed participate in sports to have fun, be happy and to merge with nature while competition, aesthetic and health and fitness dimensions were less important motivations. These findings could have important managerial implications. They can be used by managers and organisers of existing and potential sport events to help them to better serve sports and tourism needs in the destination.

According to the work plan of Project SPORTBIZMODEL, the scope of future research activities will extend to include winter sport activities. In addition, cluster analysis using motivation factors will be employed to create the optimal number of segments among active sport tourists. Finally, differences between clusters regarding business model preferences and various socio-demographic variables will be analysed in order to accumulate information for management and marketing strategies.

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Table 4: Motivation for participation in sports – I undertake this particular sport activity...

Item	TRAIL RUNNING (N=138)			SPORT FISHING (N=68)			MOUNTAIN BIKING (N=128)		
	Mean Value	*Mode*	*Standard Deviation*	*Mean Value*	*Mode*	*Standard Deviation*	*Mean Value*	*Mode*	*Standard Deviation*
Because it is fun	4.72	5	0.448	4.75	5	0.500	4.55	5	0.545
Because it makes me happy	4.71	5	0.471	4.69	5	0.629	4.44	5	0.585
Because it is interesting	4.54	5	0.514	4.24	5	0.948	3.91	4	0.788
Because I enjoy doing this sport	4.71	5	0.486	4.72	5	0.484	4.49	5	0.532
To improve my body shape	3.29	4	1.075	3.74	3[a]	1.141	2.98	3	1.119
To improve my appearance	3.17	4	1.120	2.65	1[a]	1.324	3.30	4	1.022
To maintain a trim, toned body	3.22	4	1.107	2.65	3	1.231	3.23	4	1.081
To be the best in a group	2.49	2	1.102	3.47	3	1.227	2.49	2	1.150
To compete with others around me	3.41	4	1.051	4.79	5	0.475	4.55	5	0.599
To be fitter than others	2.98	4	1.063	3.65	3	1.182	1.85	1	1.028
For the prize(s)	1.75	1	0.897	4.19	5	1.083	3.23	4	1.138
To enjoy spending time with others	4.26	4	0.757	2.51	1[a]	1.275	3.36	4	1.085
To do the activity with others	4.25	4	0.726	4.37	5	0.945	4.30	4	0.703
To be with friends	4.33	5	0.727	4.31	5	0.868	4.20	4	0.764
To raise money for charity	3.37	4	1.147	4.63	5	0.771	4.40	5	0.680
To obtain new skills/activities	3.99	4	0.904	4.38	5	0.829	3.95	4	0.797
To improve existing skills	4.05	4	0.849	4.54	5	0.656	3.93	4	0.998
To maintain a current skill level	3.87	4	0.861	4.34	5	0.908	3.94	4	0.811
To maintain my health	4.42	5	0.692	3.54	4	1.239	4.40	4	0.580
To improve cardiovascular fitness	4.30	5	0.751	3.91	4	0.926	4.46	4	0.546
To be physically fit	4.39	5	0.709	3.24	3	1.317	3.37	3	1.003
To help me relax	4.53	5	0.653	3.74	4	1.115	4.24	4	0.718
To better cope with stress	4.25	4	0.844	4.49	5	0.889	4.48	5	0.698
To get away from pressures of everyday life	4.13	5	0.958	4.38	5	0.931	4.03	4	0.939
To enjoy beautiful surroundings	4.60	5	0.548	4.63	5	0.771	4.23	5	0.856
Because I seek an unpolluted environment (clean air and/or water)	4.41	5	0.670	4.65	5	0.617	4.39	5	0.755
Because I want to connect with nature	4.51	5	0.727	4.79	5	0.442	4.68	5	0.485
Because I want to be in nature (outdoors)	4.80	5	0.421	4.84	5	0.409	4.59	5	0.525

a. Multiple modes exist. The smallest value is shown

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References

1. Alexandris, K., Kouthouris, C., Funk, D., & Giovani, C. (2009). Segmenting Winter Sport Tourists by Motivation: The Case of Recreational Skiers. Journal of Hospitality Marketing & Management, 18(5), 480-499.
2. Buning, R.J., & Gibson, H. (2015). The evolution of active-sport-event travel careers. Journal of Sport Management, 29(5), 555-569.
3. Dixon, A.W., Backman, S., Backman, K., & Norman, W. (2012). Expenditure-based segmentation of sport tourists. Journal of Sport & Tourism, 17(1), pp. 5-21.
4. Hallmann, K., Feiler, S., Müller, S., & Breuer, C. (2012). The interrelationship between sport activities and the perceived winter sport experience. Journal of Sport & Tourism, 17(2), 145-163.
5. Hodeck, A., & Hovemann, G. (2016). Motivation of active sport tourists in a German highland destination – a cross-seasonal comparison. Journal of Sport & Tourism, 30(3-4), 335-348.
6. Kaplanidou, K., & Vogt, C. (2010). The meaning and measurement of a sport event experience among active sport tourists. Journal of Sport Management, 24(5), 544-566.
7. Kulczycki, C., & Halpenny, E.A. (2014). Sport cycling tourists' setting preferences, appraisals and attachments. Journal of Sport & Tourism, 19(2), 169-197.
8. Medina Muñoz, D.R., & Medina Muñoz, R.D. (2012. Determinants of Expenditures on Wellness Services: The Case of Gran Canaria. Regional Studies, 46(3), 309-319.

9. Morris, T., & Rogers, H. (2004). Measuring Motives for Physical Activity. In: In Sport and Chance of Life: International Sport Science Congress (pp. 242-250). Seoul, Korea: The Kansas Association for Health, Physical Education, Recreation, and Dance.
10. Perić, M., Wise, N., & Dragičević, D. (2017). Suggesting a Service Research Agenda in Sport Tourism: Working Experience(s) into Business Models. Sport, Business and Management: an International Journal, 7(1), pp. 58-76.
11. Pomfret, G., & Bramwell, B. (2016). The characteristics and motivational decisions of outdoor adventure tourists: a review and analysis. Current Issues in Tourism, 19(14), 1447-1478.
12. Ryan, R.M., Frederick, C.M., Lepes, D., Rubio, N., & Sheldon, K.M. (1997). Intrinsic motivation and exercise adherence. International Journal of Sport Psychology, 28(4), 335-354.
13. Wicker, P., Hallmann, K., & Zhang, J.J. (2012). What is influencing consumer expenditure and intention to revisit? An investigation of marathon events. Journal of Sport & Tourism, 17(3), 165-182.

THE IMPORTANCE OF USING DIFFERENT MEDIA TYPES FOR PROMOTING AN ATHLETE'S BRAND

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Purpose: The personal brand of the athlete has various influencing features. The main distinguished features are appearance, personality, behavior, values, lifestyle, skills, abilities, attitudes, education, sports results and achievements as the most decisive qualification formulating the brand of the athlete (Arai et al., 2013; Carlson et al., 2009; Carlson and Donavan, 2013). Different types of media form a certain image of an athlete but at the same time each of it provides different options that help to uncover and develop a personal brand. By using different types of social networks and blogs athletes can manage and disseminate information about themselves providing more objective and accurate information, so that the consumers can form a unified opinion.

The aim of the research was to investigate different kinds of media and identify which one is the most suitable to promote athlete's personal brand.

Methods: A questionnaire of 20 questions was designed and used in the research (Cronbach alpha 0,956). 399 respondents from Lithuania participated in the study between the age of 18-29 (279 women and 120 men) during the autumn season in 2015.

Results: Respondents claim that athletes' personal brand helps to form an opinion about athletes (81.3%), sport (74.8%), country (75.5%), advertised products (83.3%), club and the team (69.2%), represented by the athlete. The results showed that the athlete's personal brand is formed by sports achievements (56%), behavior in competitions (46%) and in a public space (43%), athlete's skills and abilities (38%), and the athlete's personality (33%). There is a direct causal link between the athlete's personality and his behavior in a public place (0.554, $p < 0.01$), values (0.542, $p < 0.01$), lifestyle (0.544, $p < 0.01$) and attitude (0.543, $p < 0.01$).

The results showed that the social sites (Facebook, Twitter, Linkedin, etc.), and the websites (15min. Delfi et al.) reveal the athletes' personal brand attributes and if the respondent reads the athlete's blog, social networks or the press, it is likely that they read about sports in websites (ranges from 0.525 to 0.644, $p < 0.01$).

Conclusions: According to the results gathered the athletes have to select information very carefully which has to be provided to the users of social media. Moreover, during the sporting events or other mass media meetings athlete should act becomingly and show only positive characteristics. Furthermore, athletes have to be prepared for interviews carefully.

References

1. Arai, A., Jae Ko, Y., Kaplanidou, K. (2013). Athlete brand image: scale development and model test. European Sport Management Quarterly, 13 (4), 383-403.
2. Carlson, D. B., Donavan, T. (2013). Human Brands in Sport: Athlete Brand Personality and Identification. Journal of Sport Management, 27, 193-206.
3. Carlson, D. B., Donavan, T., Cumiskey, K. J. (2009). Consumer-brand relationships in sport: brand personality and identification. International Journal of Retail & Distribution Management, 37 (4), 370-384.

DISTRIBUTION OF WORKFORCE THROUGH PROJECT LIFE CYCLES AND ANALYSIS OF THE SATISFACTION WITH THE ORGANISATION

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Abstract

Staging a sport event is a typical example of project management. One of the most important aspects of this process are human resources, i.e. personnel management. It is a rather complex part of organising a sport event, due to organising committee's time and growth issues. The main goal of this paper is to research the organisers' level of satisfaction with various segments of organising a *European University Games 2016* (EUG2016). Using a 5 point scale, research has shown that on average the level of satisfaction was high since the lowest grade was 3,55 (salary) and the highest 4,62 (atmosphere at the games). Secondly, aim was to research into possible legacy effects of creating experienced workforce, i.e. developing experts in the field of sport event organising. The research showed that vast majority of interviewees wish to continue with this type of work (84%) confirming our expectations.

Key words: *sport events, human resources, project management, satisfaction level*

Introduction

Sport event can be described as a "social gathering that brings together a large number of people and activities on the occasion of a competition." (Boyer et al., 2007, p. 280) They are "organized throughout the world for able and disable bodied men and/or women of all ages. There are single and multi-sport formats, some of which are universally available and others that are specific to only one region of one country. In a time dimension there are various competition formats from one-day tournaments to year round championships. In a socio-economic dimension there are amateur and professional events and those that are spectator or participant led." (Masterman, 2004 , p. 13) Various classifications of sport events can be made (for example see Getz, 1997; Jago and Shaw, 1998; Boyer et al., 2007; Greenwell et al., 2014) and having in mind the complexity of staging a sport event and its possible impacts, different aspects of sport events have been studied. For example, a number of researchers studied into success determinants at major sport events, mainly Olympic games (more in Čustonja, Škorić, 2011; De Bosscher, 2016), sport event impacts and legacy (Preuss, 2004, 2015; Bartoluci, Škorić, 2008; Guadaityte et al., 2016; Rogerson, 2016), etc. However, little attention has been payed to examining the providers, i.e. organisers' point of view. The aim of this paper is to research the organisers' level of satisfaction with various segments of organising a *European University Games 2016* (EUG2016). EUG is a multi-sport university sports competition governed by the *European University Sports Association* (EUSA). Participants in these events are European university teams and individuals. Games are organised on a biannual basis, starting with 2012, and represent the largest European multisport student event (EUSA, 2017). It is the biggest multi-sport event in the history of the Republic of Croatia with more than 5500 participant and more than 2000 volunteers. In addition, aim was to research into possible legacy effects of creating experienced workforce, i.e. developing experts in the field of sport event organising.

Staging a sport event

From an organising and planning point of view, an event is temporary, planned or not, has a fixed length and is unique (Getz, 1997, quoted in Materman, 2004 , p. 15). In other words, it is a project, a "temporary endeavour undertaken to create a unique product or service." (PMI, 2000 , p. 4). It encompasses following characteristics (Torkildsen, 1994, quoted in Emery, 2002 , p. 317): a clear-cut starting and finishing point; fixed, absolute deadlines; one-off organisation, normally superimposed on other work; large risks; and many opportunities. If an event planning process is to encompass both short-term requirements for the implementation of the event and the long-term objectives that become the legacies of the event, a model consisting of up to 10 different stages is proposed (Materman, 2004). Stages include defining objectives, concept, conducting feasibility studies, decision to proceed, enter bid procedure (if required), implement planning, implement event, handover, evaluate, feedback. It is important to emphasize a key dimension of a project, which is a life cycle. A life cycle of a project consists of 5 key phases: initiation, planning and evaluation, execution, monitoring and controlling, closure (see PMI, 2000). In order to have a successful event each phase needs to be controlled, planned and driven by usage of relevant project management tools such as the *Project Master Plan*, *Milestones Plan,* etc. At the same time safe and efficient resources (primarily human and financial) and cost management planning needs to be secured. Resources and costs necessarily vary at different phases of the project, increasing all the way through the execution phase when they reach their peak and then rapidly drop at the closure phase. At a core of the process of staging an (sport) event is the organising committee. It is a social entity as it can employ thousands of workforce members (paid staff members, volunteers, secondees, contractors) over the course of its existence (Parent, 2015, p. 44) which can affect personnel management in both positive and negative way. In that sense, it is of crucial importance to have in mind several aspects specific for running a (mega) event: workers must be hired, trained and terminated within a relatively short time period; and these organisations tend to grow rapidly and may need to restructure several times during their lifecycle (see Xing, Chalip, 2012). Therefore, having experienced staff, especially when managing large-scale events, might be crucial to the point that the ability to host (organise) the event is seen as one of the factors influencing successful candidature for hosting an event (Westerbeek et al., 2002).

EUG2016 organizing committee (OC) initiated in 2012 as a bidding committee represented by the *Croatian Academic Sport Federation* (CASF). It is a National Federation and an EUSA member, therefore eligible for hosting this event. *Bidding Committee* was formed to gather ideas and knowledge of organising the games, and to create a platform for staging EUG2016. This included negotiating with local and government authorities in terms of financial resources, creating a lasting legacy plan, planning the enhancement of the sport and studying standards of the student population, and delivering a bidding book to EUSA for the evaluation. Once the CASF was awarded the hosting of the games, planning and evaluation could start. In order to create a safe, effective and efficient games *Planning Coordination Body* was formed, followed by 18 departments, i.e. *Functional Areas* at different timelines. The crucial part of this stage was forming a *Project Management Office* (PMO) in charge of creating planning tools for delivering operational plans of the departments, *Games Master Plan*, appointing *Milestones*, managing risks, managing human and financial resources etc. It is important to emphasize that from the bidding committee all the way through execution phase human resources have grown from 10 to more than 3000 (including volunteers, paid or seconded staff) and then rapidly dropped to 15 at closure phase. As an example of the games complexity, *Sports Department* counted about 90 staff members during the planning phase, and increased to 783 members during the execution phase (sports department, technical delegates and their assistants, venue technical managers, referees and other staff). Department was in charge of 21 sports and 2 sports for the athletes with disabilities in 44 sporting venues across the two host cities.

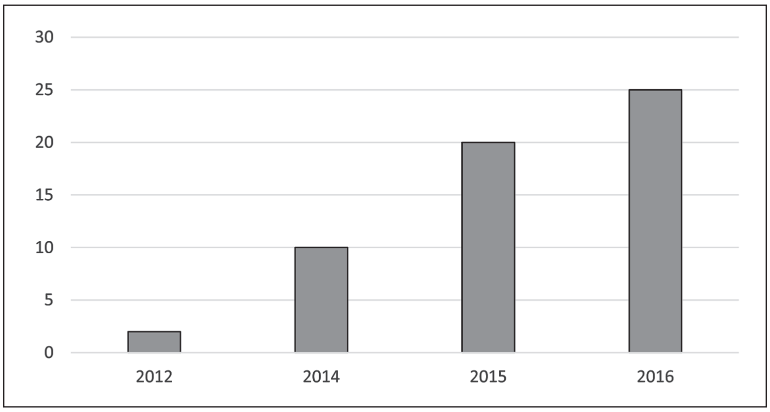
Methodology and results

During planning of the implementation phase, 18 departments were created, and people in charge of various groups of activities in those departments were interviewed. Finally, 62 questionnaires (42 male and 20 female) from 16 departments were collected (see table 1), with response rate of 38%. It should be noted that some of the interviewees were engaged in the work of several departments (2 of the interviewees worked in 3 departments, and 5 worked in 2 departments).

Table 1: Structure of the interviewees by departments

	DEPARTMENT	%
1	Coordination	14,5
2	Project management	8,0
3	Volunteers	3,2
4	Promotion and public relations	1,6
5	Marketing	3,2
6	Cultural and social activities	1,6
7	Logistics and communications	6,4
8	Protocol and ceremonies	3,2
9	Academic activities	0
10	International relations	3,2
11	Sports and venues	43,5
12	Financial and legal affairs	1,6
13	Transportation	3,2
14	Medical	0
15	Security	9,6
16	Accommodation and catering	1,6
17	IT support	6,4
18	Accreditation	3,2

Majority, i.e. 58% of the interviewees have faculty education, followed by PhD or Master of science level of education (25,8%). All three management levels were included in the research with middle level prevailing (just over 61%), followed by top management positions (29%), and finally first level management (10%).



Graph 1: The dynamic of employment

Games were held from 12th until 25th July 2016, and as can be seen from graph 1, the majority of interviewees (25 of them) were employed in 2016, and 10 of them were recruited in July. On average, by the end of the competitions, each of them spent 412 days working for the Games. During the planning phase, this meant working just over 5 hours a day, which rose to more than half a day's work during the 14 days of the games (12,7 hours a day). For majority of interviewees this was not the first time engagement in organising a sport event (84%), and they wish to continue with this type of work (also 84%). In rating the level of satisfaction with various segments of the games, a 5 point scale was used, 1 meaning completely unsatisfied and 5 meaning completely satisfied. On average the level of satisfaction was high since the lowest grade was 3,55 (salary) and the highest 4,62 (atmosphere at the games).

Table 2: Satisfaction with various segments of the games

Segment	Average grade
Atmosphere at the games	4,62
Total satisfaction with the games	4,27
Communication in the department you are working in	4,27
Organisation of the department you are working in	4,26
Knowledge and skills you gained working for the games	4,24
Organisation of the games in general	4,06
Working hours	4,04
Communication with other departments	3,79
Security	3,75
Promotion of the games	3,73
Salary	3,55

Interviewees were also asked to identify the biggest problems they faced when organising EUG2016. Only 14 of them did not fill this open-end question, i.e. find that there were no important (worth mentioning) problems. Others indicated various aspects of organising an event, most frequently the problems connected with accreditation (12, i.e. 25% of those answering this question), followed by security issues (8), communication, money issues, lack of people in organisation (5 respectively), etc.

Most importantly, a legacy concerning experienced staff was created, since majority (87%) of interviewees find that working for the EUG2016 gave them competencies needed to continue with this type of work. In addition, 84% of them wish to continue with this type of work, which contributes to creating a pool of experts in the field of staging, i.e. organising sport events.

Conclusions

European Universities Games represent the biggest multi-sport event in the history of the Republic of Croatia with more than 5500 participant and more than 2000 volunteers. As such, they represent a complexed project which was planned, delivered and closed with positive financial results. It is necessary to emphasize that risks such as the security measures or the accreditation procedures delivery were assessed and resolution strategies delivered, although from the results it is evident that security and accreditations were recognized as two major issues of the organization. This may have happened as a result of general inexperience among Croatian citizens in regards to security measures and trends. Security department engaged highest level of experts in their field and thus, provided highest standards of security implementation. Games have created a number of long lasting legacies including educated and trained workforce, enhancement of the sport infrastructure and new or renovated infrastructure of the student dormitories in both host cities of Zagreb and Rijeka.

References

1. Bartoluci, M., Škorić, S. (2008). Ekonomski aspekti velikih sportskih priredbi, primjer Europskog nogometnog prvenstva, *Računovodstvo i financije, lipanj* (2008), 182-187
2. Boyer, L., Musso, D., Barreau, G., Boyer Collas, L., Addadi, A. (2007). Organising a Major Sport Event, in J. Camy and L. Robinson (eds.) *Managing Olympic Sport Organisations* (pp. 279-343). Human Kinetics
3. Čustonja, Z., Škorić, S. (2011). Winning medals at the Olympic Games – does Croatia have any chance?, *Kinesiology, 43*(1), 107-114
4. De Bosscher, V. (2016). A mixed methods approach to compare elite sport policies of nations. A critical reflection on the use of composite indicators in the SPLISS study /online/. *Sport in Society, 2016*. Retrieved January, 2017 from http://dx.doi.org/10.1080/17430437.2016.1179729
5. Emery, P.R. (2002). Bidding to host a major sport event. The local organising committee perspective, *The International Journal of Public Sector Management, 15*(4), 316-335. /online/: http://emeraldinsight.com/0951-3558.htm, Retrieved in June 2009
6. EUSA (European University Sports Association) (2017). European Universities Games /online/: http://www.eusa.eu/events/games. Retrieved in January 2017
7. Getz, D. (1997). *Event Management and Tourism*. New York: Cognizant.
8. Greenwell, T.C., Danzey-Bussell, L.A., Shonk, D.J. (2014). *Managing sport events*. Human Kinetics.
9. Jago, L., Shaw, R. (1998). Special events: a conceptual and differential framework. *Festival Management and Event Tourism, 5*(1/2), 21-32
10. Masterman, G. (2004). *Strategic Sports Events Management. An International Approach*./online/: http://www.pseudology.org/TerOvanesian/Masterman_Strategic_Sports_Event_Management2.pdf, retrieved in December, 2016
11. Parent, M.M. (2015). Chapter 3: The Organizing Committee's Perspective. In: M.M. Parent, J-L. Chappelet, *Routledge Handbook of Sports Event Management* (pp. 43-64). Routledge /online/: https://www.routledgehandbooks.com/doi/10.4324/9780203798386.ch3 Retrieved in February 2017
12. PMI (Project Management Institute) (2000). *A Guide to the Project Management Body of Knowledge*. /online/: http://www.cs.bilkent.edu.tr/~cagatay/cs413/PMBOK.pdf Retrieved in January 2017
13. Preuss, H. (2004). *The Economics of Staging the Olympics. A comparison of the Games 1972-2008*. Cheltenham: Edward Elgar
14. Preuss, H. (2015). A framework for identifying the legacies of a mega sport event /online/. *Leisure Studies, 34*(6). Retrieved in January, 2017: http://dx.doi.org/10.1080/02614367.2014.994552
15. Rogerson, J.R. (2016). Re-defining temporal notions of event legacy: lessons from Glasgow's Commonwealth Games, Annals of Leisure Research, 19(4), 497-518. Retrieved in January, 2017: http://dx.doi.org/10.1080/11745398.2016.1151367
16. Wasterbeek, H.M., Turner, P., Ingerson, L. (2002). Key success factors in bidding for hallmark sporting events, *International Marketing Review, 19*(3), 303-322
17. Xing, X., Chalip, L. (2012). Challenges, obligations, and pending career interruptions: securing meanings at the exit stage of sport mega-event work, *European Sport Management Quarterly, 12*(4), 375-396. Retrieved in January, 2017: http://www.tandfonline.com/doi/abs/10.1080/16184742.2012.698631

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UNDERSTANDING THE MEANINGFULNESS AND POTENTIAL IMPACT OF SPORTS PSYCHOLOGY ON PERFORMANCE

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Abstract

Researchers have been testing sports psychology techniques on performance for nearly a century. Conveying the meaningfulness of sports psychology techniques to practitioners is of great practical value. Academics have utilized meta-analysis as a research synthesis method with sports psychology techniques and performance since 1983. To date, a summary of quantitative reviews of sports psychology techniques and performance does not exist. Hence, my purpose was to locate and summarize these quantitative reviews based on meaningfulness to provide examples of how the techniques or concepts might lead to performance improvement. Fourteen quantitative reports were located covering the following sports psychology topics with performance: achievement goals, anxiety, cohesion, confidence, goal setting, mental practice, mood states, quiet eye, and self-talk. Nearly all effect sizes were small to moderate in meaningfulness. But, an examination of the moderator analyses revealed that the overall effect size values vary regarding being facilitative to sports performance. Provided sports performance examples demonstrated seemingly at times life-changing performance outcomes with the use of sports psychology techniques of even small to moderate size. Last, I offered suggestions for future lines of research inquiry.

Key words: *applied sports psychology, quantitative reviews, meaningfulness, sports performance*

Introduction

Sports psychology as an academic discipline dates back to Dr. Coleman Griffith's work at the University of Illinois that formally began in 1918. Modern day sports psychology can be linked to the formation of the *International Society of Sport Psychology* in 1965 under the direction of Dr. Ferruccio Antonelli. Since, the formation of ISSP, sports psychology, as well as exercise psychology graduate programs and conferences, have flourished worldwide. For instance, this year, 2017, marks the 50th anniversary of the *North American Society for Psychology of Sport and Physical Activity*. Indeed, the academic discipline and professional practice of sports psychology are now seasoned fields with thousands of research-based publications many of which have been quantitatively summarized and extensive available registries of sports psychology practitioners.

It appears Pearson (1904) was the first to use meta-analysis techniques. Since Pearson, modern day meta-analysis guides, computer programs, and domain-specific primers abound in the social sciences (e.g. Chatzisarantis & Stoica, 2009) to assist researchers in synthesizing the exponential increase in published studies. For instance, Hattie (2015) reported on his meta-analysis of 1200 meta-analyses in education. These 1200 meta-analyses are the result of more than 65,000 individual studies, more than 150,000 individual effect sizes, and approximately 250,000,000 participants. Articles from which to synthesize, sports psychology and performance meta-analytic reviews most likely are not as voluminous of in education, but they do exist.

Feltz and Landers (1983) published the first meta-analytic review applicable to sports performance of sports psychology concerning mental practice and performance. Greenspan and Feltz (1989) provided seemingly the first review of the array of psychological interventions with athletes. To date, no one publication has reviewed these meta-analyses and sorted them relative their impact on sports performance to each other. Hagger (2006) provided a review of meta-analyses in sports and exercise psychology, but not specific to sports performance or an applicable tutorial of the meaningfulness of the results to any one particular field. Hence, my purposes were (a) to provide an exhaustive review of the meta-analyses concerned with sports performance; (b) to provide examples as to how moderator variables may greatly impact the effect size meaningfulness, and (c) to illustrate practical examples of the potential impact of effect size ranges on sports performance.

Method

Selection of quantitative reviews

The literature search was systematic with the goal of being comprehensive. The screening included electronic databases, reviewing reference lists of known to this author published meta-analyses or reviews in sports and exercise psychology (e.g. Hagger, 2006), and search for references from the retrieved articles. EBSCO was the electronic database used. The individual databases searched within EBSCO were SPORTDiscus, PsycINFO, and ERIC. The following example terms formed the keyword combinations to locate published quantitative reviews: quantitative review, meta-analysis, sports psychology, interventions, self-talk, goal-setting, confidence, anxiety, cohesion, teamwork, imagery, mental practice, mood states, POMs, and achievement goals.

Articles retained contained data effect size data of any kind specific to a sports psychology technique or construct with sports based performance. Articles excluded contained no effect size data (e.g. qualitative reviews) or non-sport based performance (e.g. sales, academic grades). Given the extensive nature of sports performance research (e.g. conditioning, strength training), the search terms produced thousands of potential hits. This list of thousands reduced dramatically with a thorough reading of the abstracts.

Effect size meaningfulness guidelines

Though at least 100 types of effect size values exist, the most likely values in sports psychology are the correlation or mean difference effect size. Within social science meta-analyses, criteria for interpretation of the correlation is as follows: 0.30 small, 0.50 moderate, and >0.50 large. For mean difference effect size values (e.g. Hedges' *g*), the standard interpretation of computed mean difference criteria is as follows: 0.20 small, 0.50 moderate, 0.80 large, and 1.30 very large.

Table 1: Meta-analyses in sports psychology, effect size used, number of ESs, constructs, and interpretation

Topic	Study	ES used	k	Constructs	Interpretation
Achievement goals	Lochbaum & Gottardy (2015)	Hedges' g	73	PAp	Small+
			19	PAv	(-)Negligible
			17	MAp	Small+
			14	MAv	(-)Negligible
			4	PGC	Moderate++
Cohesion	Castaño et al. (2013)	r	13	Social	Small
			6	Task	Small
	Filho et al. (2014)	r	13	Social	Negligible
			13	Task	Small++
	Carron et al. (2002)	Hedges' g	86	Social	Moderate++
			68	Task	Moderate
CSAI-2 constructs	Craft et al. (2003)	r	246	Cog. anxiety Som. anxiety Confidence	Negligible Negligible Small
Goal setting	Kyllo & Landers (1995)	Hedges' g	136	Overall	Small
Mental practice	Driskell & Moran (1994)	Cohen's d	62	Overall	Moderate
	Hinshaw (1991)	Glass's Δ	44	Overall	Moderate++
	Feltz & Landers (1983)	Glass's Δ	146	Overall	Small++
Mood states	Beedie et al. (2000)	Hedges' g	17	Tension	Small
			17	Depression	Small
			17	Anger	Small
			17	Vigor	Small++
			17	Fatigue	Negligible
			17	Confusion	Small++
Psychological/social interventions	Brown & Fletcher (2017)	Hedges' g	35	Overall (at post-test)	Moderate
			8	Overall (at follow-up)	Very large
Quiet eye	Lebeau et al. (2016)	Cohen's d	9	Quiet eye time	Large
Self-talk	Hatzigeorgiadis et al. (2011)	Cohen's d	62	Overall	Small++
Self-efficacy	Moritz et al. (2000)	r	102	Self-efficacy	Small

Notes. *r*=correlation; k=total number of ES; PAp=performance approach goal; PAv=performance avoidance goal; MAp=mastery approach goal; MAv=mastery avoidance goal; PGC=performance goal contrast; +=moving towards the next meaningfulness category; ++=almost the next meaningfulness category; (-1)=effect size was detrimental to sports performance

Results

Summary of included meta-analyses

Fourteen quantitative reviews met the inclusion criteria (see Table 1). Topics represented with one review included 2 x 2 achievement goals (Lochbaum & Gottardy, 2015), cohesion (Castaño et al., 2013; Carron et al., 2002; Filho et al., 2014), CSAI-2 constructs (Craft et al., 2003), goal setting (Kyllo & Landers, 1995), mental practice (Driskell & Moran, 1994; Hinshaw, 1991; Feltz & Landers, 1983), mood states (Beedie et al., 2000), psychological/social interventions (Brown & Fletcher, 2017), quiet eye (Lebeau et al., 2016), self-talk (Hatzigeorgiadis et al., 2011), and self-efficacy (Moritz et al., 2000). Cohesion and sports performance and mental and sports performance both resulted in three located reviews. The majority (n=10) of the reviews utilized mean difference effect size parameters. A wide range of samples (k range 4-246) existed. Of the 29 effect sizes in Table 1, the majority were small (k=15) in meaningfulness with some other effect sizes being negligible (k=6) in meaningfulness. Of the moderate (k=6) in meaningfulness effect size values, some tended to be close to large in meaningfulness such as the performance goal contrast score. Only the quiet eye and follow-up to psychological/social interventions were at least large in meaningfulness. Also of note was the very similar effect sizes for mental practice whereas differences existed in reported effect size values for cohesion and sports performance.

Discussion

Moderator variables

One advantage among many with meta-analysis techniques over qualitative reviews is the ability to test for heterogeneity statistically. If heterogeneity is present, examining the potential difference in effect size values based on predetermined moderate variables whether continuous (e.g. age) or categorical (e.g. age groupings) possible. Nearly all of the fourteen reviews reported the existence of significant moderator variables or categories. Examining all moderators reported certainly is too overwhelming and unnecessary for this review of reviews. Providing a few examples should encourage sports psychology researchers and practitioners to review the meta-analysis of interest carefully. For instance when reading the Craft et al. (2003), the type of sport, open or closed, dramatically impacts the importance of confidence to sports performance. The open skill sports effect (e.g. tennis) size is moderate whereas the closed skill (e.g. golf) effect size is negligible. In the Beedie et al. (2000) review, the debilitating effect of fatigue is almost zero with sports performance with objective measures whereas it is small to moderate with self-referenced performance. For both provided examples, the importance of reading each meta-analysis is clear. The impact of the sports performance technique or concept is not uniform nor an effective use of time.

Practical examples

An effect size is a Z-score of a normally distributed measured variable. This simple fact allows for statements concerning the potential to move a person or group to the desired position. For instance, if an athlete in the population of novices for golf were 1.0 standard deviations away from the score of expert golfers, he or she would have large, meaningful ways to go for personal improvement. Most likely, the effect size difference in an expert (i.e. professional golfers) and novice golfer is an effect size of 100 standard deviation units!

How much any one sports psychology technique, or concept (e.g. more confidence) can change an athlete already within the professional ranks is certainly debatable as all of these performers most likely are very homogeneous in nature. They have climbed the ranks to world-class events such as the Olympics and World Championships in their respective sports. But, it is possible to improve based on the reviewed meta-analyses as well as looking at single-subject intervention results in elite sports (e.g. Pates et al., 2012).

Thinking of athletes in an elite sport as being moved as their group to another is certainly a possibility. For instance, using small, moderate, and large effect size values for mean group differences, the 400-meter finals in the 2016 Rio Games provide interesting possibilities at least for the women's final. For the men's final, if Wayde Van Niekerk was his population what the rest would of the population of 400 meters runners need to do to catch him? The standard deviation of the 400 meters final was 0.5035 seconds. Kirani James, who was second, was still 0.73 seconds behind Niekerk, which is 1.5 times the standard deviation unit of the 400 finals. In an overly simplistic use of effect size values, this would suggest no sports psychology technique or concept could have helped James overtake Niekerk. Whereas in the 400-meter women's final, one standard deviation unit was 0.6947 seconds. Shaenae Miller, the gold medalist, finished just 0.07 seconds in front of Allyson Felix. If again, these two elite athletes were their population over and over again in the same conditions, this would equate to a very small effect size intervention needed to propel Miller to the gold.

Conclusions

Sports psychology is a seasoned field and profession of a century of research and work. Understanding the accumulated knowledge of sports psychology techniques and concepts is of great value to practitioners as well as researchers. Meta-analyses provide this accumulated knowledge base. Future research needs are complex with so many studies in existence. It is clear that sports psychology researchers must pay attention to moderator variables. Moderator variables that naturally occur in sports (e.g. the sports type, open or closed) are of great importance. One technique or concept apparently does not fit all. Also, I encourage future researchers to provide concrete examples within their manuscripts so that practitioners can assess and understand the potential impact including variability of a given performance enhancement technique.

References

1. Beedie, C., Terry, P., and Lane, A., 2000. The Profile of Mood States and athletic performance: Two meta-analyses. *Journal of Applied Sport Psychology*, 12(1), 49-68.
2. Brown, D., and Fletcher, D., 2017. Effects of psychological and psychosocial interventions on sport performance: A meta-analysis. *Sports Medicine*, 47(1), 77-99.
3. Carron, A., Colman, M., Wheeler, J., and Stevens, D., 2002. Cohesion and performance in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, 24(2), 168-188.
4. Castaño, N., Watts, T., and Tekleab, A., 2013. A Reexamination of the cohesion-performance relationship meta-analyses: A comprehensive approach. *Group Dynamics*, 17(4), 207-231.
5. Chatzisarantis, N., and Stoica, A., 2009. A primer on the understanding of meta-analysis. *Psychology of Sport and Exercise*, 10(5), 498-501.
6. Driskell, J., Copper, C., and Moran, A., 1994. Does mental practice enhance performance? *Journal of Applied Psychology*, 79(4), 481-492.
7. Craft, L., Magyar, T., Becker, B, and Feltz, D., 2003. The relationship between the Competitive State Anxiety Inventory-2 and sport performance: A meta-analysis. *Journal of Sport and Exercise Psychology*, 25(1), 44-65
8. Feltz, D., and Landers, D., 1983. The effects of mental practice on motor skill learning and performance: A meta-analysis. *Journal of Sport Psychology*, 5(1), 5-57.
9. Filho, E., Dobersek, U., Gershgoren, L., Becker, B., and Tenenbaum, G., 2014. The cohesion-performance relationship in sport: A 10-year retrospective meta-analysis. *Sport Sciences for Health*, 10(3), 165-177.
10. Greenspan, M., and Feltz, D., 1989. Psychological interventions with athletes in competitive situations: A review. *Sport Psychologist*, 3(3) 219-236.
11. Hagger, M.S., 2006. Meta-analysis in sport and exercise research: Review, recent developments, and recommendations. *European Journal of Sport Science*, 6(2), 103-115.
12. Hattie, J., 2015. The applicability of Visible Learning to higher education. *Scholarship of Teaching and Learning in Psychology*, 1(1), 79-91.
13. Hatzigeorgiadis, A., Zourbanos, N., Galanis, E., and Theodorakis, Y., 2011. Self-talk and sports performance: A meta-analysis. *Perspectives on Psychological Science.* 6(4), 348-356.
14. Hinshaw, K.E. 1991. The effects of mental practice on motor skill performance: Critical evaluation and meta-analysis. *Imagination, Cognition and Personality*, 11(1), 3-35.
15. Kyllo, L., and Landers, D., 1995. Goal setting in sport and exercise: A research synthesis to resolve the controversy. *Journal of Sport and Exercise Psychology*, 17(2), 117-137.
16. Lebeau, J., Liu, S., Sáenz-Moncaleano, C., Sanduvete-Chaves, S., Chacón-Moscoso, S., Becker, B., and Tenenbaum, G., 2016. Quiet eye and performance in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, 38(5), 441-457.
17. Lochbaum, M., and Gottardy, J., 2015. A meta-analytic review of the approach-avoidance achievement goals and performance relationships in the sport psychology literature. *Journal of Sport and Health Science,* 4(2), 164-173.
18. Moritz, S., Feltz, D., Fahrbach, K., and Mack, D., 2000. The relation of self-efficacy measures to sport performance: A meta-analytic review. *Research Quarterly for Exercise and Sport*, 71(3), 280-294.
19. Pates, J., Cowen, A.P., and Karageorghis, C.I., 2012. The effects of a client-centered approach to flow states of three elite golfers. *International Journal of Golf Science,* 1(2), 113-126.
20. Pearson, K., 1904. Report on certain enteric fever inoculation statistics. *British Medical Journal,* 2(2288), 1243–1246.

IT IS EASIER TO BE A HUNTER THAN TO BE HUNTED: PSYCHOLOGICAL PREPARATION OF SILVER OLYMPIC WATERPOLO TEAM

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The sport preparation is comprised of physical, technical, tactical and psychological training. Psychological preparation helps elite athletes to optimize their performance. Elite athletes spend several years in preparing themselves for highest-level competition as Olympic Games. On top level sport everything counts and everybody are trying to neutralise all factors that could, besides training, influence the final results. The aim is to present sport psychology interventions provided to Croatian national water-polo team, former Olympic champions, during 3-months, before the Rio Games. As one of the most challenging sport goal is to repeat the highest possible result, Olympic gold, this team needed 'a step forward' if they want to increase their chances to do it. Psychological preparation process was recognised as factor that could make a difference. It was organised in eight 3 to 5 days cycles during preparation period, firstly with wider selection, and progressively with less players. Initially, detailed psychodiagnostic evaluation of team and each player was conducted. According to the results obtained psychological preparation was organised on three levels. The first level included team-building program following 4 CO model: commitment, cooperation, cohesiveness, concentration. Second level included individual work with athletes, primarily oriented toward arousal regulation techniques by learning relaxation, breathing exercises and biofeedback, but also to individual issues. On third level sport psychologist worked intensively with a coach and whole expert team within individual consultations, workshops and daily meetings. Some psychological techniques were practiced on the pool, during or after training (concentration and relaxation exercise), implemented into conditioning or regular training sessions. Players and expert team were congruent about team mission (gold Olympic medal as a framework) but also aware and trained to keep their focus on the process– the way how to realise that ultimate goal. Team building interventions and team-work on training and competition goals contributed to team cohesion that facilitated performance on preparation games. Disciplined use of certain key words by all participant, players and expert helped to keep the focus on process. Good collaboration between coaches and sport psychologist and significant increment of group cohesion forcefully helped the process and finally, the outcome.

CROATIAN BASKETBALL AS A FRAMEWORK FOR UNDERSTANDING NATIONAL IDENTITY IN THE 1990s

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Abstract

The Croatian National Basketball Team developed out of the well-known Yugoslav basketball school, and the newly-founded national team was the continuation of this school. The team enjoyed significant sporting success from its founding in 1991 to 1995. Events related to Croatian basketball in the 1990s are not only significant in the sporting sense, but in the sociological sense as well, and it shall serve in this paper as a framework for an analysis of national identity as a social phenomenon. Two cases have been selected as determinant points of our analysis: winning the silver medal at the 1992 Olympic Games in Barcelona and winning the bronze medal at FIBA EuroBasket 1995 in Athens.

Key words: *basketball, Croatian society, national identity*

Introduction

The relationship between national identity and sport is a highly relevant social issue, and systematic sociological analysis is required to interpret it. Using the thesis that sport is the embodiment of society as a whole, we shall attempt to explain the phenomenon of national identity in Croatian society in the 1990s through two sporting (basketball) events. Nations often use sport to promote themselves, to emphasise their superiority, and to strengthen national spirit, and the winning of awards thus becomes a sign of power and superiority (Coakley, 2009). Croatia is one of a group of nations that, for want of broader political and economic power, attempted to use sport and large sporting events to attain international recognition and legitimacy. The concept of national identity is of exceptional importance in the field of sport, and it comes to its greatest expression during national team play. This subject became exceptionally important in the 1990s, in a time of great geopolitical changes, the collapse of Yugoslavia, and the creation of Croatia as an independent nation-state (Bartoluci, 2013).

Yugoslavia's national basketball team was quite well-known and celebrated in the world of sport. The player selection system, the relatively large number of players, and the politics of the sports federations of the time created a generation that left a significant mark on the international basketball scene. In the early 1990s, great socio-political changes took place in Yugoslavia, and these also manifested in the world of sport. The Serbian communist government promoted a federal state model, while Croatia and Slovenia advocated a confederate model for Yugoslavia and a parliamentary democracy based on free, multi-party secret elections (a federation of sovereign states connected by mutual interest). The creation of a confederate basketball league was also fielded, but due to political changes, this idea was never realised. As the political elites could not agree on the future of the state, the Socialist Federal Republic of Yugoslavia began to disintegrate, and this process culminated in 1990. These changes and the beginning of war in Slovenia and Croatia resulted in the end of the Yugoslav national basketball team as it had existed until this point. With the initiation of aggression against Croatia, Dražen Petrović and Stojko Vranković refused to play for the Yugoslav team at EuroBasket in Rome in 1991, the final appearance of this national team composed of players from the six Yugoslav socialist republics. After this championship, the Croatian Basketball Federation took the decision to withdraw from the Basketball Federation of Yugoslavia at its assembly on 17 November 1991. Simultaneously, an urgent request was sent to accept Croatia into the World Basketball Federation (*Fédération Internationale de Basketball*, FIBA), which enabled its entry into the qualification tournament for the Barcelona Olympic Games in 1992. The president of FIBA at the time, Borislav Stanković, played a key role in this process. It was necessary to reschedule the qualifying draw from the end of December of 1991 to early January of 1992, when the political recognition of Croatia was expected (Kovačević & Bibić 2004). Some of the best players on the Yugoslav national team at the time – Toni Kukoč, Dino Rađa, Arijan Komazec, Dražen Petrović, etc – continued playing for the Croatian national team, which won silver at the 1992 Olympic Games in Barcelona. In 1993, after the death of Croatian team captain and well-known NBA player Dražen Petrović, Croatia managed to win the bronze medal at the 1994 FIBA World Championship in Canada, as well as at FIBA EuroBasket 1993 in Germany. Two years later, at FIBA EuroBasket in Athens, they would attain their final success at a large competition with a bronze medal win. These successes in basketball were, in a way, a continuation of the sporting system of the former Yugoslav state. Simultaneously, they represented much more than simple sporting success for the new nation-state, as they served the purposes of national integration and affirmation on the international political stage.

Methods

A qualitative case study was carried out. Two cases were analysed – the 1992 Olympic Games in Barcelona and EuroBasket 1995 in Athens. Eight semi-structured interviews with key actors in both of these events were also carried out, and a discourse and content analysis of media statements made during and after particular sporting events was performed. All articles concerning key sporting events published in daily newspapers three days before, during, and three days after the events were also analysed (*Večernji list, Vjesnik,* and *Sportske novosti*). Game coverage on national television was also analysed.

Results and Discussion

Some basketball events hinted at the beginning of the "end" of the Yugoslav national team even before the collapse of Yugoslavia. This relates first and foremost to an occurrence at the 1990 World Championship in Argentina, when Vlade Divac ripped a flag with the Croatian national coat of arms out of the hands of a supporter, with the explanation that he opposed Croatian nationalism. Even though this flag was not the "official" flag of the Socialist Republic of Croatia, this event took on various connotations in the public eye and was mythologised many times over. In the face of growing nationalism, as well as because of the events that followed on the territory of the former Yugoslavia, Divac's action made him a "hero" to a great portion of the Serbian public, and made him *persona non grata* in Croatia. This event was also treated in the film "Once Brothers", a "Hollywood-style" story of the life and sporting careers of an ethnic Serb (Divac) and Croat (Dražen Petrović) and their relationship, which suffered due to ethnic nationalism and war in the former Yugoslavia. "The format for the screenplay for this film was borrowed from the mythology of the American Civil War – a cruel war that divides two best friends and forces them to fight on opposing sides" (Perica 2012), and in doing so distorts and embellishes many events, according to some interviewees. Also, according to Perica (2012), Divac "was able to use the film to force his own perspective of the cause of the war in Croatia in 1991, which does not correspond do historical fact". Our interview respondents also discuss the distortion of these historical facts, as well as the fact that Stojko Vranković, who was well-informed as to the events treated by the film, was not consulted during work on the film.

After the final performance of the Yugoslav national basketball team at EuroBasket 1991 in Rome, and after the Croatian Basketball Federation split from the Yugoslav Basketball Federation, high-standing individuals in the basketball world attempted to ensure that Croatia would be able to compete at the coming Olympic Games in Barcelona. At this time, numerous athletes undertook various actions in the role of "ambassador" of the new Croatian state at a time when it did not yet have its own diplomatic service (Pezo, 2010). During the Croatian national kick-boxing team's stay in New York, a peaceful protest against the violence in Croatia was organised by Croatian diaspora and held in front of the United Nations building – an event that was also attended by basketball players Dražen Petrović and Stojko Vranković, both successful NBA league players at the time – in order to alarm the international public to take action in stopping aggression against Croatia. This protest was later largely mythologised and branded a "hunger strike", which it was not in reality. Numerous athletes, including basketball players, used every opportunity to inform the public about the happenings in Croatia.

Croatia was accepted into the IOC in late 1991, first as a partial member, so that athletes could take part in qualifications for the Winter Olympic Games being held in Albertville, France in 1992, and the summer games taking place that same year in Barcelona. Despite the provisions of the IOC statute, which state that only UN member states can become IOC member states, Croatia was accepted prior to its international recognition. Qualifications for the basketball tournament were held immediately prior to the start of the Olympic Games in Barcelona. Mirko Novosel, as the main lobbyist for the Croatian Basketball Federation's entry into FIBA and its participation in Olympic qualifications in Barcelona, said the following about the negotiations: "Boris Lalić and myself 'drilled' Boro Stanković on a daily basis. He favoured us, he wanted to help Croatian basketball. If it weren't for him, Croatia certainly wouldn't have competed at the Olympics in Barcelona. But the top man in the American Basketball Federation, my personal friend Dave Gavitt, also played a large role. He wrote to the president of the International Olympic Committee, Juan Antonio Samaranch, and among other things, he wrote the following: 'I am bringing 11 of the best NBA players to Barcelona, I am bringing world sports superstars who will be the main attraction of the Olympic Games. We want Croatia to play there as well, they have an exceptionally strong team.' Later, this letter proved to have 'opened Samaranch's eyes', he wanted Croatia to enter the qualifying draw. We only needed recognition from FIBA, entry into the qualifying draw." (Kovačević & Bibić, 2004)

Competition at the Olympic Games in Barcelona was not the first big international competition for most of the members of so-called "Generation 92" (Seoul Olympics 1988, EuroBasket 1989, World Championships in Argentina 1990). On 8 August 1992, they played their final match against the "Dream Team", the United States national team, which consisted of 11 professional basketball players, "world superstars" such as Charles Barkley, Larry Bird, Magic Johnson, Michael Jordan, Karl Malone, Scottie Pippen, David Robinson, etc. This game was the most watched event of the Olympic Games – it was broadcast in 180 countries and watched by 3 billion people. Croatia won a "silver medal with a gold lining". The Croatian public perceived this medal as something much more than just a sporting success – headlines like "The world is watching Croatia" and "The world applauds Croatia" emblazoned the front pages of Croatian daily newspapers. It was an event that contributed greatly to the international promotion of Croatia as an emerging nation-state.

Media discourse surrounding these events emphasised sporting goals as well as national successes. The attitude towards the ethnic “other”, in which “we” are the epitome of positivity while “they” are the epitome of negativity, is an indicator of the ethnic form of nationalism. This form is evident in the example of a newspaper article in which athletes from the Federal Republic of Yugoslavia are identified as “arrogant savages in peasant shoes, holding guns and knives” alluding to their being members of a nation-state that has committed aggression against Croatia. This is also a clear example of labelling and the spread of moral panic. In this same vein, written feedback alluded to the Catalan people, who “should understand” Croatia’s independence and not allow Croatian basketball medals to be awarded by Borislav Stanković. This comment was written to point out the “problematic” Serbian ethnic origin of Stanković, disregarding his key role in lobbying within the FIBA and the IOC to enable Croatia to participate in the Olympics in Barcelona. Also, it was suggested that it was possible that Serbian journalists were being insincere when they congratulated Croatian basketball players on winning the medal, yet another display of the attitude toward the ethnic “other” manifested through media coverage: “In addition, there are two more details. Bora Stanković, vice president of the IOC, was present during the medal ceremony, standing next to Juan Antonio Samaranch. Of course, the Catalans didn’t even think of having Stanković give the medals to Croatia’s basketball players. It wouldn’t have made any sense, since the public was whistling. We also noted another detail concerning our basketball players at the press buffet. Two Serbian reporters from Belgrade newspapers congratulated our basketball players on their great success. Who knows if they were being sincere?” (Sportske novosti, 10 Aug 1992, p. 2)

These athletes themselves were socialized in the multi-ethnic society of the former Yugoslavia, and in this sense, we cannot claim that the ethnic type of nationalism was dominant. However, they were aware of their special role under special circumstances, which put the need of the nation before their own individual needs. This is apparent from an example in which the coach of the National Basketball Team chose Dražen Petrović, his best basketball player, to carry the Croatian National Flag during the exhausting opening ceremony of the Olympics, even though he was expected to do his best for both the team and the nation in a basketball match scheduled for the following day. This is a clear display of the coach’s priorities – the nation comes first.

Hobsbawm (1993) emphasises the manner in which sport can become an expression of national battles and a bloodless war. In critical times, states use sport to promote themselves, to emphasise their superiority, and to strengthen national spirit, and the winning of awards becomes a sign of power and superiority. The following statement shows how sporting success becomes a tool in realising national interests, and how specific circumstances (war in the country, the desire for international recognition, and the recognition of the new nation-state) sensitised and homogenised athletes: “Well, the 1992 Olympics have a special place in my heart, and probably in the lives of everyone involved. It was a really awkward moment – real people were dying, there was destruction, bombing, and everything. You had some kind of responsibility, not so much towards your sporting results, but to alert the world as to what was going on. “Croatia, what’s Croatia?” All of a sudden there was Croatia, and that’s why the results we achieved was so enormous. People aren’t aware of how big it was. The only thing I was aware of was the enormous national pride that kept us going. When I think of it, I get goose bumps. It was literally “one for all, all for one”. We were the same, there were no questions as to why, how, or what. Later, there were misunderstandings among the team and so on, but that year, it was simply the way I described it. Everybody was simply focused in a way, since it was a terrible time, something had to be done.” (16,7)

EuroBasket 1995 in Athens was the first big competition after Croatia’s independence at which Croatian basketball players encountered the Yugoslav national team, which at the time consisted of players from Serbia and Montenegro. Interviewees expressed their trepidation at the possibility of an encounter with their former teammates: “It was the first championship after Croatia’s independence where Yugoslavia was playing as well. We hadn’t played against them, and there was a great tension as to whether it would come down to a final match, and I think that hobbled us in the semi-final against Lithuania, although Lithuania was a world-class team with Marčiolionis, Sabonis and the others, they were a team on our level. But I’m saying, I think we didn’t play the best game because we were worried about a possible match against Yugoslavia.” (2,10)

Statements from political officials began to appear in the public discourse accenting the importance of a sporting victory against the Yugoslav team, which would have actually been a symbolic social victory. Antun Vrdoljak, head of Croatian Radiotelevision at the time, stated: “What is most important now is for our full basketball team to compete in Athens, for Dino Rađa to play, and for us to defeat this ‘Socialist Republic of Yugoslavia’. I believe that I share the opinion of every Croat when I say that a victory in this respect would be more important than a medal.” (Večernji list, 21 and 22 June 1995, p. 51) or “Every Croat would prefer for us to beat the Serbs in a direct match, even if we finished seventh…” (Vjesnik, 23 June 1995, p. 23).

Croatia lost in the semi-finals to Lithuania, while the Yugoslav team beat Greece, and a match between the two teams never took place. In what many considered a questionable final match, Yugoslavia won the gold medal. The event that marked this championship for many was when the Croatian team walked off of the podium before medals were given to the Yugoslav team. The championship took place just before the war in Croatia ended, and a large part of the Croatian public displayed a positive opinion of this act, and even glorified it: “Croatia’s basketball players left the podium during the national anthem of a non-existent, unrecognised Yugoslavia, which was once again accepted by the world in a big way. It was a wholly civilised act in the face of the hypocrisy, cheating, lies, and impudent usurpation of the parquet in Athens to promote something the world officially does not recognise but privately tolerates.” (Vjesnik, 4 July 1995, p. 17).

The media appraised this act as an expression of patriotism, and *Sportske novosti* (4 July 1995, p. 11). wrote that Croatia's "basketball players left the winner's podium and went into the dressing room, not wanting to listen to the anthem of the nation that was an aggressor against theirs, and in doing so showed their patriotism once again." In the world of sport, not shaking hands with the winner, whoever he or she might be, is considered "unsportsmanlike", and in this sense, placing the national issue and the world of politics above the "unwritten" rules of sports can be considered ethnic form of nationalism. Sport should serve as a tool of political (national) "unity", communication, and conciliation, and should rise above political disagreements. Understanding this act and its perception in the public eye is possible only if we include the specificity of the temporal and spatial context. Throughout the years, numerous speculations appeared regarding whose idea it was to leave the hall. Based upon statements by the players, it can be concluded that the decision was taken with the blessing of top politicians, but that the initial idea and its execution depended entirely on the team captain and his teammates. "Our national team, who each left the parquet showing a peace sign, did not want to allow themselves the discomfort and humiliation of listening to the national anthem of a nation that was still the aggressor. The moment when the basketball players representing Serbia and Montenegro took to the podium, the Croatian players left the hall in a column. It was a simple agreement between the players and the team management, which we few Croats here have accepted with approval." (Večernji list, 3 July 1995, p. 24).

Conclusion

In the social sense, Croatia experienced numerous transformations that also manifested in the field of sport. Ukić (2015) notes the words of the first selector of Croatia's national basketball team, Petar Skansi, who said that it was incomparable to play for the national team during the war in the early 1990s and immediately afterward, when sporting success also meant national success, and when a victory for the national team was a victory for the nation. Croatia, in spite of its large number of NBA stars, fell into obscurity a few years after winning the silver medal at the 1992 Olympics in Barcelona, says Perica (2001) – "The tragic deaths of coach Ćosić and NBA superstar Petrović, coupled with weak coaching and the erosion of the basketball organization, among other factors, help account for the demise of Croatian basketball."

Today, a quarter of a century later, the context has changed, which has also resulted in a change in the significance of playing at the national level. Despite exceptional individual players in European and international clubs, Croatian basketball is still lacking in success at large competitions. The media often claims that the "unsportsmanlike" behaviour of Croatia's basketball players – leaving the awards ceremony and not offering a hand to their opponent – sealed the fate of Croatian basketball, resulting in a lack of results at large sporting competitions. Interviewees in the 1990s were motivated by numerous external factors and were dependent on results – "The farther we go, the further they will hear about us", one of them said. Leaving the podium, "from today's perspective, was unsportsmanlike, but in that moment it was necessary. I think that I wouldn't do it again today, but at that time, we weren't making decisions logically but with heart and emotion. That heart is missing today in sport," concludes one interviewee.

An analysis of events tied to the Croatian national basketball team shows how significant sport is to the creation of a national identity, and it allows an understanding of the time and context during which Croatia was being created as an independent state.

References

1. Bartoluci, S. (2013). *Uloga vrhunskog sporta u oblikovanju nacionalnog identiteta u Republici Hrvatskoj: usporedba devedesetih i dvijetisućitih*. [The Role of High-Performance Sport in Shaping of National Identity in the Republic of Croatia: The Comparison of the 1990s and the 2000s. In Croatian.] (Unpublished doctoral dissertation, University of Zagreb) Zagreb: Filozofski fakultet Sveučilišta u Zagrebu.
2. Coakley, J. (2009): Sports in Society: Issues and Controversies. New York : McGraw – Hill.
3. Hobsbawm, E. J. (1993). Nacije i nacionalizam. [Nations and Nationalism. In Croatian.] Zagreb: Novi liber.
4. Kovačević, Z. i Bibić, M. (2004). Zlatna košarka Mirka Novosela. [Golden Basketball of Mirko Novosel. In Croatian.] Zagreb: Golden marketing - Tehnička knjiga.
5. Perica, V. (2012). Generacije protiv nacija. Postjugoslavenski diskursi heroizma. In Perica, V. & Velikonja, M. *Nebeska Jugoslavija*. (pp. 173-253). Beograd: Biblioteka XX vek.
6. Perica, V. (2001). United they stood, divided they fell: Nationalism and the Yugoslav school of basketball, 1968-2000. *Nationalities Papers*, *29*(2), 267-291.
7. Pezo, V. (2010). Sport i hrvatski identitet. In Budak, N. & Katunarić, V. (Eds.). *Hrvatski nacionalni identitet u globalizirajućem svijetu*. Zagreb: Centar za demokraciju i pravo Miko Tripalo, Pravni fakultet.
8. Sportske novosti, 10 Aug 1992, p. 2.
9. Sportske novosti, 4 July 1995, p. 11.
10. Ukić, M. (2015). *Politika i sport u hrvatskom kontekstu: slučaj Europskog košarkaškog prvenstva 1995.* [Politics and Sport: The Case of the European Basketball Championship in Athens 1995. In Croatian.] Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
11. Večernji list, 21 and 22 June 1995, p. 51
12. Večernji list, 3 July 1995, p. 24
13. Vjesnik, 23 June 1995, p. 23
14. Vjesnik, 4 July 1995, p. 17

A LIFE STORY OF A PROFESSIONAL FOOTBALL PLAYER AT THE END OF HIS CAREER

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Abstract

It is possible to more or less divide the lives of professional athletes from a professional point of view into two phases - the time of their sports career and the time after. While in the time of active sports life, sport is simultaneously also the source of living, after finishing their career the athletes have to change their life from scratch and they need to find a new position in the work market. Involution - finishing career - is an important phase in the life of professional athletes. This study presents the results of two case studies – former football players. In the frame of our research, through semi structured interview we obtained the life and sport story of the players, which we subsequently processed from the point of view of handled/non handled involution. Therefore in this discussion, we are analysing the stories of these professional football players from the point of view of involution and we observe factors and categories which influenced the end of their sports career. In the story, we for example mention the category of the position of the sportsman in the society, perception of comfort, discomfort and losses, planning the future - strategies for solving the involution, support from the side of their club, family, etc. We are interpreting the results based on logical analyses of the stories and the available literature.

Key words: *involution, handled/not handled involution, theory of transition, category*

Introduction to the matter

The lifelong evolution of an athlete, from the beginning in his/her childhood, till the peak of it followed by finishing the sports career, undergoes phases, which can be formulated from many different points of view. A well-known theory of sports training (Zahradník & Korvas, 2012) speaks about phases: sport pre-preparation, basic sport training, elite level training. This approach emphasises the physiological and the skills side of the training preparation. Further relationships are connected with the psycho-social personal development, which plays a role in the long term motivation, and the ability of self-regulation, which then secondarily help to pay interest on the physiological and skills part of training preparation, and also in the approach to solving the involution. The respect to the biodromal approach, or to the "life course" approach, i.e. respect to the long term, lifelong development, can show the way both to a mature sport career as well as to a mature life after finishing the career (Bednář, 2009; Dudová, 2011; Hoffmannová & Válková, 2012). Authors Hošek and Vaněk introduced a theory of four stages of development of the motivational structure, and they were the first who mentioned the phase of involution already in 1975 (Hošek& Vaněk, 1975). Later, this bases was many times reformulated as the development of sports career or the theory of "transition phases in the development of a sports career", i.e. the transition theory (Lavallee & Wylleman, 2000). Finishing the athlete's career is one of the main stages of their lifelong development that the athletes encounter in their lives. This last phase is inevitable for all athletes (Zaichkowsky, when the athletes leave professional sport is often perceived badly by public, and it is being compared to going into a professional retirement of people who are not making living by sport. However, not many people realize that a big number of professional sportsmen face the problems connected with the end of an active career. The length of the elite level career, so called "lifespan in sport's career" differs in relationship to the psycho-professiographic character of the sport, which is also influenced by the age, in which the athlete enters the stabilization phase: it is shorter with aesthetic – coordination sports and longer with sensory and anticipatory sports. In the submitted text the attention is focused on anticipatory team sport, concretely football players. The difference between leaving to the "player's retirement" and to professional retirement really is huge. The main difference can be in the life span of the player's career, where the athletes typically start and finish the player's career in a relatively early age. (Blinde & Greendorfer, 1985). At the age when athletes usually finish their professional career and they leave to "player's retirement", their contemporaries usually have their professional career solved, they are developing it and they are starting a family. Another difference between the end of a sports career and the end of professional career is the difference in the life experience acquired (Pearson & Petitpas, 1990). Since the professional athletes succumb all their life to their career, and they do it from a very young age, they do not have time to perceive other interests, and therefore to develop themselves in other areas. This can lead to a certain distortion during the development of their identity, when the athletes focus too much on themselves and their sport and they close themselves into a so-called bubble. The development of a sports career does not bring along just the development of physical and physiological potentials, but also psycho-social ones, such as attitude to success/failure, stress coping strategies, attitudes to the importance of the problem, self-comprehension, personal characteristics, skills in using certain strategies, and all this in two possible directions: a positive and a negative way. All these can later project into handling or not handling the involution phase of the ex-athlete. At the same time, it is very desirable that these transferable skills are carried over to normal life, since usually they are not dependent on the contents of the activity, therefore they are transferable to a different activity (Wiant, 1977). One of these personal characteristics is for instance perseverance, which is strongly supported during sport, and which is strongly sought for in future business managers (Mayocchi& Hanrahan, 2000). Football belongs among sports, which are characterised with their social environment. Its basic element from the point of view of psychology is anticipation, therefore anticipating the opponent's behaviour. The environment is artificial, however at the same time social, and therefore complex situations with not completely known elements are being created. Because of their character, anticipatory sports are very much favoured by the audience (Válková, 2014). The goal of the submitted study is to determine the factors, which can and do influence the process of transition between the career of a professional football player and his life after finishing the career, and presenting it in two case studies. The analyses of the conclusions from this work can serve as a basis for creating an educational program intended for elite level athletes, in which they will get the information and experience that they could utilize for the successful handling of their leave from the professional sport and their transition to everyday life.

Methods

The strategy of the study is a research of a retrospective character, i.e. ex post facto and biodromal approach. The outcome for the research is a transition theory, which is the theory of the transition phases in the development of the motivational structure of an athlete. Not handled or badly handled involution means various individual problems, social-economic losses and losses of the psycho-socio-economic capital of the athlete's personality.

The study presents the results of two case studies – former football players; it enables to study the up-to-date phenomena into depths and in their real context. The cases observed were two ex-professional football players, their anonymity being protected. *The means of data collection* was a semi-structured interview conducted by trained interviewers. The interviews were recorded with an informed consent of the responders, later they were transcribed and further analysed. During the analyses of the interviews we focused on the reasons they finished their career, the readiness of the athlete for the end of his career, and on the transition between the football player profession and later the "civil" profession. We categorised the statements from the interviews concerning involution, family background, education, the athletes' personality and other, and we observed the combination of categories with respect to handling or not handling the involution, to personal satisfaction of the athletes at present time and his utilization at the work market. We are interpreting the results based on logic analyses of the stories and on the currently available literature.

The Results

In our contribution we are observing and analysing the life stories of two football players, who went through several life and sport crossroads during their career. We categorise the statements related to the subjective perception of the life crossroad or player's crossroad, and we will describe them further. The categories are highlighted in the text.

From the point of view of a subjective perception, both players agreed, independently of each other, on accepting the comfort; i.e. **the position of the athlete in the society**, which means that a professional athlete, a football player concretely, is well looked after. Player No. 1: *"A man is looked after, he gets money, clothes, he does his training, plays his match, and basically he does not have to look after anything else. Many players did not think about their life after their career. We were living only in the moment and we did not think about what would follow."* Player No. 2 confirmed this: *"It is a wonderful life. We did not restrict ourselves in any way. When we wanted to travel somewhere or go and buy something we were financially ok."* Nevertheless, both players add almost simultaneously, that this wonderful life also asks some sacrifices. In our study we call this category **perceiving discomfort and losses.** Among these is stress that the professional athletes experience during their career. The first player is talking about performance. If it is good then it is "all right". The second player admitted that he perceived a certain stress throughout the whole time of his professional career. The athlete also has to adapt his everyday regime to the specific environment of the elite sport. Player No. 1: *"It is a kind of sacrifice, whether a sacrifice of my free time or some night entertainment.* Player No. 2: *"I think it limited us as far as time a bit. That the family could not be together as much as it should be".* By this, they are pointing to the problem of professionality, and the huge extent of time involved, because of traveling to the matches, which professional football players experience.

Another category is considering and planning the future after the sport's career, **i.e. the strategy for solving the involution;** what activity does the athlete want to be involved with. Player No. 1 admitted that while having health problems he was asking himself questions as far as "what to do next?". He was shown the way by his son, in a similar way as player No. 2. His son started playing football and more or less drew his father to the coach`s job. Player No. 1 admits that he never really asked himself questions such as *"I am 29. What will I do next?"* And his football agent did not help him either. After an **injury,** which we consider to be **a crossroad in the sports career**, he was still making money for some time by playing in lower grades; however, towards the end of his sports career he obtained a coaching licence **(dual career)** and started coaching. As the biggest trouble when undergoing the transition to the "normal" coach's life he mentioned *"the transfer from the regime of an elite athlete to the regime of a working person. This means that you start getting up earlier, you kind of go to work earlier. Simply it means to devote much more time to it."*

Another thing that is coming out of the interviews is that the essential thing for the successful handling of the involution and going through this process is **the existence and quality of family relationships**. Player No.1: *"I heard a lot about it (the end of the career) at home – from parents, grandma and grandpa".* Player No. 2 admits in the interview that his relationship with his son helped him to handle the transition – *"my boy was happy, that I am the coach".* Player No. 2 also stayed involved in the football sphere after finishing his career. He acquired his coaching licence already during his active playing. His main motivation there was to ensure the family: *"I mostly wanted to ensure the family, so I was thinking a lot about it, and it was clear to me that I should continue with coaching."* However, a really difficult decision he considers that he had to make was, to start something new and to not think about what it will bring. In his words it was very uncertain, as there are many coaches. The statement: "however, I trusted myself and I went for it" belongs to the category **features of personality** (passive/active attitude to problem solving, escape reactions, loneliness, etc.). Other statements that we classed in this category: player No. 2 highlights an interesting life phase, when he was working in a store for building material for almost a year after finishing his playing career. He evaluates this experience as *"an awakening into how the normal people live, what is their regime. One realizes that there is more than just football. And where there is no football, you just go to work for eight or nine hours.*" His wife even pointedly marked these nine months as *"nine month of pregnancy".*

There is a difference in the perception of the **support from the club.** Player No.1 was changing teams, and he did not feel support neither from the club or the management, neither from the coach. Player No.2 did not perceive support from the club, but he did feel support from his coach. *"He sent me to do my coaching licence".* Both of them agreed that the support from the clubs should be different and bigger.

Discussion

Reasons for finishing a career can vary as much as the lives of the individual athletes. Lavallee and Wylleman (2004) differentiate types of transition between the individual phases of sports career to normative (expected) ones and non-normative (unexpected) ones. An injury was a reason for the untimely finish of a professional career of the first of the interviewed players. Because of a combination of two injuries – a broken Achilles tendon and the tear of the anterior cruciate ligament, which is a very common injury in football, the player had to finish his playing career at the age of thirty. The second player finished his career according to expectations.

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Both of them agreed, that as players they totally identified with their profession, and by that they found themselves in a bubble, in which they were moving as professional athletes (McGillivray et al., 2005). One of the negative elements in the life of a professional athlete, that both the interviewed football players admitted, is the fear of the result, fear of their own performance (constant stress), which is what Richardson et.al research (2012) confirms. The interviewed players stayed involved with football after finishing their professional athlete`s career, they both currently work as coaches, and therefore they confirmed Gearing's theory (1999). The players confirmed, that while choosing their further career, they were most influenced by the fact that they have been professional football players for a long time, and that they wanted to stay involved with football and so they did, in a similar way as Wacquant (1995) observed it with boxers. This behaviour can serve as a usual case of transition of skills from a player's career into another career (Mayocchi & Hanrahan, 2000). Our research also confirms, that the athletes, who prepare for leaving into their sport's retirement and for handling the "non-sporting role" with the aid of their family, experience the transitions from sport more smoothly, and also that the support on the side of the clubs at the moment is not sufficient.

Conclusions

Despite the fact that the reasons for finishing their careers were different with our two respondents, their further professional growth is very similar. They both perceived a certain comfort in the time of their professional playing career, they also perceived certain losses because of being too narrowly focused on their sporting career, and they both were considering and planning their professional future. There is also a similarity in how they perceive the role of their families.

What came out of the interviews is that the support from the clubs is not sufficient, in the contrary to the support from the coach. In that case, what plays an important role is the personal relationship with the coach, who is in a closer contact with the players. Both players were preparing for the end of their career already during their active sporting time, as they each acquired a coaching licence, and they were coaching young football players. The transition between the athlete`s career and the life after this career was easier for the players, thanks to their coaching practice, and despite the fact that the players perceived certain obstacles and limitations.

References

1. Baillie, P. H., & Danish, S. J. (1992). *Understanding the Career Transition of Athletes.* The Sport Psychologist, 6(1), 77-98.
2. Bain, A. (2005). *Constructing an Artistic Identity.* Work, Employment & Society, 19(1), 25-46. http://doi.org/10.1177/0950017005051280
3. Bednař, M. (2009).*A Movement of a Person on a Biodrome: A Path through Life from the Point of View of (not only) Kinantropology.* Prague: Karolinum.
4. Blinde, E. M., &Greendorfer, S. L. (1985).*A Reconceptualization of the Process of Leaving the Role of Competitive Athlete. I*nternational Review for the Sociology of Sport, 20(1-2), 87-94. http://doi.org/10.1177/101269028502000108
5. Crook, J. M., & Robertson, S. E. (1991). *Transitions Out of Elite Sport.* International Journal of Sport Psychology, 22(2), 115-127.
6. Dudová, R. (2011). *A Qualitative Research of Life Paths: Life Stories and Biographic Research.* Socioweb 11/2011.
7. Gearing, B. (1999). *Narratives of Identity among Former Professional Footballers in the United Kingdom.* Journal of Aging Studies, 13(1), 43-58.
8. Hoffmannová, J., &Válková, H. (2012). *Biodromal Approach to the Analyses of the Important Phenomena in the Development of Sportsmen in Selected Risky Sports.* Česká kinantropologie [Czech Kinantropology.]16(3), 173-188.
9. Hošek, V. &Vaněk, M. (1975). *Success as the Factor of Motivation During Sports Activities.* In: Psychologie a sport. [Psychology and Sport.] Proceedings of Sport Psychologist, FEPSAC. Prague: Olympia. Pp. 76-93.
10. Lavallee, D., &Wylleman, P. (2000). *Transitions in Youth Sport: A Developmental Perspective on Parental Involvement.* Career transitions in: International Perspectives, 305.
11. Mayocchi, L., & Hanrahan, S. J. (2000). *Transferable Skills for Career Change.* Fitness Information Technology. 95-110.
12. McGillivray, D., Fearn, R., & McIntosh, A. (2005). *Caught up in and by the Beautiful Game. A Case Study of Scottish Professional Footballers.* Journal of Sport & Social Issues, 29(1), 102-123. http://doi.org/10.1177/0193723504268730
13. Pearson, R. E., &Petitpas, A. J. (1990). *Transitions of Athletes: Developmental and Preventive Perspectives.* Journal of Counseling & Development, 69(1), 7-10. http://doi.org/10.1002/j.1556-6676.1990.tb01445.x
14. Richardson, D., Littlewood, M., Nesti, M., & Benstead, L. (2012). An Examination of the Migratory Transition of Elite Young European Soccer Players to the English Premier League. *Journal of Sports Sciences*, *30*(15), 1605-1618.
15. Zaichkowsky, L., Kane, M. A., Blann, W., & Hawkins, K. (1993). *Career Transition Needs of Athletes: A Neglected Area of Research in Sport Psychology.* Proceedings: 8th World Congress of Sport Psychology, Lisbon, Portugal, 785-787.
16. Wacquant, L. J. D. (1995). *The Pugilistic Point of View: How Boxers Think and Feel about Their Trade.* Theory and Society, 24(4), 489-535. http://doi.org/10.1007/BF00993521 Wylleman, P. & Lavallee, D. (2004). *A Developmental Perspective on Transitions Faced by Athletes.* Developmental Sport and Exercise Psychology: A Lifespan Perspective, 507–527.http://drmichellecleere.com/wpcontent/uploads/downloads/2013/01/LifeSpan_Chap19_screen2.pdf

RELATION BETWEEN INCOMES, PHYSICAL ACTIVITY AND QUALITY OF LIFE IN ELDERLY

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Purpose: The quality of life and physical activity are very closely related factors. Physical activity enhances the quality of life and improved quality of life motivates to continue to be physically active (Gill et al., 2013).

The aim of our research was to evaluate relationships between incomes, physical activity and quality of life in elderly.

Methods: The survey involved 113 men and 209 women whose average age was 71.07 ± 6.79 years. The participants' quality of life was assessed using the questionnaire SF-36 short version. Physical activity was measured using RAPA (Rapid Assessment of Physical Activity) scale.

Results: Research results showed that women better than men assessed the quality of their life. They had fewer functional limitations related to physical fitness, they were more energetic, sociable and better evaluated their mental health.Physically active people better evaluated the quality of their life in all areas.Incomes play a significant role for the quality of life. Persons with higher incomes experience fewer restrictionsof physical functioning, they are more energetic, sociable and they better evaluate their mental health.

Conclusions: Research results showed that the effect of physical activity and income levels were greater on the quality of life than gender, lifestyle or place of residence. Women and persons with higher incomes, those living in urban places better evaluate their mental health. People with higher incomes are more motivated to be physically active for enjoyment and people living in rural areas are less motivated to be physically active for sociability.

References

1. Gill, DL; Hammond DD, Reifsteck, ER; et al. (2013). Physical Activity and Quality of Life. Journal of Preventive Medicine and Public Health 2013; 46(Suppl 1): S28-S34.

FRANJO BUČAR IN THE CROATION SPORTS HISTORIOGRAPHY

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Abstract

Aim of this paper is to analyse 'Franjo Bučar' as a topic in the Craotian sports historiography. It is reasonable to expect that the most important person in Croatian sport history is well investigated and that, relatively to his importance and contribution, will be represented in Croatian sports historiography. Although Croatian sports historiography can be traced back to the early twentieth century, it was not until the post WWII period especially during 1960s and 1970s that scholarly researches and academic sports historiography in Croatia developed rapidly. Until today, over 500 books about Croatian sport history were published in Croatian language. Despite the advances and development of the historiography of sport in Croatia, it remained the case that researchdriven, in-depth scholarly studies of Franjo Bučar, "father of Croatian sport", remain almost untouched field since 1970s.

Key words: *history, Croatia, sport, Franjo Bučar*

Introduction

Franjo Bučar (1866–1946), also known as the "father of Croatian sport", is the most prominent and well-known historical figure in the Croatian sports history. His name is connected to nearly every significant sport and PE event in Croatia from the end of the 19th century to the middle of the twentieth century. He introduced Croatian with many modern sports. He organised or was part of the first important sport societies in Croatia like Croatian Sports Association (established in 1909). He wrote many books about Physical Education and tried to modernised the than Physical Education curricula. Franjo Bučar organized and managed a two-year course for secondary school gymnastics teachers (1894–1896) after his return from a two-year educational programme at the Royal Central Gymnastic College in Stockholm (Sweden). This high school was the first for PE training not only in Croatia but also in this region of Europe. He was the first Croat that brought news about establishment of International Olympic Committee, he was first to advocate Croatian participation at the Olympic Games and later he become first Croat to be a member of the International Olympic Committee (1920–1946).

Having in mind all those facts and significance of Franjo Bučar for Croatian sports history this research analysed the place and role of Franjo Bučar in the historiography of Croatian sports. It is reasonable to expect that the most important person in Croatian sport history is well researched and that, relatively to his importance and contribution, will be represented in Croatian sports historiography.

Short overview of the historiography of sport in Croatia

Although Croatian sports historiography can be traced back to the early twentieth century, when a few sport enthusiasts and physical educators sought to introduce Croatian citizens to modern sports, it was not until the post WWII period that scholarly research started. Franjo Bučar published in 1908 a book "History of gymnastics" which is the first relevant historiographical material that deals with the history of the sport written in Croatian language. This relatively extensive work (over 200 book pages) covers world and national history of sport. A significant part is devoted to the emergence and development of physical education in Croatia. In the methodological sense, it is first serious contribution to the historiography of sport, but Bucar refrain from making any assessment, analysis of the causes or consequences, assessment of the significance of certain events and contributions of individuals. One of the possible reasons of such approach probably lies in the fact that a significant part of the event that Bučar described referring to himself and therefore, for the sake of objectivity, limited to a statement of the facts.

Beside Bučar's only one more book has been published before WWI – Ivana Hirschmann "Short notes from the History of gymnastics" (1st edition in 1906 and 2nd edition in 1913) – a small books without historical methodology and mostly translated from various written materials on other (German and Czech) languages. In the same period, we can find few smaller contributions to the historiography of sport in form of the articles (Bučar, 1896; Mosso, 1897; Unknown 1890a; Unknown 1890b; Sorlini, 1901; Sorlini 1902; Sorlini 1898; Sorlini 1906, etc.) but all of them rarely use sources and it is hard to consider them as scholarly papers.

Between two World Wars one historiographical contribution particularly stands out – Milutin Mudrinić "History of Physical Exercise", a two volume publication published in 1932 (volume I - Ancient and Medieval period) and 1938 (volume II – Modern period). On over 400 book pages, Mudrinić summarized basic information's, mainly facts, about development of sport in World and Croatia. Franjo Bučar published in 1925 his historical study about development of Sokol movement in Croatia "History of Croatian Sokol – Zagreb 1874-1885" and Dušan Bogunović published in 1925 "Overview of Physical education and Sokol", a smaller contribution mainly devoted to the development of Sokol movement in Croatia and other Slavic countries.

After World War II and especially during 1960s and 1970s sports historiography in Croatia developed rapidly. That period was marked by Prof. Živko Radan, PhD (1920-1989). He was first scholar that earned PhD in sport history in Croatia (in 1976) and was a professor of Sport history at the University of Zagreb Faculty of Kinesiology (1960-1989). Since 1960, Živko Radan wrote a number of valuable studies making important and relevant contribution to the understanding of the historical development of individual sports to complex studies that comprehensively describe the work of Franjo Bučar (Radan, 1970) and the development of the Olympism in the South Slavic countries (Radan, 1976). His studies are distinguished by factual credibility, good observation of developmental trends and by putting sport in wider social, cultural and political context. He also published first university textbook about sport history in Croatian language (Radan, 1966, 1973, 1981). Živko Radan undoubtedly was a founder of Croatian sports historiography.

In 1970, Committee for the History of Sport of the Croatian Sport (Physical Culture) Association launched new journal "History of Sport". Journal was published quarterly until 1999 (30 volumes, 120 issues). About 2450 scientific, professional and other sport history articles represent the most important historiographical contribution to the Croatian sport historiography.

In the 1990s and 2000s most important sport history researcher was Zdenko Jajčević (1946-2011) who published 16 books, 45 articles in journal "History of Sport" and over 2000 articles or entries in encyclopaedias as well as daily and weekly newspapers. (Čustonja, 2011) In 2000s and 2010s, Jurica Gizdić published 67 books about sport history in Croatia.

Until today, over 500 books about Croatian sport history were published in Croatian language. Vast majority of them are not scholar or academic book but rather popular ones not written by professionally trained historians.

Franjo Bučar and Historiography of Sport

Franjo Bučar (1866-1946) was historian, secondary school teacher and sports official. After studying history and geography at the Universities of Vienna and Zagreb (1886-1890) Franjo Bučar attended courses in Swedish gymnastics and modern sports in Stockholm (1892-1894). On his return home from Sweden, he took up post as a secondary school teacher until retirement in 1925. He received PhD in history at the University of Graz in 1897 with thesis "Geschichte des Protestantismus in Croatien" [History of Protestantism in Croatia]. He introduced and helped to popularise many sports in Croatia such as football, tennis, field hockey, fencing, skiing, ice hockey, figure skating, basketball etc. After taking the initiative in forming the Yugoslav Olympic Committee in 1919, he became the first President of the newly formed organization and served until 1927. He held many other senior positions in sports administration including Vice-President and President of Croatian Sports Association, President of the Physical Education teachers Association, President of the Croatian (1919-1935) and Yugoslavian (1936-1938) Skating Federations and Vice-President of the Yugoslavian Fencing Federation (1928). When Yugoslavia was allocated a second seat on the IOC in 1920 Bucar took this up until his death in 1946. Franjo Bučar organized and managed a two-year course for secondary school gymnastics teachers (1894–1896). It was the first high school (college) of PE in Croatia and in this region of Europe. (Radan, 1970; Buchanan, Lyberg, 2010; Škegro, Čustonja, 2014). He is generally considered as a pioneer of sport in Croatia and popularly called "father of Croatian sport".

Historiography defined as the academic study of the way that "history has been and is written" (Furay and Salevouris 2010:223), as a "results of historical researches" (Nikolić Jakus 2008:8) and as "looking at historians' work" (Polley, 2007:38) can give us insight on what, when, why and how certain topics were treated by historians. Authors of this paper consider 'Franjo Bučar' as a best starting point in the analysis of the Croatian sport historiography.

There is only one book in Croatian sport historiography devoted exclusively to the Franjo Bučar – "Franjo Bučar and gymnastic and sport movement in Croatia" written by Živko Radan and published in 1970. That book is in fact a Master of Science Thesis of Živko Radan accepted in 1967 by the University of Zagreb and later published by University of Zagreb High School for Physical Culture (today Faculty of Kinesiology). Radan, in this 283 pages book, wrote first relevant historical research about Franjo Bučar. Book has seven chapters and two most important are: 3rd Chapter - Activities of Franjo Bučar in the area of Physical Education (pp. 15-97) and 4th Chapter - Activities of Franjo Bučar in the area of Physical Culture and Sport (pp. 98-264). Radan, as a trained historian (earned Master of Arts degree in history at the University of Zagreb in 1960), extensively used primary sources, archive materials, presented number of documents and analysed Bučar's personal correspondence. Although Radan's work is not entirely deprived of the then communist and Yugoslav ideology – Bučar "was a typical offspring of the Bourgeois class" (Radan, 1970:275), Bučar was "well known and convicted Slavophile" (Radan, 1970:276) – most of his analysis and conclusions are well documented and argumented. This pioneer historical research stands out as foundation of Croatian sport history.

Živko Radan's PhD. Thesis "Olympism in Yugoslavia until 1919" was accepted in 1976 by the University of Belgrade Faculty of Physical Education and published as a book in the same year. Again, Radan used proper historiographical methodology and processed big amount of primary sources. This research included Franjo Bučar and his work in the field of Olympism from 1894 until 1919 but not exclusively since Bučar was not involved in activities in Serbia and other South Slavic nations. In previously mentioned book "Franjo Bučar and gymnastic and sport movement in Croatia" Radan described Bučar's activities in the field of Olympism in separate subchapter on 26 pages. However, in this book Radan described Bučar's activities in that field in much more extensive and detailed way.

There are 17 articles in journal "History of sport" dedicated to 'Franjo Bučar'. Only one article is original and new scientific contribution (Macanović, 1970) while other articles mainly recycled and repeat already known facts from previous researches.

Many other sport history books written in Croatian language mention Franjo Bučar and describe his work but all of them used Radan's two books as a source of information's. We could not find any other new, significant or historiographical relevant contribution to the body of knowledge about Franjo Bučar his life, work and contribution to the history of sport in Croatia. Unfortunately, Radan's books and one article in journal "History of Sport" (Macanović, 1970) all from 1970s remain as the only relevant historical researches about Franjo Bučar.

Conclusion

Despite the advances and development of the historiography of sport in Croatia, it remained the case that researchdriven, in-depth scholarly studies of Franjo Bučar, "father of Croatian sport", remain almost untouched field since 1970s. That fact could mean that Croatian sport history on academic and scholar level is satisfied with researches made more than 40 year ago and that no new analysis or interpretation of Franjo Bučar are necessary. However, more likely is that sport history in Croatia on academic level declined in the last couple of decades. Although other areas or fields of interest to the sport historians were not analysed or mentioned in this research it is reasonable to assume that situation with them is not much better. Nevertheless, University of Zagreb in the last five year accepted at least three PhD. Thesis in the field of sport history and maybe new and positive tendencies for the sport history on the academic level are coming in Croatia.

Literature

1. Bučar, F. (1908). Povijest gimnastike [History of gymnastics *in Croatian*]. Zagreb: Hrvatski sokolski savez.
2. Hirschman, I. (1906). Kratki izvadak iz historije gimnastike [Short notes from the History of gymnastics *in Croatian*]. Zagreb.
3. Hirschman, I. (1913). Kratki izvadak iz historije gimnastike [Short notes from the History of gymnastics *in Croatian*]. 2nd edition. Zagreb: Knjižare L. Hartmana (St. Kugli).
4. Bučar, F. (1896). Grčke gimnastičke i narodne svečanosti [Greek gymnastic and folk festivals *in Croatian*]. Gimnastika, 6(3):36-41; 6(4):52-55; 6(5):65-69; 6(6):81-84.
5. Mosso, A. (1897). Prošlost i budućnost tjelesnog uzgoja (prijevod I. Širola) [History and Future of Gymnastics *in Croatian*]. Napredak, 38(31):483-485; 38(32):501-504; 38(33):554-556; 38(34):565-567; 38(35):580-582.
6. Unknown (1890a). Pentatlon kod starih Grka [Pentathlon in Ancient Greece *in Croatian*]. Gimnastika, 1(7):103-109; 1(8):119-124.
7. Unknown (1890b). Razvitak gimnastike u našoj domovini [Development of Gymnastics in our Country *in Croatian*]. Gimnastika, 1(10):154-158; 1(11):164-172.
8. Sorlini, Lj. (1901). Gimnastika u doba humanizma [Gymnastics during Humanism *in Croatian*]. Škola, 12(6):86; 12(7):102.
9. Sorlini Lj. (1902). Filantropisti i tjelesne vježbe [Philanthropists and physical exercises *in Croatian*]. Škola, 13(1):4; 13(2):19; 13(3):35.
10. Sorlini, Lj. (1898). Miroslav Ljudevit Jahn [Friedrich Ludwig Jahn in Croatian]. Gimnastika, 8(9):129-136.
11. Sorlini, Lj. (1906). Tjelovježba kod Rimljana [Physical Exercise in Ancient Rome *in Croatian*]. Škola, 17(6):114-115.
12. Janković, V. (1954). Iz prošlosti fizičkog odgoja u školama Hrvatske [History of Physical Education in Croatian schools *in Croatian*]. Zagreb: Društvo učitelja, nastavnika i profesora fizičkog odgoja NR Hrvatske.
13. Bučar, F. (1925). Povijest Hrvatskog sokola – Matice u Zagrebu: 1874-1885 [History of Croatian Sokol – Zagreb 1874-1885 *in Croatian*]. Zagreb: Hrvatski sokolski savez.
14. Mudrinić, M. (1932). Istorija telesnog vežbanja [History of Physical Exercise *in Croatian*]. Volume 1. Zagreb: Tiskara C. Albrecht.
15. Mudrinić, M. (1938). Istorija telesnog vežbanja [History of Physical Exercise *in Croatian*]. Volume 2. Zagreb: Tiskara C. Albrecht.
16. Radan, Ž. (1970). Franjo Bučar i gimnastički i sportski pokret u Hrvatskoj [Franjo Bučar and gymnastic and sport movement in Croatia *in Croatian*]. Zagreb: Visoka škola za fizičku kulturu.
17. Radan, Ž. (1976). Olimpizam u krajevima naroda Jugoslavije do 1919. [Olympism in Yugoslavia until 1919 *in Croatian*]. PhD. Thesis. Zagreb: Visoka škola za fizičku kulturu.

18. Radan, Ž. (1966). Kratak pregled povijesti fizičke culture [Short overview of the history of Physical Culture *in Croatian*]. Zagreb: Visoka škola za fizičku kulturu.
19. Radan, Ž. (1973). Pregled historije tjelesnog vježbanja i sporta [History of physical exercise and sport. *In Croatian*]. Zagreb: Visoka škola za fizičku kulturu.
20. Radan, Ž. (1981). Pregled historije tjelesnog vježbanja i sporta [History of physical exercise and sport. *In Croatian*]. Zagreb: Školska knjiga.
21. Čustonja, Z. (2011). Zdenko Jajčević – In Memoriam. Historijski zbornik, 64(1):299-301.
22. Buchanan, I., Lyberg, W. (2010). The Biographies of All IOC-Members. Part IV. Journal of Olympic History, 18(3):41-54.
23. Škegro, D., Čustonja, Z. (2014). The Beginnings of Education and Training for Delivering Physical Education Classes in Croatia – 140 Years of Tradition. Kinesiology, 46(Supp. 1):126-132.
24. Furay, C., Salevouris, M.J. (2010) The Methods and Skills of History: A Practical Guide. 3rd edition. Wheeling, IL: Harlan Davidson.
25. Nikolić Jakus, Z. (2008). Uvod u studij povijesti [Introduction to the study of history. *In Croatian*]. Zagreb: Leykam International.
26. Polley, M. (2007). Sports History: A Practical Guide. Basingstoke: Palgrave Macmillan.
27. Macanović, H. (1970). Osnivanje Jugoslavenskog olimpijskog odbora u Zagrebu 14.12.1919. [Establishment of Yugoslavian Olympic Committee in Zagreb 14th December 1919. *In Croatian*.]. Povijest sporta 1(1):5-13.

EXPRESSION OF VALUES IN LITHUANIAN YOUNG FOOTBALL PLAYERS

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Abstract

Development of values in young persons – both actively engaged into physical activity or physically inactive – is an urgent trend in researches. Such factors as social environment, parents, competitive atmosphere during sport event, as well as external social values have the greatest influence on the emotions and experience of young people engaged into sporting activity; these factors can either enhance their motivation to engage into sporting activity and make progress, or, on the contrary, lead to drop out from sport.

Scientific works treat football as a holistic process, taking into consideration the aspects of social development of the players. This process embraces attitudes and motivation, physical preparation, teaching and further development of the motions and habits, as well as expression of the players' skills in competitive activity. So far, Lithuanian scientific works have been dealing mostly with young football players' motor habits, as well as with the expression of physical and functional capacities in their training sessions and competitions; however, analysis on value expression in the process of young football players' (self) development has not been carried out yet.

Key words: *football, young football players, values*

Introduction

Values are fundamental part of competencies development, while successful development of competencies is possible only if the values of the person are perceived and conditions are provided for their actualization (Aramavičiūtė, Martišauskienė, 2006).

D. Richardson, T. Reilly (2001) point out that such factors as child‘s experience in sport-related, educational and everyday life environment, together with the relation between a child and people of his near environment – coaches, teammates, parents, single parents, patrons, teachers, friends, contemporaries, make impact on a child‘s values and form them along with his believes, self-confidence, emotions, attitudes and devotion to sport, cognitive processes and decision making; all this conditions child‘s willingness to participate in sporting activity (Richardson, 2000; Richardson, Reilly, 2001).

According to I. Leliūgienė (1997), the period of middle school age is important for a child to help him understand himself in current situation, awake creative powers, direct towards universal values, help him become socially active, civic, honest, physically and spiritually sane and intellectual personality.

We agree with S. J. Danish et al. (2003), stating that participation in sporting activity is an important factor in development of adolescents' personality, self-respect and competencies; sport is a challenge which provides habits in relation with character values – such as responsibility, perseverance, risk-taking, courage and self-control. According to a great number of authors, sport activity includes moral and sport-characteristic will-power values (Žilinskienė, 2008; Budreikaitė, Adaškevičienė, 2010).

Development of values in young people, actively engaged into sporting activity or physically inactive ones, is an urgent trend for investigations (Cruz, 1995; Perenyi, 2008; Whitehead et al., 2013). Aspects of young people in Lithuania, both involved into sporting activity or physically inactive, was the object of investigation of Budreikaitė, Adaškevičienė (2010). Value orientations of young athletes of track-and-field have also been investigated (Žilinskienė, 2008).

Scientific works treat football as a holistic process, social aspects of football players' development are discussed. This process includes athlete‘s attitude, motivation, teaching and development of habits, as well as expression of skills in competitive activity. So far, Lithuanian scientific works have been dealing mostly with young football players' motor habits, as well as with the expression of physical and functional capacities in their training sessions and competitions, but the analysis on value expression in the process of young football players' (self) development has not been performed yet.

Investigations in the field of football players' values expression are important in such aspect as they disclose peculiarities of integral relation of cognitive processes and practical activity of the persons involved into sporting activity. The conclusions might provide additional conditions for development of special sport competencies, too. The aim of the research was to disclose the expression of values in young football players aged 12–18.

Methods

The questionnaire for the research was compiled following the methodological requirements. Using questionnaire interrogation, specific features of value expression in young football players (aged 12–18) regarding different age groups were disclosed. Variety exists in classification of the values, however, in our research the list of the values was made basing on the studies of other authors (Danish et al., 2003; Zilinskiene, 2008). In particular, the list of the values used in N. Zilinskiene (2008) research of doctoral thesis was applied in our study, aiming to establish value orientation in physically active persons. From 23 values, all will-power values were selected for our research (14 values), excluding five morality values, which were the most rarely marked by the respondents in Zilinskiene (2008) performed research on the investigated persons of the same age period. These morality values are the least characteristic to football sports as well. The list (18 values) of the main values of will-power (14 values) and morality (4 values) were presented to the investigated persons, asking them to mark out five the most important to them. The research was carried out in 2009–2010. 499 young Lithuanian football players were selected for participation in the research. Respondents were from ten different cities of Lithuania (Vilnius, Kaunas Klaipeda, Siauliai, Panevezys, Alytus, Marijampole, Jonava, Gargzdai, Sirvintos). They were young football players, having football players experience not less than 2 years and participating in training sessions 3–5 times per week. Considering proved samples reliability, conclusions are applicable to the whole Lithuanian population. Answers of the respondents were analyzed splitting them into three groups: juniors – E1 (aged 12–14; n=289); youth – E2 (aged 15–18; n=192); youth team – E3 (aged 15–18; n=18); the latter took part and gained leading position in Lithuanian Youth Championship.

Research data were processed using SPSS (13.0 version) program. Percentage frequency was calculated. Differences between the groups were calculated applying χ^2 (chi square) criterion. Level of significance was: $p<0.05$. Difference statistically significant at $p<0.05$*.

Results

According to all respondents of the research, football training sessions and competitions assist in development of such values: persistence (80.2 percent), determination (59.3 percent), courage (48.3 percent), perseverance (44.5 percent), responsibility (43.3 percent), diligence (37.1 percent), disciplining (33.7 percent), will-power (27.9 percent), creativity (23.0 percent) and dutifulness (22.4 percent) (Figure 1).

Rather little percentage of the respondents pointed out importance of such values as self-control, self-dependence, self-respect, honesty, keeping to principles, politeness, orderliness, sincerity in training process (Figure 1).

However, statistically significant differences ($p<0.05$) occur between the groups (Figure 2 and Figure 3). Younger players (E1) give priority to courage ($p<0.05$), while older ones prefer perseverance ($p<0.05$) and responsibility ($p<0.05$) (Figure 2).

Players in E3 group give higher importance to the values of disciplining ($p<0.05$) (Figure 2), dutifulness ($p<0.05$) (Figure 2), orderliness ($p<0.05$) (Figure 3) than E2 group players; less important to them are the values of persistence ($p<0.05$) and courage ($p<0.05$) (Figure 2). For players from the same team (E3 group respondents) determination was less important and responsibility they marked more often than their counterparts (but these differences were not significant).

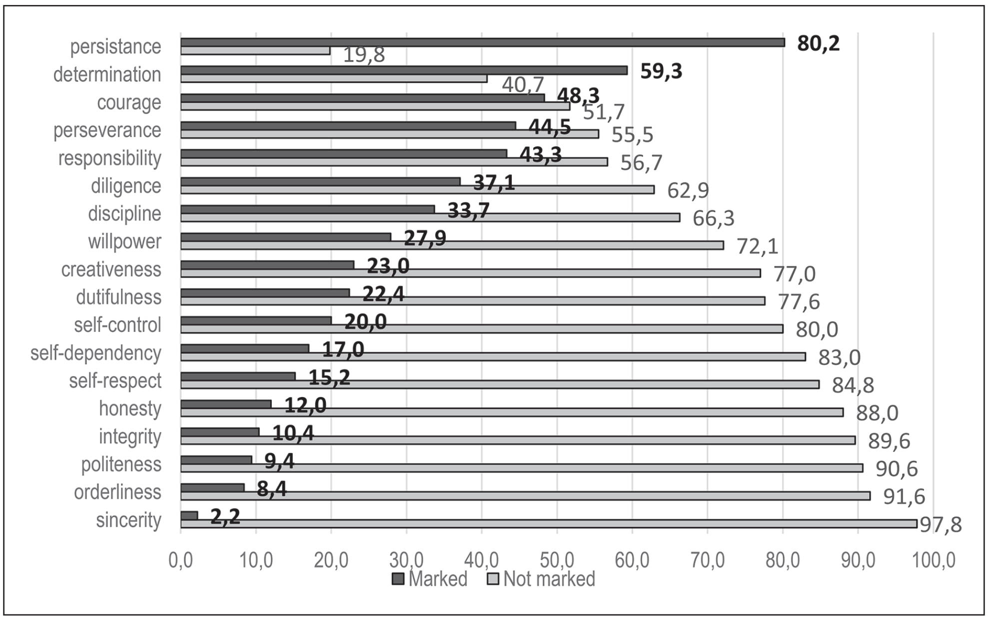

Figure 1: Expression of values (percent) in young football players (n=499).

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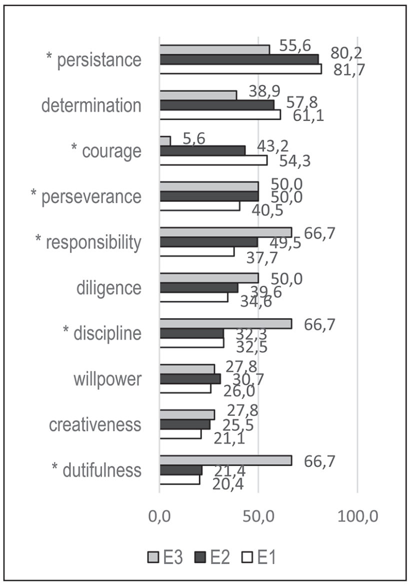

Figure 2: Expression of values (perc.) more often marked by young footballers in three groups (* - significant difference between the groups, p<0.05)

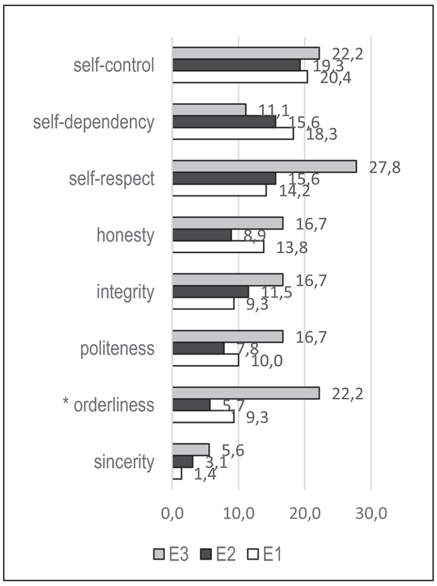

Figure 3: Expression of values (perc.) less marked by young footballers in three groups (* - significant difference between the groups, p<0.05)

Discussion

Performed research analysis reveals peculiarities of values expression in Lithuanian people engaged in football sport. The research results confirmed the fact that young football players, aged 12–18, perceive importance of values for (self) development of their personality as an athlete and point out the most important to them values during training sessions and competitions. This process provides opportunities for better self-understanding and self-evaluation, and is also in line with holistic development concept and the need for purposeful development and expression of competencies under conditions of contemporary children and youth (self) development.

Children and youth‘s opinion confirms this fact, as they themselves are concerned by good own health condition, novelty, friendship, love, success, self-dependency, freedom of choice, initiative, i.e. – everything, ensuring personal happiness. Rather great significance is allocated to being recognized by others, as well as to beauty, prestige and belief. Authority is of least importance for the youth (Ruškus et al., 2008). Children and youth would like to spend more time for sport than they do it now, and this shows sport being to them an urgent value and the factor for personal development, self-expression and self-confidence (Žilinskienė, 2008).

Sport activity is in relation with value development (Whitehead et al., 2013). Engaged into sporting activity young people give value to friendship and creativity, while inactive ones tend to appreciate material well-being more (Perenyi, 2008). Social environment, parents, competitive sport environment, as well as external social values influence formation of the persons‘ emotions and experience also enhance motivations for further progress or drop out from sport (Nache et al., 2005; Molinero et al., 2009; Garcia Calvo et al., 2010).

The research has also contributed in enlarging the limits of educational values cognition in sporting activity. Basing on young football players’ (aged 12–18) opinion, it was established that training process mostly contributes to the development of such values as persistence, responsibility, disciplining and courage. There are some significant differences (p<0.05) comparing football players’ results with the results obtained from individual sports - such as track and field athletes (Žilinskienė, 2008). Football players more often marked creativeness, responsibility, discipline, courage, while track and field athletes – willpower, self-dependency, diligence, perseverance, integrity, sincerity.

In another study the results of children and youth football players’ will-power characteristics showed that determination is more characteristic to older players, comparing to younger ones. Higher level of responsibility, patience, energy and attention is characteristic to junior players, besides, no difference was established between children and juniors regarding such features as initiative, determination, self-dependence, perseverance and purposefulness (Urbelionis, 2008).

As showed the results of the research, performed by E. Martišauskienė (2004), the most positive attitude of young football players is expressed towards responsibility; they perceive importance of moral values; national identity receives the highest evaluation, while entertainments are considered to be the source of joy. Young people involved into sporting activity fulfill their duties best, their commitment for empathy and sacrifice is expressed the most. Such attitude is very positive in social education and sport-related sense, as cognition of values and their development is the basic part of competencies development (Aramavičiūtė, Martišauskienė, 2006). Besides, highlighted is the fact that youth, involved into sporting activity, cherish true friendship, creativity, interesting and diverse life, unlike those not involved into sports: the latter appreciate wealth and material well-being more (Perenyi, 2008). J. Cruz et al. (1995) in their study have established that young football players, aged 12–16, give value to winning, demonstration of habits, usefulness and justice. The research results of D. Urbelionis (2008) showed difference between the groups of football players (aged 13–14 and 15–16) according to their attitude towards such values as purposefulness, determination and perseverance: older players expressed purposefulness, determination and perseverance, while no difference was established regarding courage.

Value expression of an athlete takes place during the process of integral interaction of rational thinking and practical activity. This actually coincides with theoretical concept of competence and emphasizes holistic trend in athletes' development, implemented during sport training sessions. All these facts prove that football team as a separate unit has sufficient conditions to transform the values of the team members, together with their competencies.

Conclusions

1. Young football players are able to recognize and give evaluation on the values important in their sport, the main values being persistence, determination, courage, perseverance, responsibility, diligence, dutifulness, will-power, creativity and dutifulness.
2. Different age groups of the football players possess different characteristic features. Attitude of juniors and youth towards such values as courage, perseverance and responsibility differs; juniors feel more courageous, while youth are more persistent and responsible.
3. Youth team members have distinguished themselves among their contemporaries in value aspect. Values of disciplining, dutifulness, orderliness were more important to them comparing to their contemporaries, while less important were the values of persistence and courage.

References

1. Aramavičiūtė, V., Martišauskienė, E. (2006). Vertybių ugdymas – pedagoginių kompetencijų pamatas. *Pedagogika*, 84, 33–37.
2. Budreikaitė, A., Adaškevičienė, E. (2010). Sportuojančių ir nesportuojančių paauglių požiūris į vertybes ir jų prasmės suvokimą. *Ugdymas. Kūno kultūra. Sportas,* 1 (76), 13–20.
3. Cruz, J., Baixados, M., Valiente, L., Capdevila, L. (1995). Prevalent values in young Spanish soccer players. *International Review of the Sociology of Sport*, 30 (3/4), 353–374. Retrieved from http://www.cabdirect.org/abstracts/19951812406.html
4. Danish, S. J., Taylor, E. T., Fazio, R. J. (2003). Enhancing adolescent development through sports and leisure. In G. R. Adams, D. Berzonsky (Ed.). *Handbook of Developmental Psychology: Blackwell Handbook of Adolescence*. Blackwell publishing, 92–108. Retrieved from http://books.google.com/boo_ks?hl=lt&lr=&id=BHPhyXMHeOUC&oi=fnd&pg=PA92&ots=2gkD6XvGf7&sig=T9QriE9U72BIwvqekScn2HWasyQ#v=onepage&q&f=false
5. Garcia Calvo, T., Cervello, E., Jimenez, R., Iglesias, D., Moreno Murcia, J. A. (2010). Using self-determination theory to explain sport persistence and dropout in adolescent athletes. *Spanish Journal of Psychology,* 13 (2), 677–684. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/20977017
6. Leliūgienė, I. (1997). Žmogus ir socialinė aplinka. Kaunas.
7. Martišauskienė, E. (2004). *Paauglių dvasingumas kaip pedagoginis reiškinys: monografija*. Vilnius: VPU.
8. Molinero, O., Salguero, A., Alvarez, E., Marquez, S. (2009). Reasons for dropout in youth soccer: a comparison with other team sports. Motricidad. *European Journal of Human Movement*, 22, 21–30.
9. Nache, C. M., Bar-Eli, M., Perrin, C., Laurencelle, L. (2005). Predicting dropout in male youth soccer using the theory of planned behavior. *Scandinavian Journal of Medicine Science in Sports*, 15, 188–197.
10. Perenyi, S. (2008). *Value preferences of the physically active and non-active hungarian youth population*. Retrieved from www.idrottsforum.org/articles/perenyi/perenyi081029.html
11. Richardson, D. (2000). The influence of 'significant others' in the development of talented young football players. *Insight – The F.A. Coaches Association Journal*, 4 (3), 28–29.
12. Richardson, D., Reilly, T. (2001). Talent identification, detection and development of youth football players – sociological considerations. *Human Movement. Polish Scientific Physical Education Association*, 1 (3), 86–93.
13. Ruškus, J., Žvirdauskas, D., Stanišauskienė, V. (2008). *Mokiniai dalyvaujantys neformaliajame švietime*. Švietimo ir mokslo ministerijos užsakymu atliktas tyrimas. Retrieved from http://www.smm.lt/svietimo_bukle/docs/tyrimai/sb/MOKINIAI_DALYVAUJANTYS_NEFORMALIAJAME_SVIETIME_2008.pdf
14. Urbelionis, D. (2008). *Futbolininkų vaikų ir jaunučių valios ypatumai: magistro darbas*. Kaunas: LKKA.
15. Žilinskienė, N. (2008). *Šuolininkių į aukštį sportinio rengimo skirtingais etapais optimizavimas: daktaro disertacija* (07 S). Vilnius.
16. Whitehead, J., Telfer, H., Lambert, J. (2013). *Values in youth sport and physical education*. Routledge.

CONSTRUCTION AND VALIDATION OF SCALE FOR EVALUATING COACHING COMPETENCE

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Abstract

The scale of 10 items was constructed to assess coache's competence. The questionnaire was applied to two samples of respondents. The first sample consisted of 189 students of the first and second year of Faculty of Kinesiology, University of Zagreb; the second sample consisted of 602 senior athletes from Zagreb from 39 different sports. The scale show good measurement properties on both samples, and can be recommended for individual use as well as research.

Key words: *athlete, coach, coaches competence*

Introduction

The importance of the coaches' competence has been recognized by the Law of Sport of the Republic of Croatia (NN 71/06, 150/08, 124/10, 124/11, 86/12, 94/13, 85/15, 19/16) where the article 59 and 60 cite professional jobs in sports, but also the formal requirements that coaches must meet in order to perform certain jobs according to this Law. Thus, professional jobs in sport are: programming and implementing sports preparation, programming and implementing sport education for children and youth in sport schools, programming and implementing sports recreation, programming and implementing extracurricular school sport activities and teaching people the basic technique of a specific sport. According to the Law of Sport of the Republic of Croatia, professional tasks in sport can be performed by persons with adequate professional qualification at least at level of first-degree coaches and people who are trained by institutions for personnel training based on pursuing the licensing program of world or European governing associations of particular sport.

In addition to formal education, there are other indicators of coaches' competence. The effectiveness of coaches work is manifested in three main areas, training, competition and management (Côté & Salmela, 1996, according to Moen & Federici, 2013). Jobs that coaches do are related to different physical, technical-tactical and psychological aspects of the preparation of athletes, and require a very dynamic interaction with the athletes, their parents and other members of the professional team, for example, assistant coaches (Moen & Federici, 2013). The power of mutual relationship between athletes and coaches is determined by the mutual coherence of their feelings, thoughts and behavior (Jowett, 2005, 2007; Jowett & Meek, 2000). For the importance of mutual understanding responsibility, complementarity and empathic understanding are important (Jowet, 2007). Starting from the fact that top coaches require competencies related to the question of mutual relationships and gaining the athletes attention during sports teaching, Moen and Federici conducted a study to determine corelation between coaches competence estimated by athletes and athletes satisfaction related to their own progress in sports (Moen & Federici, 2013). The sample consisted of a top level Norwegian athletes from different sports: skiing, biathlon, swimming, handball, cycling, etc. A total of 161 athlete (60 women and 101 men). The average age of their coaches, mainly coaches of the Norwegian Olympic Committee and the Norwegian University of Science and Technology, was 36.5 years. Scale of coaches competence consisted of five dimensions. The first dimension was creation of the relationship, and one of the items of this dimension was: *"With his/her approach, my coach has been expressing confidence and respect for me."* The second dimension - the skill of showing understanding and focus towards interlocutor is described by items such as: *"I have a feeling that my coach understands me when we talk to each other"*. One of the item that is used for the third dimension - the skill of impact on the communication process is described as: *"My coach usually sets open and direct questions."* The fourth dimension - facilitating the learning process and accomplishments is described by items such as*: "My coach encourages me to independently solve the challenges that I face."* Defining responsibilities was the fifth dimension, and one of the items was: *"My coach clearly defines my responsibility in the learning process."* The results showed a high correlation between the results of athletes at all five dimensions and their satisfaction with their progress in the sport. Athletes who were more satisfied with personal progress in the sport in the last year, evaluated their coaches as more competent. The only exception were the athletes with the lowest satisfaction of personal achievement in sport, in which case corelation wasn't noticed with the dimensions of coache's competence.

According to the assumption of the author, one of the possible explanations for this could be learned helplessness in these athletes.

The degree of perceived coaches competence by athletes could provide answers to a series of questions, starting with those related to the coaches, like, whether the coach, who is estimated by his/her athlete as competent, could substantially motivate athletes to achieve their maximum potential; or questions related to the athletes, for example, whether athletes with longer length of training career and better sports results perceive their coaches as more competent than athletes who do not invest too much effort and do not have too high expectations. Therefore, the aim of this study is to present the newly constructed scale and verification of metric characteristics on two samples of respondents.

Methods

The study was conducted on two samples. The first sample of respondents consisted of students of the first and second year of Faculty of Kinesiology, University of Zagreb, a total of 189 respondents, of which 30.69% were women, and 69.31% were men. The second sample consisted of senior athletes from Zagreb, total of 602 respondents from 39 sports; in the sample 39.36% were women, and 60.63% were men. The average age of the athletes was 23.31 years, while over 90% of coaches were aged between 20 and 60 years. The largest number of athletes accomplished the results at the National level and were members of the National Team. Students of Faculty of Kinesiology were filling out the questionnaire during the theoretical lectures The athletes were completing the questionnaire at their clubs and the premises of the Zagreb Sports Federation; the athlets were given instructions individually.

Questionnaire for evaluation of coaches' competence was constructed by Hrženjak (2016) as a measuring instrument consisting of 10 items - statements (Table 3 and Table 4). Statements were constructed on the basis of observed formulations that athletes routinely use to describe the expertise or coaches competence. Respondents evaluated each statement on Likert scale (1-5), where 1 means that the statement is completely untrue, and grade 5 that statement is completely true.

The survey in student sample was conducted in May 2016; the second study was conducted in the period between May and September 2016. The results of the first measurement show that statement 8 *"I feel lost at the competition without my coach"* was not completely appropriate and was modified in *"I feel better at the competition when my coach is next to me"* for the second study (Table 3 and Table 4).

Data analysis was done by Software package Statistics 12 (Dell Inc., 2015).

Results and Discusion

Metric properties of the total result of Assessment of Coaching Competence Scale (Hrženjak, 2016) in the sample of 189 students of kinesiology and 602 senior athlets are in the Table 1 and Table 2, respectively. The scale show good measurement properties on both, student and athlete sample. Estimations of reliability of the scale are high and there is no need for the extension of it. In both samples the number of eigenvalues greater than 1 was one, meaning that scale measures only one thing, assuming, the assessment of coaching competence, and nothing else.

Table 1: Metric properties of the total result of Assessment of Coaching Competence Scale (Hrženjak, 2016) in the sample of 189 students of kinesiology

Cronbach's alpha coefficient of reliability	0,91
First eigenvalue of inter-item correlation matrix, percentage of explained variance	5,74 57,41%
Number of eigenvalues greater than 1	1
Average Inter-Item Correlation	0,52
Average of total result	35,76
Standard Deviation of total result	8,25
Minimal observed value of total result	11
Maximal observed value of total result	50

Table 2: Metric properties of the total result of Assessment of Coaching Competence Scale (Hrženjak, 2016) in the sample of 602 senior athletes

Cronbach's alpha coefficient of reliability	0,88
First eigenvalue of inter-item correlation matrix, percentage of explained variance	5,04 50,46
Number of eigenvalues greater than 1	1
Average Inter-Item Correlation	0,45
Average of total result	41,73
Standard Deviation of total result	6,56
Minimal observed value of total result	18
Maximal observed value of total result	50

In Table 3 and Table 4 are the results of item analysis of the questionnaire in the student sample and athlete sample, respectively. Values of item – total correlations and projections at the first principal component show that all items measure the assessment of coache's competence. As was stated earlier, item number eight in the first version (Table 3) was not as good as other items, and was revised for second measurement (Table4), obtaining much higher values. It is possible, that in the statement *"I feel lost at the competition without my coach."* the athletes did not recognize the higher or lover competence of their coach but mainly the perception of themselves during the competition.

Table 3: Metric properties of the items from Assessment of Coaching Competence Scale (Hrženjak, 2016) in the sample of 189 students of kinesiology

Statement	AS	SD	r-sm	K1	Alpha-
1. My coach is an excellent psychologist and works great with athletes.	3,33	1,17	0,80	-0,85	0,89
2. My coach strayed into profession that he/she is doing.	1,81	1,08	0,74	0,81	0,90
3. My coach knows very well our sport.	4,29	0,87	0,66	-0,74	0,90
4. My coach knows exactly what he/she needs to do at any point of the practice.	3,73	1,11	0,77	-0,84	0,89
5. My coach is so talented for the job that he/she is doing, that he/she would be successful in any other sport.	2,96	1,03	0,69	-0,75	0,90
6. My coach is a top expert in his/her profession.	3,56	1,23	0,83	-0,89	0,89
7. My coach sometimes speaks unclear and leaves the impression that he/she doesn't understand what he/she is trying to explain to athletes.	2,09	1,03	0,59	0,65	0,90
8. I feel lost at the competition without my coach.	2,66	1,19	0,28	-0,33	0,92
9. My coach knows exactly how to work with beginners and how with elite athletes.	3,53	1,18	0,73	-0,79	0,90
10. My coach is accepted as an expert and top-level authority of his/her sport in sport environment.	3,54	1,20	0,70	-0,76	0,90

Note: (AS) average; (SD) standard deviation; (r-sm) item-total correlation; (K1) value on the first principal component; (Alpha-) Alpha if item is deleted.

Table 4: Metric properties of the items from Assessment of Coaching Competence Scale (Hrženjak, 2016) in the sample of 602 senior athletes

Statement	AS	SD	r-sm	K1	Alpha-
1. My coach is an excellent psychologist and works great with athletes.	3,97	0,99	0,68	-0,76	0,86
2. My coach strayed into profession that he/she is doing.	1,48	0,97	0,51	0,59	0,87
3. My coach knows very well our sport.	4,68	0,65	0,61	-0,70	0,87
4. My coach knows exactly what he/she needs to do at any point of the practice.	4,18	0,89	0,75	-0,82	0,86
5. My coach is so talented for the job that he/she is doing, that he/she would be successful in any other sport.	3,52	0,97	0,61	-0,70	0,87
6. My coach is a top expert in his/her profession.	4,25	0,88	0,74	-0,82	0,86
7. My coach sometimes speaks unclear and leaves the impression that he/she doesn't understand what he/she is trying to explain to athletes.	1,91	1,16	0,49	0,56	0,88
8. I feel better at the competition when my coach is next to me.	4,20	0,98	0,52	-0,61	0,87
9. My coach knows exactly how to work with beginners and how with elite athletes.	4,18	0,94	0,70	-0,77	0,86
10. My coach is accepted as an expert and top-level authority of his/her sport in sport environment.	4,16	0,93	0,57	-0,66	0,87

Note: (AS) average; (SD) standard deviation; (r-sm) item-total correlation; (K1) value on the first principal component; (Alpha-) Alpha if item is deleted.

Conclusion

The scale showed good measurement properties on both samples of respondents, and can be recommended for use for research and practical applications. Although formal coaches education is important and is legal requirement for the employment, it does not ensure high competence in all the aspects of coaches' duties. This scale can help finding the coaches with lower competence, estimated by athlets, and help them by permanent education and work with sport psychologists.

References

1. Côté, J., Salmela, J. H. (1996). The organizational tasks of high-performance gymnastic coaches. The Sport Psychologist, 10, 247-260.
2. Dell Inc. (2015). Dell Statistica dana analysis software system. Version 12. Software dell com.
3. Hrženjak, M. (2017). Povezanost faktora motivacije sportaša s procjenama trenerovih karakteristika. Doktorska disertacija (neobjavljena). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
4. Jowett, S. (2005). The coach-athlete partnership. The Psychologist, 18, 412-415.
5. Jowett, S. (2007). Interdependence analysis and 3+1 Cs in the coach-athlete relationship. In S. Jowett, & D. Lavallee (Eds.), Social psychology in sport (pp. 15-28). Human Kinetics, Champaign, IL.
6. Jowett, S., & Meek, G. A. (2000). The coach-athlete relationship in married couples: An exploratory content analysis. The Sport Psychologist, 14, 157-175.
7. Moen, F., Federici, R. A. (2013). Coaches' Coaching Competence in Relation to Athletes' Perceived Progress in Elite Sport. Journal of Education and Learning; Vol. 2, No. 1, 240-252
8. Zakon o sportu. (NN 71/06, 150/08, 124/10, 124/11, 86/12, 94/13, 85/15, 19/16).

GENDER DIFFERENCES DURING ADOLESCENCE IN THE MOTIVES FOR PHYSICAL EXERCISE, DEPRESSION, ANXIETY AND STRESS

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Abstract

Lately, there has been increase of interest in examining the motives of male and female adolescents for taking part in physical activities, as well as examining their depression, anxiety and stress. *The objective of this paper was to investigate intergender differences between male and female adolescents concerning the motives for physical exercise, depression, anxiety and stress. The pertinent sample accounted for 332 high-school students of both sexes from Valjevo (164 female and 168 male high school seniors), aged 18.10*±.86. Three measuring instruments were used: Questionnaire for collecting basic data, The Excercise Motivation Inventory 2 ("EMI–2") questionnaire and the Depression anxiety stress scale (DASS – 21), and its' internal consistency was evaluated using Cronbach's α coefficient. The given results showed that there are statistically significant gender differences, as the male adolescents, compared to the female adolescents, more frequently took part in physical activities. The important difference between the *motives for participating in physical activities between the* male and female participants was defined, so the motives: Socializing, Competition, Enjoyment, Social recognition and Strength and Persistence were more dominant with male adolescents, whereas motives: Appearance, Agility, Maintaining and improving health, and Body mass control were manifested more with female *high school* seniors.The internal consistency coefficients (Cronbach's alpha) of the measuring instruments used showed good metric characteristics. Statistically significant gender differences in the motives for taking part in physical activities were determined, the motives of maintaining and improving health and organism reinvigoration being dominant with the participants of both genders. The difference appeared within the sample of high school seniors on the depression variable, while there was no significant gender difference on the stress and anxiety variable. On the contrary, when it comes to female high school seniors, no statistically significant differences were found on the depression, anxiety and stress scale.

Key words: *Graduate student, female graduate student, physical activities, motivation, physical health*

Kinesiology and Social Sciences

CORRELATION BETWEEN MEDALS WON IN KARATE WORLD CHAMPIONSHIPS, GDP AND THE NUMBER OF POPULATION

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Abstract

Aim of this study is to answer the question whether every country has the same chance to win a medal in karate world championship. By using regression analysis and correlation we established how the connections between the variables (total medal number, GDP, and population number) vary. Regression analysis shows how there is no statistical significance between the total medal number and the population number(.200) however, the correlation between the medal number and GDP is significant (.015). Similarly, Pearson correlation indicates stronger connection between GDP and medal nuber (.270), than there is betwee n medal number and population (.059). In conclusion, every country does not have the same chance of winning a medal at a world championship, and economic resources will in fact make a difference.

Key words: *medals, GDP, population, economy, success*

Introduction

There are different researches that represent hypotheses about the possibility of winning Olympic medals based on economic and political factors. Bernard and Busse (2004), have proved that there is no significant relation between population and the medal number won at Olympic games. In contrast, they have come to the conclusion that there is a significant correlation between the won medals and the GDP of the countries. Similarly, this paper aims to show the results between mentioned variables on the example of karate world championships. In addition, Andreff and Andreff (2011) indicate that GDP is the crucial factor in predicting number of medals that will be won at the Olympic games (in their case Sochi 2014) and present results that show how variations in GDP of a country will affect the number of medals. For example, when Russia's GDP decreased, the number of medals won at Olympic games decreased as well. Also, we assume that the countries that are poor according to their GDP, will more likely invest less in sport than rich countries do. This could potentially also make a difference and cause richer countries to win more medals due to their more quality investment into karate as well as in rehabilitation of the athletes, diagnostic, supplementation etc. Another paper done by Andreff and Andreff (2015), shows somewhat different results and indicates how both population number and GDP will similarly affect the number of medals won at Beijing Olympic games. More research on sport economics and this topic in general is needed in order to gather more concrete results. However, sometimes GDP is not the only predictor of possibilities of winning medals. By taking population number into account, there is an assumption that countries with larger number of population will have a greater success in sports due to the higher number of people living in the country and therefore a higher possibility of gathering a larger number of people competing in karate, but the question is whether the statistics will show the same. This paper will analyze the connection between total medal number from the last 23 world karate senior championships and GDP and population number of the countries that have won medals. Considering the mentioned factors, this paper will try to answer the question whether each country has an equal chance of winning a medal at the world karate championship.

Methods

The source of information for the GDP (gross domestic product) of the countries was the World Bank, data on the population was selected from United Nation databases, and the medal statistics was used from official website of World Karate Federation (WKF). Also, all the medal statistics is based on 23 senior world championships and considers 63 countries that have won medals during last 23 championships. Statistical methods used to determine the connection between the total number of medal, GDP and population number were regression analysis and correlation. Based on this analysis, we want to determine whether there is a statistical significance between mentioned variables. For data analysis statistical program SPSS was used, and all the figures are presented and explained in the "results".

Results

Table 1:

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	15.419	4.684		3.292	.002
	GDP	5.464E-6	.000	.410	2.505	.015
	Population number	.000	.000	-.212	-1.295	.200

Table 2:

		population	GDP	medals
Population number	Pearson Correlation	1	.662**	.059
GDP	Pearson Correlation	.662**	1	.270*
medals	Pearson Correlation	.059	.270*	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 1 indicates that there is no statistical significance between total medal number and population number (.200), on the other hand, statistical significance exists between medal number and GDP of countries (.015). In addition, looking at the beta coefficient, GDP has a greater impact on medal number (.410), than population number does (-.212.). Table 2 shows Pearson correlation and confirms the numbers from the regression analysis. There is a stronger correlation between the total medal number and GDP (.270), than there is between medal number and population number (.059).

Discussion

If we take into consideration Croatia with about 4 million people and Mexico with more than 20 times larger population number, and also higher GDP, and we compare total medal number won at karate world championships, the medal number of these two countries is the same. Due to cases like these, we assume that every country has the same chance to win a medal however, the numbers are showing something different.

The results obtained show that the population number of each country will not affect the total number of medals, in addition the population number will not be a decisive factor in when considering success in karate world championships. Unlike the number of population, GDP represents a more important role, and we can assume how richer countries will have a greater chance of success. Also, the statistical significance between GDP and total medal number indicates that economic resources have a relevant role in winning medals at big competitions.

Mentioned correlations show good positive correlation between GDP and the number of inhabitants (. 662), but what is more important is the higher correlation between GDP and medal number than it is between the number of medals and population number (. 059). In fact, the correlation between these two variables (medals and population number) is extremely small. This type of relationship is seen since the correlation coefficient between the number of medals and the population number is not close to 1, i.e. the coefficient of correlation between the number of medals and the level of GDP is approaching 1. Even though this research implies that economic resourses play an inevitable role in success, we also believe that the countries with a greater GDP probably invest more into sports and all the aspects of sports such as rehabilitation, psychological support, nutrition, diagnostics ect. Therefore, these countries will probably be more successful. However, USA, for example, even though being at the top of GDP list, are not in the top of the world championship medal list. In accordance, it is also important to consider that it might be crucial not only to what extent a country invests into karate, but also how represented karate is in the particular country. Even though it is impossible to detect only one economic/political factor which will have the greatest effect on the total number of medals, we are able to answer the question from the introduction and deduce that every country does not have the same chance of winning a medal. Meaning, according to the results, economic power will make a difference. For example, rich Germany will have larger total number of medals (35), than Croatia (10). Finally, more scientific papers on this topic are needed in order to further develop sports economy and to bring new findings and potentially help in development of karate, but also other, particularly, smaller sports. This paper can be a start for future researhes upon similar topics considering sport and economics with a goal to invest into and develop karate on a new, more qualty level.

Conclusion

Considering the number of population, after analysing all the variables, results indicate that it does not have a crucial role in success at karate world championship. In contrast, the correlation between the amount of GDP and the number of medals, is statistically significat and shows a fairly great connection between the two variables. Therefore, we can simply conclude that richer countries will more likely win a larger number of medals.

References

1. Andreff, W., & Andreff, M. (2015). Economic prediction of sport performances from the Beijing Olympics to the 2010 FIFA World Cup in South Africa: the notion of surprising sporting outcomes. *The Economics of Competitive Sports,* 185-215.
2. Bernard, A. B., & Busse, M. R. (2004). Who wins the Olympic games> economic resources and medal totals. *The Review of Economics and Statistics,86*(1), 413-417.
3. Dizdar D. (2006) Regresijska analiza. *Kvantitativne metode* (str. 160, 182-200).
4. D. F., McHale, I. G., I. S., & Tena, J. D. (2016). An analysis of country medal shares in individual sports at the Olympics. *European Sport Managment Quarterly,* 1-15.
5. M. O. (2012). Medal-Count Economics: What Factors Explain the Olympics' Biggest Winners? *The Atlantic*.
6. Putt, G. D. (2013). National Performance Versus Population at the Olympic Games: A Methodology for Determining Elite Performers. *International Journal of Sport Science ,3*(3), 74-80.
7. WORLD KARATE FEDERATION. (n.d.). Retrieved February 25, 2017, from http://www.wkf.net/

ENGAGEMENT IN SPORTS ACTIVITY AS AN IMPORTANT FACTOR AMONG SPORTS ACTIVITY, RELIGIOSITY AND ALCOHOL CONSUMPTION

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Abstract

The research was conducted with the aim of investigating the relationship between sport, religion and alcohol beverages consumption. The study was conducted on the sample of 569 examinees. Besides age, gender and profession the sample were divided regarding the motive of sports involvement: live for sport, must exercise, and exercise from time to time. Religiousness, estimated by means of Santa Clara questionnaire, did not show statistical differences according to gender, age and degree of sports involvement, but there was a significant difference between professions ($p=0.03$). Athletes who "live for sport" had statistically significantly lower score on alcohol consumption ($p<0.01$). The role of religion in problem of alcoholism is still unclear, while sport is a risk factor and a protective factor as well, depending on the sports involvement motives. The further studies should analyse this problem from the viewpoint of motivation.

Key words: *strength of religious faith, substance use, sport involvement*

Introduction

The studies that dealt with sports as a protective factor in alcohol consumption showed contrary results. Although earlier studies determined sports as a protective factor (Straus and Bacon, 1953), certain studies did not relate sports to alcohol consumption (Kopp et al., 2015, Kroll et al., 2016). Recent studies show sports as a risk factor (Hildebrand et al., 2001, Lisha and Sussman, 2010, Spence and Gauvin, 1996, Turrisi et al., 2006) We can assume that the reason for these oscillations was the sample of examinees that could be divided into subsamples according to different criterions. None of the studies divided the examinees to those involved in sports voluntarily and gladly (out of love for sports) and those that were forced to practice sport. For example, students with obligatory classes of Physical education, police officers, army members, fire-fighters that have to be physically ready to perform their duties are forced to practice sports. All of these groups are obliged to fulfil certain physical criterions, with constant check-ups of motor knowledge and abilities (Adams et al., 2014, Knapik and East, 2014) Alcohol has an impact on sports on several levels: general impact on human physiology, on sports performance and exercise recovery (Barnes, 2014). The question is why would somebody investing enormous effort in improving their sport performance, would at the same time negatively influence those performances. In this paper, the sample was divided into 3 subsamples (1. live for sport, 2. must exercise, 3. exercise from time to time) in order to examine the hypothesis that those involved in sports are not prone to habits that are harmful for sports. Sports and religion are similar (Wann, 2001). In the past, sport and religion were considered protective factors regarding the alcohol consumption. If sports and religion are similar, their influence on the problem of alcohol should be similar. These studies partly do consider religion a protective factor (Bravo et al., 2016, Porche et al., 2015), but other part does not share this opinion (Cerkez et al., 2015, Galbraith and Conner, 2015). The basic aim of this research was to investigate the relation of sport and religion with alcohol beverages consumption.

Methods

The study was conducted on a total sample of 569 subjects, which consisted of three subsamples of students, professional athletes and army members. Subjects were heterogeneous regarding the age, gender, degree of involvement in sports and professional occupation (Table 1). Most of the subjects were students (78%), aged between 20 and 25 (59%), with equal number of males (52%) and females (48%). All subjects were informed that the questionnaire was anonymous and subject to their own will.

Table 1: Demographic characteristics of sample

	Males		Females		*P*
	N	%	N	%	
Age (years)					
Lowest thru 19	57	40	87	60	<0.01
20 - 25	159	48	175	52	
26 thru highest	80	89	10	11	
Sports					
None	16	24	50	76	<0.01
Recreational	181	50	181	50	
Active	58	60	39	40	
Professional	41	93	3	7	
School & professional					
Faculty of Humanities and Social Sciences	11	10	96	88	<0.01
Business & Law	20	15	112	85	
Engineering	48	77	14	23	
Kinesiology	55	60	36	40	
Professional Studies	46	87	7	13	
Sports	38	95	2	5	
Army	78	93	6	7	

There were significant differences in the proportion of males and females within some groups of Age, Sports and School & professional. Males and females were similarly engaged in recreational sports, but in active sports category there was a higher proportion of males, because of the proportion of rowers and basketball players. Sociodemographic data in this study included gender and age. New classification, according to the possibilities of choice: 1. those who participate in sports voluntarily and intensively (**live for**), 2. those who must do sports (**must do**) and those who do sports from time to time (from time to time). Professional orientation of the sample was: students of different professions (humanities & social sciences, business & law, engineering, kinesiology, college), sports and army. The Alcohol Use Disorders Identification Test – (AUDIT) is used for alcohol consumption evaluation (Saunders et al., 1993). The Questionnaire is a reliable measure of alcohol consumption (Lundin et al., 2015), Questionnaire consists of ten items with scores ranged from 0 to 4, while participants can achieve minimally 0 to maximally 40 points. The focus of this study is on consumption score, observed as overall AUDIT result (Sekulic et al., 2012). The Santa Clara Strength of Religious Faith Questionnaire (SCSRF) (Plante and Boccaccini, 1997) was used in measuring the strength of faith. SCSRF is a reliable tool (Plante and Boccaccini, 1997) and it is suitable for use with multiple religious traditions. SCSRF is 10-item instrument with variety of brief statements. Answers are on 4-point Likert scale, from 1 strongly disagree to 4 strongly agree and possible range of results are from 0 to 40. about religious faith. The approval of the corresponding author's Institutional Ethical Board was obtained prior the study (EBO 2181-205-02-05-14-005).

Data was analyzed using Statistica 12 software (StatSoft, USA). Analysis of covariance (ANCOVA) analysis was performed to avoid the impact of age on ADUIT among groups involved in sports activities. The 95% confidence intervals and P values was calculated using the standard maximum likelihood asymptotic. We considered $p < 0.05$ as significant.

Results

Table 2: Santa Clara Strength of Religious Faith (SCSRF) and Alcohol Disorder (ADUIT)

		Santa Clara			Alcohol		
	N	M±SD	F	P	M±SD	F	P
Gender							
Male	294	26.41 ± 9.58	3.10	0.078	5.87 ± 5.43	1.21	0.275
Female	272	27.81 ± 9.24			5.41 ± 4.45		
Age (years)							
Lowest thru 19	144	27.13 ± 8.77	0.07	0.935	4.94 ± 4.85	8.21	<0.01
20 - 25	331	26.98 ± 9.77			6.33 ± 5.26		
26 thru highest	90	27.39 ± 9.34			4.27 ± 3.58		
Sports							
None	66	26.11 ± 9.87	0.79	0.500	5.58 ± 4.88	7.68	<0.01
Recreational	361	27.53 ± 9.48			5.80 ± 5.04		
Active	96	26.52 ± 9.69			6.49 ± 4.99		
Professional	44	26.07 ± 7.76			2.36 ± 3.31		
Sports engagement							
Army (‘must have’)	84	29 ± 8.22	2.39	0.09	4.5 ± 3.61	17.83	<0.01
Sports (‘live for’)	40	25.6 ± 7.65			1.83 ± 2.15		
Students (‘from time to time’)	445	26.9 ± 9.76			6.21 ± 5.21		
School & professional							
Faculty of Humanities and Social Sciences	107	27.25 ± 9.82	2.29	0.034	6.58 ± 4.94	10.01	<0.01
Business & Law	132	28.52 ± 9.37			5.03 ± 4.16		
Engineering	60	24.88 ± 9.41			5.26 ± 5.66		
Kinesiology	91	26.11 ± 9.20			6.93 ± 5.79		
Professional Studies	52	25.36 ± 11.42			8.30 ± 5.68		
Sports	40	25.60 ± 7.64			1.80 ± 2.15		
Army	84	29.01 ± 8.21			4.50 ± 3.61		

A higher mean score on SCSRF questionnaire, close to 95% significance (p=0.078), was observed on the sample of females. The alcohol consumption questionnaire showed a statistically significant difference in mean values, according to age and degree of sport involvement. There were no statistically significant differences in means of SCSRF questionnaire, but significant difference in means of ADUIT questionnaire was found. ANCOVA analysis was performed in order to avoid the impact of age on ADUIT among groups involved in sport activities, and it showed certain different results. Athletes who “live for” sports had statistically significant lower score on ADUIT questionnaire.

Discussion

Age and gender are determinant factors in alcohol consumption patterns (Boyle et al., 2016). This research confirmed the thesis that the most vulnerable age was adolescence and young adulthood, but there were no differences between the gender – women consumed alcohol in only somewhat lesser amount than men (AUDIT overall result - male 5.87 vs female 5.41). We can assume that the reason for this was age, in the group of younger than 26 years (when the alcohol consumption was lower) there were 10 women and 80 men. Some professions are especially stressful (monotonous work, work overload, high responsibility) so the workers look for alcohol (Trice & Sonnenstuhl, 1988), what is a part of a phenomenon called stress related drinking. In some professions, zero alcohol tolerance is necessary, such as being a pilot or a train driver, but sudden and rigorous controls are necessary in order to diminish alcohol related problems (Marques, Jesus, Olea, Vairinhos & Jacinto, 2014). Professional athletes drink the least, followed by professional soldiers. Although military profession is stressful, we can assume that in the time of peace the stress accumulation is much lower so it is no surprise that other studies indicate lower alcohol consumption among soldiers in relation to the rest of population

(Dahl and Kristensen, 1997). Among the students of humanity studies, social sciences, business, law and engineering, there were no significant differences in alcohol consummation; similar studies also did not report differences among professions (Coogle & Owens, 2015). We can assume that the reason for this was the fact that some professions cause more stress, but the study does not have to be as stressful as the profession itself. Standard division regarding the type of sport engagement showed significant differences among groups, alcohol consumption in professional athletes was significantly lower than in other groups. Earlier studies included athletes in risk groups regarding the alcohol (Diehl et al., 2012). This study brought similar results, active athletes drink more than recreation athletes, but not more than professional athletes. Lorente et al. (2004) also determined that athletes consume alcohol more, but not those competing on national and international levels. We can assume that the reason of lower alcohol consummation is the fact that sport was their profession, that is, the source of income. The influence of gender on the result was excluded because the group that was drinking statistically less than the others (live for) had no women included. Although soldiers are professionals that have to engage in sports activities, they do not consume less alcohol, like professional athletes, so the hypothesis that sport was protective if it is a source of income is questionable. The relation between sport and alcohol can be explained as stress related drinking (Lisha and Sussman, 2010), the other hypothesis was that sport potentially engages award sets (dopamine and endogenous opioids), so athletes achieve them with alcohol supplementation (Leasure et al., 2015). We can assume that the "live for" group, due to dedication and commitment is always ready for competition, the consequence is a good sports result, causing lower stress accumulation, as well as higher level of award sets engagement. People engage in sports because of health, physical appearance, out of obligation or because it was socially desirable behaviour, while only a small number engage out of love for sports. We can say that the motive (for sport engagement), alongside with age and gender, was a determining factor in alcohol consumption patterns. According to this research, women had greater strength of faith than men, but the difference between them was not statistically significant ($p=0.07$). Women seem to have stronger faith and consume alcohol less, the pattern of religion as a protective factor regarding alcohol was observed, in concordance with the report from other studies (Holt et al., 2015). This study did not show difference in the strength of faith between age groups, although previous studies suggest that religiosity and age were positively correlated (Jose & Alfons, 2007). The lack of differences can be explained by the low age span, since older examinees, over 40 years of age, were not present. The hypothesis that scientific and intellectual elites have abandoned religion was not correct, but the fact is that the percentage of believers among them was lower (Gay, 2009). This research showed that there was a statistically significant difference in the strength of faith among different professions. The fact that humanities and social sciences students were high on the scale of strength of faith was surprising, since Hout and Greeley consider them sceptical regarding the religion (Hout and Greeley, 1998).

Conclusion

The role of religion in problem of alcoholism is still unclear, but it is only one of the factors included in the problem of alcoholism. Sport is a risk factor and protective factor, depending on the motivation of sport involvement. If one practices sport out of love and is fully dedicated then sport is a protective factor, but all other types of sport involvement are connected to the risk of increased alcohol consummation. This is alarming since most people consume sport in a way connected to risky behaviour regarding the alcohol. Further studies should address this subject from the motivation aspect.

References

1. Adams, J., Cheng, D., Lee, J., Shock, T., Kennedy, K. & Pate, S. (2014). Use of the bootstrap method to develop a physical fitness test for public safety officers who serve as both police officers and firefighters. Proceedings (*Baylor University. Medical Center)*, 27, 199-202.
2. Barnes, M. J. (2014). Alcohol: Impact on Sports Performance and Recovery in Male Athletes. *Sports Medicine*, 44, 909-919.
3. Boyle, S. C., Labrie, J. W., Froidevaux, N. M. & Witkovic, Y. D. (2016). Different digital paths to the keg? How exposure to peers' alcohol-related social media content influences drinking among male and female first-year college students. *Addictive Behaviors*, 57, 21-29.
4. Bravo, A. J., Pearson, M. R. & Stevens, L. E. (2016). Making religiosity person-centered: A latent profile analysis of religiosity and psychological health outcomes. *Personality and Individual Differences*, 88, 160-169.
5. Cerkez, I., Culjak, Z., Zenic, N., Sekulic, D. & Kondric, M. (2015). Harmful Alcohol Drinking Among Adolescents: The Influence of Sport Participation, Religiosity, and Parental Factors. *Journal of Child & Adolescent Substance Abuse*, 24, 94-101.
6. Coogle, C. L. & Owens, M. G. (2015). Screening and Brief Intervention for Alcohol Misuse in Older Adults: Training Outcomes Among Physicians and Other Healthcare Practitioners in Community-Based Settings. *Community Mental Health Journal*, 51, 546-553.
7. Dahl, S. & Kristensen, S. (1997). Health profile of Danish army personnel. *Military Medicine*, 162, 435-440.
8. Diehl, K., Thiel, A., Zipfel, S., Mayer, J., Litaker, D. G. & Schneider, S. (2012). How healthy is the behavior of young athletes? A systematic literature review and meta-analyses. *Journal of Sports Science and Medicine*, 11, 201-220.

9. Galbraith, T. & Conner, B. T. (2015). Religiosity as a Moderator of the Relation Between Sensation Seeking and Substance Use for College-Aged Individuals. *Psychology of Addictive Behaviors,* 29, 168-175.
10. Gay, V. P. (2009). *Neuroscience and Religion: Brain, Mind, Self, and Soul*, Lexington Books.
11. Hildebrand, K. M., Johnson, D. J. & Bogle, K. 2001. Comparison of Patterns of Alcohol Use Between High School and College Athletes and Non-Athletes. *College Student Journal*, 35, 358.
12. Holt, C. L., Roth, D. L., Huang, J. & Clark, E. M. (2015). Gender Differences in the Roles of Religion and Locus of Control on Alcohol Use and Smoking Among African Americans. *Journal of Studies on Alcohol and Drugs*, 76, 482-492.
13. Hout, M. & Greeley, A. (1998). What church officials' reports don't show: Another look at church attendance data. *American Sociological Review*, 63, 113-119.
14. Jose, O. A., & Alfons, V. (2007). Religiosity and forgiveness among first-married and remarried adults. *Mental Health, Religion & Culture*, 10(4), 379-394 316p.
15. Knapik, J. J. & East, W. B. (2014). History of United States Army physical fitness and physical readiness training. *U.S. Army Medical Department journal*, 5-19.
16. Kopp, M., Burtscher, M., Kopp-Wilfling, P., Ruedl, G., Kumnig, M., Ledochowski, L. & Rumpold, G. (2015). Is There a Link Between Physical Activity and Alcohol use? *Substance Use & Misuse*, 50, 546-551.
17. Kroll, L. E., Muters, S. & Lampert, T. (2016). Unemployment and Health. An overview of current research results and data from the 2010 and 2012 German Health Update. *Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz*, 59, 228-237.
18. Leasure, J. L., Neighbors, C., Henderson, C. E. & Young, C. M. (2015). Exercise and alcohol consumption: what we know, what we need to know, and why it is important. *Frontiers in Psychiatry*, 6, 13.
19. Lisha, N. E. & Sussman, S. (2010). Relationship of high school and college sports participation with alcohol, tobacco, and illicit drug use: a review. *Addict Behav*, 35, 399-407.
20. Lorente, F.O, Souville M, Griffet J and Grelot L. (2004) Participation in sports and alcohol consumption among French adolescents. *Addictive behaviors*. 29: 941-6.
21. Lundin, A., Hallgren, M., Balliu, N. & Forsell, Y. (2015). The Use of Alcohol Use Disorders Identification Test (AUDIT) in Detecting Alcohol Use Disorder and Risk Drinking in the General Population: Validation of AUDIT Using Schedules for Clinical Assessment in Neuropsychiatry. *Alcoholism-Clinical and Experimental Research*, 39, 158-165.
22. Marques, P. H., Jesus, V., Olea, S.A., Vairinhos, V. & Jacinto, C. (2014) The effect of alcohol and drug testing at the workplace on individual's occupational accident risk. *Safety Science*. 68: 108-20.
23. Plante, T. G. & Boccaccini, M. T. (1997). Reliability abd validity of the Santa Clara Strength of Religious Faith Questionnaire. *Pastoral Psychology*, 45, 429.
24. Plante, T. G. & Boccaccini, M. T. (1997) The Santa Clara Strength of Religious Faith Questionnaire. *Pastoral Psychology*, 45, 375-387
25. Porche, M. V., Fortuna, L. R., Wachholtz, A. & Stone, R. T. (2015). Distal and Proximal Religiosity as Protective Factors for Adolescent and Emerging Adult Alcohol Use. *Religions*, 6, 365-384.
26. Saunders, J. B., Aasland, O. G., Babor, T. F., Delafuente, J. R. & Grant, M. (1993). Development of the Alcohol-Use Disorders Identification Test (AUDIT) - WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol-Consumption 2. *Addiction*, 88, 791-804.
27. Sekulic, D., Ostojic, M., Ostojic, Z., Hajdarevic, B. & Ostojic, L. (2012). Substance abuse prevalence and its relation to scholastic achievement and sport factors: an analysis among adolescents of the Herzegovina-Neretva Canton in Bosnia and Herzegovina. *Bmc Public Health*, 12.
28. Spence, J. C. & Gauvin, L. (1996). Drug and alcohol use by Canadian University athletes: A national survey. *Journal of Drug Education*, 26, 275-287.
29. Straus, R. & Bacon, S. D. (1953). Drinking in college, Yale Center of Alcohol Studies, Yale University Press.
30. Trice, H. M. & Sonnenstuhl, W. J. (1988) Drinking Behavior and Risk-Factors Related to the Work Place - Implications for Research and Prevention. *Journal of Applied Behavioral Science*, 24: 327-46.
31. Turrisi, R., Mallett, K. A., Mastroleo, N. R. & Larimer, M. E. (2006). Heavy drinking in college students: who is at risk and what is being done about it? *J Gen Psychol*, 133, 401-20.
32. Wann, D. L. (2001). Sport Fans: *The Psychology and Social Impact of Spectators*, Routledge.

RESILIENCE OF ADOLESCENTS IN RELATION TO LEVEL OF SPORT COURAGE AND SELECTED DEMOGRAPHIC, PHYSICAL HEALTH, FAMILIAL, EDUCATIONAL AND SPORT VARIABLES

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Abstract

Objective: The purpose of this study was to research; resilience of adolescents in relation to level of sport courage and selected demographic (i.e; gender and age), physical health (i.e; Body Mass Index-BMI and Dominant Limbs, vision disorders, hearing problems, attention deficit hyperactivity disorder-ADHD, bone fracture past etc.), familial, (father and mother attitudes), educational (past school failure, grade point average-GPA, physical education great point average/PE-GPA) and sport (sport participation 3 times a week, physical education and sport participation before the age of 10, participation for the school sport team, game preference etc.) variables.

Method: Data were collected from 420 students (secondary school, high school and university students) aged 13 to 29 (M=15.02 ± 1.26 yrs; 161 males, 251 females and 8 unstated). Students were administered the validated "Sport Courage Scale-31" (SCS-31) and the "Child and Youth Resilience Measure" (CYRM, unidimensional with 12 items) along with personal information form. SCS-31 comprises 5 factors (Mastery, Determination, Assertiveness, Venturesome and Self-Sacrifice Behavior). Collected data was analyzed by normality tests, Pearson and Spearman correlations, parametric and non-parametric tests and univariate and multivariate analyses.

Results: 1) Spearman correlation analysis showed that resilience has positive low correlations with determination (r=.217), assertiveness (r=170), venturesome (r=.194), sacrifice behavior (r=.149) and total sport courage (r=.210).

2) Multivariate analyses indicated that adolescents with the higher scores of mastery (p<.011), determination (p<.001), assertiveness (p<.001), venturesome (p<.002), sacrifice behavior (p<.003) and total sport courage (p<.001) have significantly higher scores of resilience than adolescents with the lower points of mastery (p<.011).

Conclusion: It seems that resilience and sport courage are positively correlated and important as regard with the indicated demographic, physical health, familial, educational and sport variables. Development of resilience and courage through physical education and sports would be important assets for adolescents.

Key words: *resilience, sport courage, adolescent students, physical health, father and mother attitudes, education, sport participation*

Introduction

Adolescence is generally accepted as a transition period from childhood to adulthood (Steinberg, 2007). This period is very critical in terms of identity and independence creating adaptation problems such as adolescent self-centeredness. Therefore, resilience of adolescents could be important going through this tough period of time. Resilience encapsulates one's capacity to regain or sustain relatively stable, healthy levels of psychological and individual functioning (Eklund & Tenenbaum, 2014).

Theory and practice of psychology have much to say about stress, anxiety and fear, but little to say about courage (Corlett, 2002). People overwhelmingly describe courageous actions with a successful outcome (Pury, Kowalski, & Spearman, 2007). Sport Courage is defined as a "natural and developed, interactional and perceptual concept between person and situation, and the task at hand that enables person to move in competence, mastery, determination, assertiveness, venturesome and sacrificial (altruistic) behavior on voluntary basis and in danger(ous) circumstances" (Konter, 2013, p.966). Sport specific courage model is also put forward to be multidimensional and interactional between factors including (Konter, 2013); situation, personal differences, type of sport and the task at hand. A number of research showed significant differences between sport courage and assertiveness, individual self-perception, individual self-description, sport participation, perception of success, being introvert-extrovert, achievement of the first three standing, adventures and risk taking behaviors, negative and positive referee decisions, prosocial and antisocial behaviors in children and adolescents and adults (Konter, 2016). However, there is a lag of research in relation to resilience and sport courage considering various individual, familial, educational and sport variables. Therefore, the purpose of this study was to find answers the following questions;

1 – What are the correlations between sport courage (measured by SCS-31) and resilience (Measured by CYRM)?

2 – Are there significant differences between resilience and selected demographic (i.e; gender and age), physical health (i.e; BMI, Dominant Limbs, vision disorders, hearing problems, ADHD, bone fracture past), familial, (i.e; father and mother attitudes), educational (i.e; past school failure, GPA, PE-GPA) and sport variables (i.e; sport participation 3 times a week, physical education and sport participation before the age of ten, participation for the school sport team, game preference)?

3 – Are there significant differences between sport courage and selected demographic, physical health, familial, educational and sport variables indicated above?

Method

Participants: Data were collected from 420 students (secondary school, high school and university students) aged 13 to 29 (M=15.02 ± 1.26 yrs; 161 males, 251 females and 8 unstated).

Measures and Procedures: Students were administered validated the "Sport Courage Scale-31" (SCS-31) and the "Child and Youth Resilience Measure" (CYRM, unidimesional with 12 items) along with personal information form. SCS-31 comprises 5 factors (Mastery, Determination, Assertiveness, Venturesome and Self-Sacrifice Behavior). (Konter & Ng, 2012). In addition, the exploratory and confirmatory factor analysis results of the CYRM indicated that a total of 51.28% the variance was accounted for by a factor. The Cronbach alpha coefficient of CYRM was.91 (Arslan, 2015).

Data Analysis: Collected data was analyzed by normality tests of the data, Pearson and Spearman correlations, parametric and non-parametric tests and multivariate analyses.

Results

Results of resilience

Correlation results of resilience in relation to sport courage

Spearman correlation analyses showed that resilience has positive low correlations with determination (r=.217), assertiveness (r=.170), venturesome (r=.194), sacrifice behavior (r=.149) and total sport courage (r=.210).

Results of the resilience in relation to selected demographic variables

2) Resilience has negative low correlations with age (r=-.208) and weight (r=-.098).
3) Females have significantly higher points of resilience than males (p<.023).

Results of the resilience in relation to selected physical health variables

1) Multivariate analyses indicated that underweight adolescents have higher points of resilience than normal weight and pre-obese adolescents (p<.14). In addition, normal weight adolescents have significantly higher points of resilience than pre-obese adolescents.
2) Kruskal-Wallis regarding resilience revealed that right handed-right footed participants have significantly higher points of resilience than left handed-left footed participants (p<.045),
3) Multivariate analyses (hearing problem X Gender-Covariate) showed that participants with no hearing problem have significantly higher points of resilience (p<.040) than participants with the hearing problem.
4) Multivariate analyses (ADHD problem X Gender-Covariate) yielded that Adolescents without ADHD problem have higher points of resilience (p<.027) than adolescents with ADHD problem. However, result of the effect size is low (r squared: 0.018).
5) Multivariate analyses (Bone Fracture Past X Gender-Covariate) revealed that Adolescents without bone fracture past have higher points of resilience (p<.043) than adolescents with bone fracture past.

Results of the resilience in relation to selected familial variables

1) Multivariate analyses (Mother Attitude X Gender-Covariate) showed that participants with the democratic mother attitudes have significantly higher points of resilience than participants with the authoritarian, indifferent and protective mother attitudes.
2) Multivariate analyses (Father Attitude X Gender-Covariate) showed that participants with the democratic father attitudes have significantly higher points of resilience than participants with the authoritarian, indifferent and protective father attitudes (p<.001). In addition, participants with the protective father attitudes have significantly higher points of resilience than participants with the indifferent father attitudes.

Results of the resilience in relation to selected educational variables

Resilience has positive low correlations with success of physical education class (r=.190) and great point average (r=.168).

Results of the resilience in relation to sport variables

1) Mann-Whitney U analyses regarding resilience and sport participants at least 3 times a week indicated that sport participants at least 3 times a week have significantly higher points of resilience than non-sport participants (p<.001). 2 X 2 (Sport Participation X Gender) ANOVA gave the same results.
2) Mann-Whitney U analyses yielded that sport participants at least 3 times a week before the age of 10 has significantly higher points of resilience than non-sport participants at least 3 times a week before the age of ten (p<.039). Multivariate analyses (Sport Participation 3 Times a Week X Gender) gave the same results.

Results of sport courage

Results of the Sport Courage in relation to selected demographic variables

1) Univariate analyses with the gender in covariate indicated that adolescents with the higher points of mastery (p<.011), determination (p<.001), assertiveness (p<.001), venturesome (p<.002), sacrifice behavior (p<.003) and total sport courage (p<.001) have significantly higher points of resilience than adolescents with the lower points of mastery (p<.011).
2) Males have significantly higher points of determination p<.009), assertiveness (p<.003), venturesome (p<.001) and total sport courage (p<.006) than females.
3) Mastery and determination have positive low correlations with age (r=.107),

Results of the Sport Courage in relation to physical health variables

1) Further univariate analyses with the gender covariate indicated that underweight adolescents have significantly higher points of determination, assertiveness and total sport courage than normal weight and pre-obese adolescents (p<.012, p<.002 and p<.005 respectively). In addition, normal weight adolescents have significantly higher points of determination, assertiveness and total sport courage than pre-obese adolescents. Moreover, underweight and pre-obese adolescents have significantly higher points of venturesome and sacrifice behavior than normal weight adolescents (p<.002 and p<.081 respectively).
2) Kruskal-Wallis analyses related to limb preference indicated that: a) Right handed-right footed participants have higher points of mastery than left handed-left footed participants (p<.068), b) Right handed-left footed participants have higher points of venturesome than right handed-right footed participants (p<.167), c) Right handed-left footed participants have significantly higher points of mastery (p<.023) than left handed-left footed participants, d) Right handed-left footed participants have higher points of venturesome than left handed-right footed participants (p<.087).
3) Multivariate analyses (sight problem X Gender-Covariate) revealed that participants with no sight problem have higher points of determination, (p<.10), assertiveness (p<.010), venturesome (p<.001) and total sport courage (p<.033) than participants with low level and moderate to high level of sight problem (p.10). In addition, participants with low sight problem have higher points of determination, assertiveness, venturesome and total sport courage than participants with moderate to high level of sight problem.
4) Multivariate analyses (hearing problem X Gender-Covariate) indicated that Participants with no hearing problem have higher points of mastery (p<.003), determination (p<0.70) and total sport courage (p<.02) than participants with the hearing problem. In addition, participants with hearing problem have higher points of assertiveness (p<.003) and venturesome (p<0.70) than participants with non-hearing problem.
5) Multivariate analyses (ADHD problem X Gender-Covariate) revealed that adolescents without ADHD problem have higher points of mastery (p<.134), determination (p<0.027), assertiveness (p<.007) and total sport courage (p<.011) than adolescents with ADHD problem. In addition, Adolescents with ADHD problem have higher points of venturesome (p<.001) than adolescents without ADHD problem.
6) Multivariate analyses (Bone Fracture Past X Gender-Covariate) indicated that adolescents with bone fracture past have higher points of determination (p<0.070), assertiveness (p<.019), venturesome (p<.001) and total sport courage (p<.027) than adolescents without bone fracture past.

Results of the sport courage in relation to familial variables

1) Multivariate analyses (Mother Attitude X Gender-Covariate) yielded that participants with the democratic and authoritarian mother attitudes have significantly higher points of determination than participants with the indifferent and protective mother attitudes. Secondly, participants with the democratic and authoritarian mother attitudes have significantly higher points of assertiveness than participants with the indifferent mother attitudes. Thirdly, participants with the democratic and authoritarian mother attitudes have significantly higher points of venturesome than participants with the indifferent and protective mother attitudes. Fourthly, participants with the democratic and authoritarian mother attitudes have significantly higher points of total sport courage than participants with the indifferent and protective mother attitudes.

2) Similarly, multivariate analyses (Father Attitude X Gender-Covariate) indicated a number of significant differences for example, participants with the democratic and protective father attitudes have significantly higher points of mastery than participants with the authoritarian, indifferent and protective father attitudes (p<.005).

Results of the sport courage in relation to educational variables

1) Spearman correlation analyses yielded that: a) Mastery has positive low correlations with success of individual education class (r=.133) and Great Point Average (r=126), b) Determination has positive low correlations with Success of individual education class (r=.230) and Great Point Average (r=124). Assertiveness has positive low correlations with success of individual education class (r=.214) and Great Point Average (r=158), d) Venturesome has positive low correlations with success of individual education class (r=.158), e) Sacrifice behavior has positive low correlations with success of individual education class (r=.176) and Great Point Average (r=101), f) SCS-31 has positive low correlations success of individual education class (r=.231) and Great Point Average (r=153), f) SCS-31 has positive low correlations with PE-GPA (r=.231).
2) Adolescents without the school failure past have higher points of mastery than adolescents with the school failure past (p<.133).

Results of the sport courage in relation to sport variables

1) Mann-Whitney U analyses in terms of sport courage and sport participants at least 3 times a week revealed that sport participants at least 3 times a week have significantly higher points of mastery (p<.001), determination (p<.001), assertiveness (p<.001), venturesome (p<.001), sacrifice behavior (p<.004), total sport courage (p<.001) than non-sport participants.
2) Mann-Whitney U test as regard with school sport team participation and gender indicated that School sport team participants have significantly higher points of mastery (p<.002), determination (p<.015), assertiveness (p<.002), venturesome (p<.004) and total sport courage (p<.001) than non-school sport team participants.

Discussion

Results revealed a number of significant differences. It seems that resilience and sport courage are positively correlated and important as regard with the selected demographic, physical health, familial, educational and sport variables. Results, in general, supportive the previous research findings for example, males have significantly higher points of determination, assertiveness, venturesome and total sport courage than females (Konter, 2016). In addition, analyses in terms of sport courage and sport participants at least 3 times a week, and school sport team participation revealed the same supportive results for example, sport participants at least 3 times a week have significantly higher points of mastery (p<.001), determination (p<.001), assertiveness (p<.001), venturesome (p<.001), sacrifice behavior (p<.004), total sport courage (p<.001) than non-sport participants (Konter, 2016). Various research findings in relation to resilience and sport courage support of the present research (Konter, 2016; Konter & Ng, 2012). Development of resilience and courage through physical education and sports would be important assets for adolescents. Development of resilience and sport courage necessitate multidimensional and interactional approaches including indicated variables above (Konter, 2013). This could be important for health, satisfaction, performance and success of adolescents participating in physical education and sports.

References

1. Arslan, G. (2015). Psychometric Properties of Child and Youth Resilience Measure (CYRM-12: The Study of Reliability and Validity. *Ege Eğitim Dergisi (Aegean Educational Journal)*, (16) 1: 1-12
2. Corlett J. (2002). Wirtue lost: Courage in sport. In: *Philosophy in sport*. Eds: A Hollowchak. *New Jersey: Prentice Hall*, pp.454-465
3. Eklund, C.R. Tenenbaum, G. (2014). Encyclopedia of sport and exercise paychology. Sage: Los Angeles, 591-593.
4. Konter, E. (2016). Sport courage profile of Adolescents in relation to level of empathic tendency, physical education education and sport participation. 14th. International Sport Science Congress. 1-4 October, Antalya.
5. Konter, E. (2013). Towards Multidimensional Interactional Model of Sport Courage. *Energy Education Science and Technology Part B: Social and Educational Studies*. 5(2), 957-968.
6. Konter, E., & Ng, J. (2012). Development of sport courage scale. *Journal of human kinetics, 33*, 163-172.
7. Pury C.L.S, Kowalski R.M & Spearmen J. (2007). Distinctions between general and personal courage. *Journal of Positive Psychology*, 2, 99-114

CONCEPTUAL MODEL OF EDUCATIONAL PARENT–ATHLETE INTERACTION IN SPORT

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Abstract

The purpose of this study is to theoretically ground the educational interaction between parents and athletes in sporting activities. Another aim is to design a conceptual model basing on theoretical analysis. Scientific literature review and generalization methods were applied. This study illustrated by means of the conceptual theoretical model of parent–athlete educational interaction in sports and designed to demonstrate the expression of parent–athlete interaction, its action and empowering factors. Parent–athlete educational interaction in sport is a bi–directional system. Parents influence children; Children influence parents. The educational interaction depends on psychological support from parents, the child's physical and emotional security, the coach's positive coaching education strategy, competence and authority. The above listed elements confirm the importance athlete triangle: tri–dimensional interaction between parents, children and coaches.

Ke ywords: *parenting, coaching strategy, athlete triangle, tri–dimensional interaction*

Introduction

Most of researchers acknowledge that parents have the greatest influence in sporting activities of their children (Dorsch et al., 2016; Holt, Knight, 2014; Lisinskiene, 2016), that participation in youth sport is the process where parents play the most important role (Sanchez–Miguel et al., 2013). Initially children enjoy sports for small achievements; later on sport becomes a motivating factor, an interesting and meaningful activity that eventually becomes a lifestyle (McMillan et al., 2016) passed on to children and grandchildren, i.e. to the next generations.

In order to involve children into sporting activities from the early age and to achieve progress in fully disclosing their talents it is necessary to create a favourable environment in the early years of the child's personality development and parents play a very important role in this process (Sánchez–Miguel et al., 2013; Dorsch et al., 2016). The child's success in sports can be regarded as the parents' merit too (Bailey et al., 2013). Parents can shape the child's behaviour and give the right direction (Smoll et al., 2011). Parents are involved in disclosing and recognizing the child's talent (Côté, Vierimaa, 2014), experienced joy from participation in sporting activities (McCarthy, Jones, 2007), understanding the athletic competence (Lee et al., 2008), competition anxiety and stress management experience, and development of psychological skills (Gould et al., 2012) . It is noted that participation in youth sport also teaches parents to be responsible and emphatic. Parents learn to respect children's decisions, start building closer and more open relations than before (Smoll et al., 2011). Family relations is the context where answers to questions how and why participation in sporting activities changes the child's thinking and behaviour. Such issues as the role of parents in this process and how they cope with this role, how sporting activities modify not only children's but also parents' personality orientations, behaviour and communication in the family. **The purpose of this study is** to design the conceptual, theoretical model of educational parent–athlete interaction in sport. **Research objectives:** 1. Theoretically ground the educational interaction between parents and athletes in sports. 2. Design a theoretical model of educational parent–athlete interaction in sport. **Research methods:** Research literature analysis and generalization methods aiming to reveal the characteristics of educational parent – athlete interaction in sports and design a theoretical model.

Parent–athlete educational interaction in sport

In the context of educational interaction, this study is based on social learning theory (Bandura 1977), which highlights the importance of personality teaching and learning, educational effect and interaction between individuals. According to the theory, a human being learns while observing the behaviour of others, the reaction of surrounding people to that behaviour and then the individual either adopts or rejects such behaviour, or tries other ways of behaviour. In this sense, social learning theory is a useful lens in trying to understand parent–child educational interaction in sporting activities.

Parenting in youth sport. In childhood parental support is the main and the most important reason influencing the child' decision to start playing sports (Nunomura, Oliveira, 2013; Elliott, Drummond, 2015; Dorsch, Smith, 2016). Researchers have found different roles of parents in children's sporting activities: parents become secondary teachers, counsellors, managers, referees, financial sponsors, important members of the fan's group in competitions (Kaplanidou, Gibson, 2012). However, irrespective of the role taken, the most important factor is parental participation itself (Dorsch et al., 2009; Dorsch et al., 2016). Researchers highlights that participation of parents in youth sport strengthens family relationships (Holt, Knight, 2014). For instance, the child's participation in organized sport influenced communication, relations with parents, brought family members closer and strengthened relations in the family (Dorsch et al., 2009). The study by C. J. Knight and N. I. Holt (2014) defines the optimal parental involvement in the child's sporting activities as follows: parents understand and boost the child's experience by acknowledging that every child is different and has individual needs, whereas the sporting experience is gained over time. Besides, positive, flexible and emphatic communication between the participants creates a more attractive to youth sporting environment. E. Dorsch, A. L. Smith and M. H. McDonough's (2009) study of parents by applying the group discussion method is worth mentioning. The study revealed that children's sporting activities influence parents' behaviour, cognition, emotions and relations with children. Parent behaviour changed: parents noted that they got involved into sports themselves through the sporting activities of their children. The involvement in youth sport changed the areas of cognition in parents and they got more interested in sports. Many parents noted the important benefits of this process that has changed their lifestyle. Parents named the change of their emotional relation with sporting activities. The result of parental involvement into children's sports was the feeling of pride and liking. Other parents indicated the feelings of anxiety and competition. The changes in parent–child–athlete relations should be also mentioned. Therefore, relations with parents change at the age of adolescence. Sporting activities provide an opportunity to find new friends. Young people face new challenges related to their independence, autonomy and identity building. Adolescents spend more time away from parents, thus their personality development is influenced not only by the family but also by peers (Arnon et al., 2008).

Prerequisites for the effectiveness of parent–athlete educational interaction: coach's role. The coach's support and advice influences in part the motivated parental involvement in youth sport (Barker, Winter, 2014; Domingues et al., 2014). Coaches may perform the role of a moderator, intermediary, counsellor (O'Connor, 2011). The participation of both athlete and parents in sports depends on the professional performance of the coach, i.e. his/her competencies that have to be continuously developed, on coaching strategy, methods have been used (McCann, 2011). A coach has an important role for strengthening parent–child interaction in sports and creating the environment that would give a positive direction to the young athlete's motivation. A young athlete, parents and a coach are the three key elements in the process of educational interaction in sports (McCann, 2011). Parents, children and coaches can create an effective education system through motivated participation in youth sports. This system can be described as the process of positive interaction of all three system members. Scientific literature highlights the importance of the athletic triangle. Researchers claim that the method of tripartite relations should be used for creating the culture of intellectual skills building (McCann, 2011). Therefore, parents, children and coaches are analysed as complementary and interchanging elements, the reciprocation of which aims at maximizing the benefits of sport and positive communication of all elements, i.e. interaction.

Theory based parenting in youth sport model

The educational parent–athlete interaction in sports is illustrated in Fig.ure 1. The system involves three interacting elements. Parental influence on a child will depend on interpersonal relations, the prevailing communication culture in the family. In the period of transition from childhood to adolescence the parental role gains significance and their support, by understanding the importance of peers and their influence in adolescent's daily and sporting life, is essential. The child's involvement and remaining in sports is greatly influenced by the parents' ability to recognize the child's individual needs, interest in the child's sporting activities, psychological and financial support and awareness of the importance such engagement.

The coach is another important element in the educational parent–child interaction in sports system identified through theoretical analysis. Thus, the athlete continuation of sporting activities depends not only on parents but on the coach, too. The coach's tasks are to communicate the importance of parental involvement in the child's sporting activities to parents, strengthen bilateral collaboration for the benefit of young athletes and help parents to understand the goals set forth by the sporting environment through the strengthening of parental role in children's sports. Positive coaching strategy is the key objective in the building of the coach's relationship with adolescent athletes. The coach shall not only professionally train young athletes but should also create psychologically safe environment, apply modern education methods and convey his/her positive coaching philosophy. The coach's objective in educational interaction is to achieve that both parents and children would have the same understanding of the aims of doing sport.

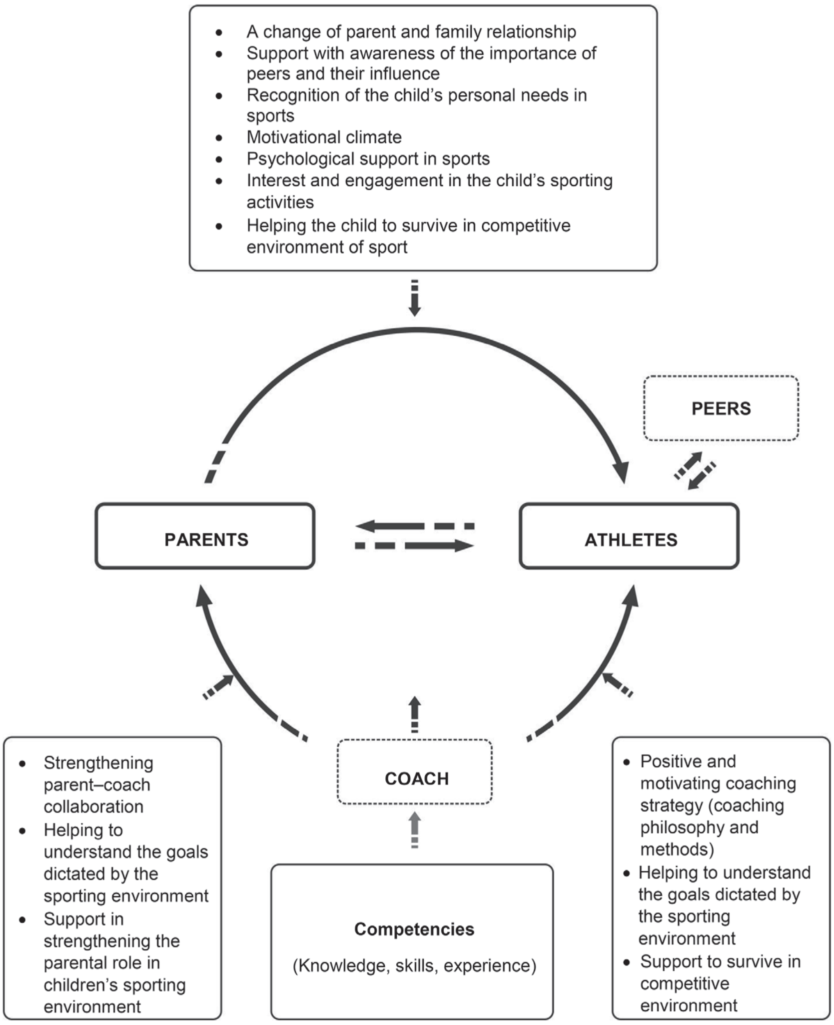

Figure 1: Conceptual model of educational parent–athlete interaction in sport

Conclusions

Scientific literature analysis and theoretically grounded conceptual model revealed that parent–child educational interaction in sport is a bi–directional system. Parents influence children: they learn to be emphatic, self–disciplined, self–respected, they build communication skills, and plan their daily routine. Children influence parents because involvement in the child's sport naturally changes parents and modifies their lives: parental daily routine alters, interpersonal relations with the child, in the family, with other participants in sports also change. The analysis also revealed the importance of the coach's role for strengthening parent–child interaction in sport. Parent–child educational interaction in sport depends on coach competences, the coaching strategy selected by the coach. This understanding confirms the importance of positive tri–dimensional interaction among parents, children and coaches.

References

1. Arnon, S., Shamai, S., Ilatov, Z. (2008). Socialization agents and activities of young adolescents. Adolescence, 43, 373–397.
2. Bailey, R., Cope, E. J., Pearce, G. (2013). Why do children take part in and remain involved in sport? A literature review and discussion of implications for sports coaches. International Journal of Coaching Science, 7 (1), 56–75.
3. Bandura, A. (1977). Social Learning Theory. New York: General Learning Press.
4. Barker, S., Winter, S. (2014). The practice of sport psychology: a youth coaches' perspective. International Journal of Sports Science & Coaching, 9 (2), 379–393.
5. Côté, J., Vierimaa, M. (2014). The developmental model of sport participation: 15 years after its first conceptualization. Science & Sports. Supplement, 29, S63 1p.
6. Domingues, M., Cavichiolli, F. R., Concalves, C. E. (2014). Sport coaching context and social organization. Asian Journal of Exercise & Sports Science, 11 (1), 1–15.

7. Dorsch, T. E., Smith, A. L., Dotterer, A. M (2016). Individual, relationship, and context factors associated with parent support and pressure in organized youth sport. Psychology of Sport & Exercise, 23, 132–141.
8. Dorsch, T. E., Smith, A. L., McDonough, M. H. (2009). Parents' perceptions of child–to–parent socialization in organized youth sport. Journal of Sport & Exercise Psychology, 31, 444–468.
9. Elliott, S., Drummond, M. (2015). The (limited) impact of sport policy on parental behaviour in youth sport: A qualitative inquiry in junior Australian football. International Journal of Sport Policy, 7 (4), 519–531.
10. Gould, D., Flett, R., Lauer, L. (2012). The relationship between psychosocial developmental and the sports climate experienced by underserved youth. Psychology of Sport and Exercise, 13, 80–87. doi:10.1016/j.psychsport.2011.07.005.
11. Holt, N. L., Knight, C. J. (2014). Parenting in youth sports. From research to practice. London and New York: Routledge.
12. Kaplanidou, K., Gibson, H. J. (2012). Event image and traveling parents' intentions to attend youth sport events: A test of the reasoned action model. European Sport Management Quarterly, 12 (1), 3–18.
13. Lisinskienė, A. (2016). The educational interaction between parents and adolescents in sporting activities. Summary of doctoral dissertation. Kaunas. Lithuania.
14. McCann, S. (2011). In the huddle. Journal of Sport Psychology in Action, 2 (2), 123–129.
15. McCarthy, P. J., Jones, M. V. (2007). A qualitative study of sport enjoyment in the sampling years. The Sports Psychologist, 21, 400–416.
16. McMillan, R., McIsaac, M., Janssen, I. (2016). Family structure as a correlate of organized sport participation among youth. PLoS ONE, 11 (2), 1–12.
17. Nunomura, M., Oliveira, M. S. (2013). Parents' support in the sports career of young gymnasts. Science of Gymnastics Journal, 5 (1), 5–17.
18. O'Connor, D. (2011). Enhancing coach–parent relationships in youth sports: Increasing harmony and minimising hassle. International Journal of Sports Science & Coaching, 6 (1), 49–52.
19. Sanchez–Miguel, P., Leo, F. M., Sanchez–Oliva, D., Amado, D., Caecia–Calvo, T. (2013). The importance of parents' behavior in their children's enjoyment and motivation in sports. Journal of Human Kinetics, 36, 171–179.
20. Smoll, F. L., Cumming, S. P., Smith, R. E. (2011). Enhancing coach–parent relationships in youth sports: Increasing harmony and minimizing hassle. International Journal of Sports Science & Coaching, 6 (1), 13–26.

PHYSICAL ACTIVITY OF SERBIAN URBAN AND RURAL ADOLESCENT GIRLS

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Purpose: Physical activity decreases and sedentary behavior increases throughout adolescence. Many factors (intrapersonal, interpersonal, social) affect the physical activity behavior (Evenson et al., 2010). The aim of the study was to examine the physical activity of early adolescent girls from urban and rural areas of Novi Sad municipality.

Methods: The sample consisted of 293 5th-grade adolescent girls from 11 elementary schools in Novi Sad (Serbia). Two groups were composed: 145 urban girls and 148 rural girls. Physical activity was assessed by the short version of the IPAQ for children (Craig et al., 2006), providing scores on walking, moderate, vigorous and total PA, and additional sedentary behavior score. Data were analyzed by descriptive statistics and MANOVA.

Results: The results revealed a significant multivariate main effect for level of urbanization (p=0.016), with significant univariate effects obtained for walking (p=0.039) and sedentary behavior (p=0.036). No significant differences between the adolescent girl from urban and rural areas in moderate, vigorous and total physical activity were identified.

Conclusions: The level of urbanization is associated with physical activity and sedentary behavior in adolescent girls. The results might be explained by higher availability of leisure time and sports activities in urban areas and rural girls' dependence on passive transportation (Frazer et al., 2015).

References

1. Craig, C. L., Marshall, A. J., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E.,…Pekka, O.J.A. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise*, 35(8),1381-1395.
2. Evenson, K.R., Murray, D.M., Birnbaum, A.S. & Cohen, D.A. (2011). Examination of Perceived Neighborhood Characteristics and Transportation on Changes in Physical Activity and Sedentary Behavior: The Trial of Activity in Adolescent Girls. Health Place, 16(5), 977-985, doi: 10.1016/j.healthplace.2010.06.002
3. Frazer, A., Voss, C., Winters, M., Naylor, P., Higgins, J.W. & McKay, H. (2015). Differences in adolescents' physical activity from school-travel between urban and suburban neighborhoods in Metro Vancouver, Canada. PrevMed Rep. 2, 170-173, doi: 10.1016/j.pmedr.2015.02.008

GENDER DIFFERENCES IN SOCIAL EMOTIONAL DEVELOPMENT AND PHYSICAL ACTIVITY LEVEL IN PRESCHOOL CHILDREN

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Abstract

Preschool period is a time of significant transition in a child`s life. Children learn and master motor abilities that help them interact and communicate with their social environment. The purpose of this study was to investigate differences between genders, regarding social emotional development and physical activity level. In order to obtain necessary data parents of preschool children were asked to complete questionnaires assessing social emotional development of their children (ASQ:SE-2, Squires, Bricker, & Twombly, 2015) and a questionnaire about physical activity (NPAQ, Božanić, 2011) of their children. Obtained results show a statistically significant gender differences both in physical activity and social emotional development. Girls were assessed as having higher level of social- emotional development than boys. According to parental assessments, physical activity in general, was in favor of boys, who are more physically active then girls.

Key words: *social emotional development, preschool children, physical activity, gender differences, NPAQ, ASQ:SE-2*

Introduction

The most intensive period of children's development ranges from 3 to 6 years of age. Studies indicate that preschool period is the best time to stimulate child`s development in motor, functional, social, cognitive and emotional developmental domain, enabling them to acquire healthy habits for the whole lifespan. Crucial factors in early development include physical movement, because children through first movement structure experience the world surrounding them. One of the first sensory systems that develop during the intrauterine development is the vestibular system, which controls the sense of movement and balance, and is thought to be the most important for daily functioning and the ability to move and act against the gravity (Hannaford, 2007). Human development involves a sequence of changes in the characteristics, abilities and behavior of the child. Under the influence of those changes the child grows and becomes bigger, more skillful and capable, more socialized, adaptable etc. (Starc et al., 2004). Without psychological maturity there are no preconditions for the emergence of any conduct, especially in early childhood (Čuturić, 2001). Vasta et al. (2004) reported the following domains of child's development: physical, emotional, social and cognitive. Psychomotor development includes a child's increasing ability for purposeful and harmonious use of own body to move in space which includes coordination of movements, handling objects, posture, movement and lateralization (Starc et al. 2004), in which preschool children progress very fast. Appropriate motor stimulation for preschool children includes a systematic sequence of activities which stimulate the development of basic motor skills. Activities should be organized through child's play which also promotes social, emotional and cognitive development of the child (Gallahue, Ozmun and Goodway, 2012; Lubans et al., 2010). Constant repetition of different motor movements and activities helps children develop their relationship with the environment, and compatibility of motion and movement, manipulation as well as, in learning how to control subjects and skills. Through mastering basic activities, children become prepared for easier adoption of knowledge and develop skills that will contribute to mastering everyday activities (Rečić, 2006). Mastering various skills usually refers to physical activity. Emotional development involves differentiation of feelings, learning the emotional significance of situations, and ways of expressing emotions and their control. Social development involves the development of behavioral patterns necessary for the establishment, maintenance and termination of social contact, therefore it is particularly important for preschool period in which child increasingly socialize with peers, since it leads to the development of independence and reduces the child's dependency on adults. Social-emotional development is a combination of social and emotional aspects of child's development, including intrapersonal and interpersonal processes, whereby the emotional development occurs under the influence of social constructs and refers to the child's capacity to develop self-confidence, trust and empathy, as well as skills in the use of language and cognitive curiosity. Emotions and social behaviors affect child's ability to persist in target activities, to ask for help when needed, to participate in relationships and gain the benefits of them. The first experiences are formed in interaction with the child`s environment and in the social world. As a result of these experiences are emotions which motivate cognition and behavior and regulate physiological, cognitive and behavioral aspects of individual behavior in the environment (Goodyer, 1990; Vander- Zander 1993, according to Brajša- Žganec, 2003). Benefits of physical activity do not exclusively refer to the welfare of the children's health, but also to the well-being in the following developmental domains: physical, psychomotor, emotional, social and cognitive area (Cardon et al., 2011; Cliff et al., 2011; Jones et al., 2011).

There is a growing body of evidence to support the positive association between physical activity and human development. Studies show that most preschool children, who participate in sports and are physically active in childhood, retain positive health and cultural habits in adulthood (Reilly et al., 2011). Physical activity is of great importance in the development and maintenance of human capabilities throughout life, which means that it is an important factor in achieving optimum state of health, and also works to reduce the risk of various diseases. At the age of 3-6 years, children adopt positive lifestyle habits for a healthy and active way of living, which are later transferred into adulthood (NASPE, 2002). An adequate form of physical activity for preschool children is play which has a great impact on promoting socio-emotional development as well. Enabling early start in developmentally appropriate physical activities for children will provide the foundation for managing a healthy lifestyle and the acquisition of more complex motor skills necessary in life, with the help of cubes, games and sports activities. It is important to teach children that movement is crucial, since movement will also provide an opportunity for the various options later in life. The purpose of this study was to investigate differences between social-emotional development level and physical activity level among boys and girls of preschool age.

Methods and procedures

The aims of this study were to check weather preschool girls and boys statistically significantly differ in their social-emotional development and in the level of their physical activity. The hypotheses are: girls and boys of the same age will statistically significantly differ regarding their social-emotional development level and the level of their physical activity.

In order to obtain necessary data, two questionnaires were administered to parents of preschool children who attend the program of preschool education in the city of Zagreb. The data about 449 children were collected. The distribution of gender was almost equal; 45% girls and 55% boys (N= 202 female and N= 247 male). Children's average age was 5,44 years (65 months). Parents were asked to complete paper-pen type questionnaires about socio-emotional development of their children, and a questionnaire assessing their child's physical activity level. Parents were provided with guidance and support from the research leaders.

Measures

The *"Ages and Stages Questionnaire: Social Emotional: Second Edition"* (ASQ:SE- 2) (Squires, Bricker & Twombly, 2015) was used to screen child's socio-emotional development in seven key domains: self-regulation, cooperation, communication, adaptive functioning, autonomy, affect and interpersonal interaction. The questionnaire is used to assess children from 1 month to 72 months of age (9 versions due to the age of the child). Social-emotional development is assessed on three levels. Low level indicates that the child`s social-emotional development appears to be on schedule at the time of administration. Monitor level indicates a need for monitoring and may require follow- up actions. Refer level indicates a need for further evaluation and additional follow-up actions. Reliability of this screening instrument is .89, the internal validity of 0.84, validity 0.83, sensitivity 0.81 and specificity 0.83 (Squires, Bricker & Twombly, 2015).

The *"Netherlands Physical Activity Questionnaire"* (NPAQ) (Božanić, 2011) was used to assess the level of physical activity of children (activity/inactivity). Parents reported on questions according to the preference of certain activities in children. Some of the activities are closely related to physical activities such as sports, while some are closely associated with sedentary behavior, such as reading. Answers are reported on a 5 point Likert type scale. The final result of the questionnaire is numerical (ranges from 7- low level to 35 points- high level) and tells us on average, below-average and above average physical activity in children. Low level was set from 0 to 15 points, medium from 16 to 25 points and high level of activity from 26 to 35 points.

Results

Data were analyzed with SPSS program (SPSS, 2009). According to the obtained results the majority of children have normal level of socio-emotional development (89,3%), while 7,6% have monitor level, and 3,1% have refer level.

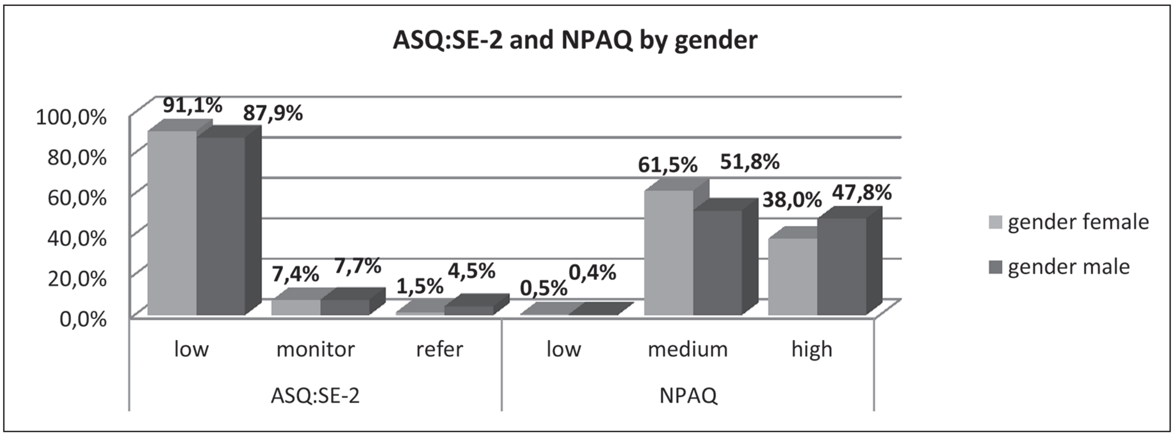

Figure 1: Distribution of results for ASQ:SE-2 and NPAQ by gender

Results also show that most of the children have medium (56,2%) and high level (43,4%) of physical activity, and low level of activity has only 0,4% of children.

Physical activity level of children was mostly medium or high. Mostly boys are on a refer level of social emotional development (4,5%), while 1,5% girls are on this level. Monitor level of social emotional development was almost equal between genders. Majority of girls were on typical level of social emotional development (91,1%). Refer level of social emotional development means that the development is not according to the child's age and should be accessed. Monitor level of social emotional development means that the level is not yet to be referred to, but needs to be constantly monitored. In majority, boys were assessed as having a high physical activity level (47,8%).

Table 1: Independent samples test between genders according to ASQ:SE-2 scores

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ASQ:SE-2	Equal var assumed	9,848	**,002**	-1,536	447	,125	-,062	,040	-,141	,017
	Equal var not assumed			-1,583	442,215	,114	-,062	,039	-,139	,015

In order to check whether there is a statistically significant difference in the social emotional and activity level of girls and boys, independent samples t-test was conducted. A statistically significant difference in social emotional development between boys and girls was found in this study (Table 1.). The results indicate that girls have a higher level of social- emotional development then boys. There is also a statistically significant difference in physical activity level between boys and girls (Table 2.). Boys were, on the average, assessed by their parents as 10% more physically active than girls (Figure 1.).

Table 2: Independent samples test between genders according to NPAQ scores

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
NPAQ	Equal var assumed	7,853	,005	-2,064	445	,040	-,09868	,04782	-,19266	-,00471
	Equal var not assumed			-2,069	430,037	,039	-,09868	,04769	-,19242	-,00495

Discussion

Obtained results are expected in the cultural framework. Across the cultures boys are usually more involved in different kinds of physical activities while girls are dominantly more involved in sedentary activities. Although such results correspond with those obtained in previous studies (Grøntved et al., 2007; Telford et al., 2016), we do not know whether these differences are primarily caused by socio-cultural or biological factors. Previous studies have shown, for instance that the play of preschool boys usually involves a higher level of activity and that preschool boys tend to play in larger groups, take greater risks and have more bodily contact than preschool girls (DiPietro et al., 1981).

Conclusion

If we want to emphasize the importance of physical activity in children`s development we should try to avoid social, cultural or other differences which impact their physical activity, and try to give children the freedom to play and be physically active. Based on our results, we recommend that an extra effort is to be given to encourage physical activity among girls from an early age. The focus should be on expanding the variety of activities that are offered in the child's environment. We need to pay attention to equality of support and opportunities for both boys and girls.

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References

1. Božanić, A. (2011). Vrednovanje i analiza razvoja motoričkih znanja u ritmičkoj gimnastici. Doktorska disertacija, Kineziološki fakultet, Sveučilište u Splitu.
2. Brajša- Žganec, A. (2003). *Dijete i obitelj*. Naklada Slap. Jastrebarsko.
3. Cardon, G., van Cauwenberghe E. & de Bourdeaudhuij, I. (2011). Physical activity in infants and toddlers. Reilly, J.J., topic ed. In: Tremblay, R.E., Boivin, M., Peters, R.DeV,, Barr, R.G., eds. *Encyclopedia on Early Childhood Development* [online]. Montreal, Quebec: Centre of Excellence for Early Childhood Development; 1-6.
4. Cliff, D.P & Janssen, X. (2011). Levels of habitual physical activity in early childhood. Reilly, J.J., topic ed. In: Tremblay, R.E, Boivin, M., Peters, R,DeV,, Barr, R.G., eds. *Encyclopedia on Early Childhood Development* [online]. Montreal, Quebec: Centre of Excellence for Early Childhood Development; 1-6.
5. DiPietro, J.A. (1981). Rough and tumble play: A function of sex - *Developmental Psychology*.
6. Ćuturić, N.(2001). *Psihomotorički razvoj djeteta u prve dvije godine*. Naklada Slap. Jastrebarslo.
7. Gallahue, D.L., Ozmun, J.C. & Goodway, J.D. (2012). *Understanding Motor Development: Infants, Children, Adolescents, Adults*. New York City, NY: McGraw-Hill Companies.
8. Grøntved, A., Pedersen, G.S. & Froberg, K. (2007). Physical Activity among Preschool Children. Institute of Sport Sciences and Clinical Biomechanics, University of Southern Denmark.
9. Jones, R.A. & Okely, A.D. (2011). Physical activity recommendations for early childhood. Reilly, J.J, topic ed. In: Tremblay, R.E., Boivin, M., Peters, R.DeV,, Barr, R.G., eds. *Encyclopedia on Early Childhood Development* [online]. Montreal, Quebec: Centre of Excellence for Early Childhood Development; 1-9.
10. Hannaford, C. (2007). *Pametni pokreti*. Ostvarenje, Buševec.
11. Lubans, D.R., Morgan, P., Cliff, D.P., Barnett, L.M. & Okely, A.D. (2010). Fundamental movement skills in children and adolescents: *Review of Associated Health Benefits*. *Sports Medicin*e, 40 (12), 1019-1035.

12. National Association for Sport and Physical Education (2002) Active start: A statement of physical activity guidelines for children birth to five years. Reston.
13. Reilly, J.J. (2011). Physical activity in early childhood: Topic commentary. Reilly, J.J, topic ed. In: Tremblay, R.E, Boivin, M., Peters, R.DeV., Barr, R.G., eds. *Encyclopedia on Early Childhood Development* [online]. Montreal, Quebec: Centre of Excellence for Early Childhood Development; 1-4.
14. Telford, R.M, Telford, R.D., Olive, L.S., Cochrane, T. & Davey, R. (2016). Why Are Girls Less Physically Active than Boys? Findings from the LOOK Longitudinal Study. *PLOS ONE*; 11 (3): 10.1371/journal.pone.0150041, 27.3.2017.
15. Starc, B., Čudina- Obradović, M., Pleša, A., Profaca, B. & Letica, M. (2004.) *Osobine i psihološki uvjeti razvoja djeteta predškolske dobi: priručnik za odgojitelje, roditelje i sve koji odgajaju djecu predškolske dobi*. Zagreb: Golden marketing –Tehnička knjiga.
16. SPSS- Statistical Package for Social Sciences (2009). PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc.
17. Squires, J., Bricker, D. & Twombly, E. (2015). *Ages and Stages Questionnaire: Social- Emotional, Second edition* (ASQ: SE-2). Brookes Publishing Co.
18. Vasta, R., Haith, M.H. & Miller, S.A. (2004). *Dječja psihologija*. Naklada Slap. Jastrebarsko.

DOES FAMILY SUPPORT IS ASSOCIATED WITH MOTIVATION AND PHYSICAL ACTIVITY IN ELDERLY?

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Purpose: Participation in physical activity in older adults is influenced by a number of factors. Additionally, choices of older adults to be regularly physically active are influenced by social support from family members or friends, availability of facilities for exercise and/or recreational activities, personal determinants and self-regulation skills (King & King, 2010).

The aim of the study was to evaluate relationship between family support and physical activity in elderly.

Methods: The survey involved 113 men and 209 women whose average age was 71.07 ± 6.79 years. Motivation for physical activity was assessed using MPAM-R scale.Physical activity was measured using RAPA (Rapid Assessment of Physical Activity) scale.

Results: For women, appearance was a statistically significant motivational factor to be physically active compared to men. For men, the main motives to be physically active were interest/enjoyment and fitness. Alone living elderly are more motivated to be physically active compared with elderly living with family in all areas of motivation: the mean scoresto be physically active for competence –4,1 vs 3.14; for enjoyment – 4.7 vs 3.67; for appearance 3.65 vs 2.69; for improving fitness – 4.95 vs 3.94 and for social relationship – 3.49 vs 2.53.

Conclusions: Family support ensures a sense of security, so elderly pay less attention on their health. Elderly, who areliving alone, are more responsible for themselves and more invest in health.

References

1. King AC, King DK. Physical activity for an aging population. Public Health Rev. 2010;32(2):401-426.

THE PSYCHOLOGY AND SPORTS PROFILES OF YOUNG PLAYERS IN URBAN AND RURAL AREAS OF PAKISTAN

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Abstract

The increased stress in athletes has proven to have negative impacts on their sporting performance. The worry of the outcome of the competition and the inability to concentrate on the given task in a tense situation, has led researchers to take interest in this area. That is why, the psychological factors are well studied throughout the world in order to identify the talent development process. There are many psychological factors which can predict the ability of an athlete to perform in top level sports competitions (Macnamara, Button, & Collins, 2010). Recent developments in the area of social cognitive theory relating to achievement and motivation, highlights the relevance of task and ego goal perspectives in sport. Pakistan is a developing country with rapid growth in the urban population (Qutub, 1992) but still the performance of their sportsmen has been in a state of decline. The objective of this study is to find out task and ego perspective among the players of school sports in urban and rural areas of Pakistan, in order to plan policies for future sports development.

In this study n =450 sports players from urban schools aged 15.4±0.8 years and n=450 from rural schools aged 16±1 were examined. TEOSQ (Task and Ego Orientation in Sport Questionnaire) has been used under the supervision of researchers. Questionnaires were completed in approximately 20 minutes. Participants were informed that there were no right or wrong answers, assured of their confidentiality and encouraged to be honest and to ask questions if necessary.

The results showed, no significant difference in relation to ego goal perspectives between both groups. However, significant difference has been found in task orientation $p<0.05$. The results suggest, that the rural school players are more task oriented as compared to the urban school players. To be the task oriented players, the key factor in predicting the talent for competitive success, primarily it is the motivation that helps during the whole developmental process. Therefore, the government and sports association should consider, even though as the urban population is increasing, the more potential they can find in rural areas.

Key words: *psychology, rural, urban, sports, Performance*

References

1. Macnamara, Á., Button, A., & Collins, D. (2010). The Role of Psychological Characteristics in Facilitating the Pathway to Elite Performance Part 1: Identifying Mental Skills and Behaviors, 52-73.
2. Qutub, S. A. (1992). Rapid population growth and urban problems in Pakistan. Ambio, 46-49.

WHAT MAKES THEM ACTIVE? THE DETERMINANTS OF PHYSICAL ACTIVITY LEVEL OF OLDER ADULTS

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Abstract

Purpose: The study PANGeA: Physical Activity and Nutrition for Great Ageing (2007-2013) showed in general that all participants exceed the limit of >3000 mean metabolic equivalent task unit (METs)/minutes/week (women =4412,03 ± 3414,74 METs; men =5268,78 ± 4242,76 METs), what classified them into the health enhanced physical active (HEPA) population, according to General Physical Activity Questionnaire (GPAQ) guidelines (Pišot and Marušič, 2014). Thus, because of high variation of data and individual differences in quantity of PA our further investigation was focused on determinants of active lifestyle of older adults.

Methods: The sample consisted of 444 older adults of which 63,7% were females (66.8 ± 5,1 years) and 36,7% males (68.3 ± 5.5 years). Questionnaire data were used to investigate influence of various factors (i.e. gardening, marital status, possession of dog and sports history) on self-reported physical activity level (PAL) of participants.

Results: Our results showed that gardening was the only significant ($p = 0.042$) predictor of weekly PAL of older adults. Therefore, participants who gardening ($n = 254$) were more likely (1.85 times) to report greater PAL than those who doesn't gardening ($n = 197$). Beside marital status and sports history (being sports active in the youth) which showed no significant prediction power, a dog ownership (p=068) was near-significant predictor suggesting that dog owners (n=71) were 0.5 times more likely to report more PAL than non –owners (n= 380).

Conclusion: Gardening as an important weekly routine of older adults again (Detweiler, 2012) showed to be positive agent in achieving the limit of recommended PAL). As previously observed (Carspersen et al., 1991) PAL achieved with gardening is reported as positively associated predictor of health status. Regular exposure to nature has been associated with positive health effects (reduction in pain, improvement in attention and modulation of stress responses), especially with dementia patients (Detweiler, 2012). In addition, positive social effects of gardening (e.g. social networks, friendly bonds etc.) and economic effect (food self-production) which may also benefit to general health status of older adults, confirm that gardening should be preferred among older adults in order to elicit their PAL and quality of life, accordingly.

References

1. Caspersen, C.l J, Bloemberg, B. PM, Saris, Wim HM, Merritt, R. K, & Kromhout, D. (1991). The prevalence of selected physical activities and their relation with coronary heart disease risk factors in elderly men: the Zutphen Study, 1985. *American journal of Epidemiology, 133*(11), 1078-1092.
2. Detweiler, M. B., Sharma, T., Detweiler, J. G, Murphy, P.F, Lane, S., Carman, J., Kim, K. Y. (2012). What is the evidence to support the use of therapeutic gardens for the elderly? *Psychiatry investigation, 9*(2), 100-110.
3. Pišot, S., Marušič, U. (2014). Gender related differences of physical activity among older adults. V: Milanović, D. (ur.), Sporiš, G. (ur.). Fundamental and applied kinesiology : steps forward : proceedings. Zagreb: University, Faculty of Kinesiology, str. 668-671, t

IS IT POSSIBLE TO AFFECT ATTITUDE TOWARDS SAILING THROUGH THE SAILING SCHOOL?

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Abstract

The research is directed to determining if a well-aimed and organized sailing school can affect students' attitude towards sailing. Additionally, is teaching affecting differently regarding gender or place of residence? 71 examinees with no experience in sailing prior to this research (44 male and 27 female participated. Examinees answered 30 questions on attitude towards sailing (positive and/or negative), before and after taking a sailing school course. Differences in answers showed that under influence of sailing school, more positive attitude was created in all the examinees (p=,004). Participants with residence in inland areas had significantly more positive attitude towards sailing when compared to the those residing in the coastal areas (p=,03). It can be concluded that through sailing school attitude towards sailing can be affected, regardless of the gender or residence of examinees. Also, that it is easier to affect the change in attitude of the examinees living in the inland areas using teaching, than in examinees residing in coastal areas for which it can be expected *to have more formed attitude towards sailing.*

Key words: *sailing beginners, learning process, sailing school, physical activity*

Introduction

In the last years Croatia is, experiencing continuous growth and is posted in almost all foreign nautical portals in magazines and touristic agencies as one of the top world sailing destinations (http://www.discoverboating.com/resources/worlds-top-charter-destinations.aspx). So, it is not surprising that nautics is one of the most important export industries in Republic of Croatia. Except by nautics, promotion of Croatia in the World is affected by Croatian sailors; through their results Croatia has become mayor World force in that sport (http://net.hr/ostalo/stipanovic-i-kljakovic-gaspic-prvi-na-svjetskim-ljestvicama). Therefore, low interest of media for the afore mentioned results in that sport, together with low knowledge of sailing as a sport in a young adult population in Croatia is so surprising. Besides, decreasing activity of young adults is also affecting the low interest in sport in general, and with it also in sailing.

Many researches in the field of sailing (Allen & De Jong, 2006) show frequent injuries in the back, especially lower back, knees, thighs, cervical spine, shoulders, forearms and elbows. Legg, et al. (1997) reported that as much as 57 % sailors suffered an injury in the last three years, while 68% of sailors suffered from dehydration during a competition. Although top sport is very different from recreational sport, such information has a bad influence on attitude towards the sport, and on decreasing of physical activity in general. Physical activity is closely related to health improvement, and therefore it is of vital importance to find ways and methods of learning the activity that will ensure increasing of the quality of life and prevention of diseases on the one hand and also secure and injury- free learning of the new activity on the other (Trudeau & Shephard, 2005). Decreasing the number of injuries and bringing individual sport closer to the recreational sportsman affects creating of positive attitude towards sports. According to research, people have positive attitude towards sport in general, but totally negative attitude towards *dangerous* sports (Bosnar, Sertić, Prot, 1996). It is often witnessed that in a population negative attitude towards individual sport is developed due to the unfamiliarity with that sport. Differences in attitude towards individual sport in regard to the gender of the examinees support that statement. In the research (Oreb, Kostanić & Prlenda, 2010) conducted on 397 students of Electrotechnics and Kinesiology faculty in Zagreb it is determined that female students have more positive attitude towards sailing. Such result is surprising regarding the fact that sailing, according to its characteristics (Oglesby & Hill, 1993, according to Bosnar, Sertić & Prot, 1999) is in stereotype *male* sport.

It is known that attitude is continuous evaluation of the people, objects and ideas (Aranson, Wilson & Akart, 2005) and those attitudes, once formed, are hard to change as long as there is a functional and motivational basis on which formation of the attitude is based. This brings out the question how much well directed and organized education of the sailing school can affect the students' change of attitude towards sailing. Vlašić, Oreb & Katović (2012) and Cigrovski, et al. (2014) in their researches in dance and skiing lessons exactly prove that through teaching one can affect more positive attitude towards individual sport.

Methods

Subjects

In the research 71 participants were included (44 men and 27 women), of the average age 21,8±1,05 years. They were all motorically competent young people, students of the Kinesiology faculty of the Zagreb University, who never sailed before this research.

Procedures

Participants have filled the questionnaire on their attitude towards sailing just before their field lesson in Water sports. The questionnaire included three general questions related to the place of residence, age and gender. Except general questions, scale for attitude towards sailing consisting of 30 questions was used (Table 1).

Metric characteristics of the scale (Prlenda, Oreb, & Kostanić, 2010) are: (test reliability: Cronbach α=.95, and homogeneity: r=.38).

Scale consists of positive and negative questions and has five choices of answer on a Lickert-type- scale: I don't agree at all; I don't agree; It's all the same to me; I agree, and I absolutely agree. Results of negative questions were transposed so that higher grade represents more positive attitude. Participants have passed elementary sailing school in duration of seven days on Scholz 22 type sail boats for four persons. After finishing the sailing school they completed the same sailing attitude assessment questionnaire that they completed before their seven days sailing course.

Statistical analysis

For tha data analysis statistical package Statistica 12 was used. For determining possible changes in the attitude of examinees towards sailing between the initial and final measurement, statistical method ANOVA for repeated measures was used. The level of statistical significance was set at p≤.05.

Table 1: 30 question sailing attitude assessment scale

N	STATEMENT
1	I love sailing
2	The idea of spending time on a sailboat makes me feel good
3	I enjoy watching sailboats moving gracefully in the wind
4	It fills me with great joy to cover some distance using natural forces, respectively wind
5	I love sailing because it brings me constantly in touch with nature
6	Sailing is very boring sport
7	I don't like watching sailing on TV
8	Sailing is not an interesting sport because it is very difficult to master
9	Sailing is an indicator to the humanity that it is possible to move using natural energy
10	I don't consider sailing a sport at all
11	Sailing should be banned from the Olympics
12	I would never allow my child to sail
13	I really don't understand people who enjoy sailing
14	As soon as I see sea, I think of sailing
15	If I lived on the coast, I would surely go for sailing

N	STATEMENT
16	If I had possibility, I would spend every summer at least seven days sailing with my family or friends
17	I would never sail, even if it were the only sport existing
18	In Croatia much greater care should be invested in sailing considering that sailing is expected to become a Croatian brand in the future
19	I am too timid to do sailing
20	I associate sailing to the lying in the sun, swimming and doing nothing
21	I don't like sailing because I go insane waiting for the wind
22	Fear of the sea and natural forces takes me away from sailing
23	I would like to live of sailing
24	Sailing is exceptionally monotone and boring sport
25	I love sailing so much that I would like to teach others sailing
26	To be a good sailor you have to be intelligent too
27	I would do sailing because I love to live healthy life
28	Croatian academic society should invest more in creating quality professional staff in sailing
29	I don't like sailing because of the constant wind
30	Always when I think of sailing I get cold

Results

In order to determine differences between initial and final measuring, the results of descriptive analysis were compared (arithmetic mean and standard deviation). The significance of achieved results is tested using ANOVA. Results are shown in the Tables 2 and 3.

Table 2: Results of descriptive statistics and results of differences between groups in initial and final measurement

Group	Number	Sum		Mean		SD		ANOVA	
		IN	FIN	IN	FIN	IN	FIN	F	p
All participants	71	7691	8292	108,32	116,79	36,65	31,44	2,02	0,00
Male	44	4792	5214	108,91	118,50	23,94	20,20	1,40	0,14
Female	27	2899	3078	107,37	114,00	13,29	11,97	2,46	0,01
Inland	60	6487	7018	108,12	116,97	30,70	26,40	1,79	0,02
Coast	11	1204	1274	109,45	115,82	6,43	5,89	0,48	0,83

IN = initial testing; FIN = final testing; SD = standard deviation

Values of the average answer results (Table 2) show higher results, i.e. more positive attitude in all the final measurements compared to the initial measurements. Although the greatest differences in average answers are found in men (9,59) dispersion of the answers is greater than in women (23,94) which is the reason for not being shown as significant by ANOVA. The greatest significant difference between final and initial measurement is found in all participants (p=,00). The slightest significance is present in participants living on the coast (p=,83). One of the reasons is possibly low number of examinees coming from that area (11). Results are more significant for the participants coming from the inland areas compared to those from the coastal area. Although in initial measurement they had lower average result (inland - 108,12; coast - 109,45), after completing sailing school average result in final measurement was higher (inland – 116,97; coast 115,82).

Table 3: Differences between groups in initial and final measurement concerning place of residence

Attitude	Inland		Coast		Anova	
	AS	SD	AS	SD	F	p
Initial test	108,12	30,70	109,45	6,43	1,20	0,29
Final test	116,97	26,40	115,82	5,89	1,84	0,03

The difference showing higher answer results of the examinees living on the coast as compared to those living inland in initial results wasn't significant (Table 3). On the contrary, the difference in final results, when examinees living inland showed higher results, proved to be significant (p=,003).

Discussion and conclusions

Promotion of healthy lifestyle should be the most important aim of every kinesiologist. In this, important role is that of the approach to the education, which affects the interest of the individual towards active exercise. The quantity of active exercise is affected also by the formed attitude towards specific sport. Many authors have been determining attitudes towards physical activity (Luke & Sinclair, 1991; Christodoulos, Douda, Polykratis & Tokmakidis, 2006; Rikard & Banville, 2006). That attitude is affected from the earliest childhood. If the formed attitude is based on the functional and motivational basis it is very difficult to change it (Aranson, Wilson & Akart, 2005). Anyhow, by teaching, meaning well organized school of individual sport, it is possible to affect change in attitude in young adults (Vlašić, Oreb & Katović, 2012; Cigrovski, et al., 2014). Such results are also affirmed by the results in Table 2, which shows better results after sailing school regardless of participants gender or place of living. More positive attitude towards individual sport implies higher interest in that sport. Such results should play important role in breaking of the stereotype about *male* and *female* sports (Oglesby & Hill, 1993, according to Bosnar, Sertić & Prot, 1999). Stereotypes are slowing down development of sport, including sailing, and it is therefore important to educate young people non-restricted by gender boundaries. Significant difference in female population (Table 2) before and after teaching shows exactly positive changes in attitude of women. Differences in attitude towards physical activity regarding gender are shown by Luke & Sinclair, 1991; Milligan, et al., 1997; Krouscas, 1999; Kumar Tyagi & Kumar, 2013. Also, high level of significant change in positive direction is noted also in participants coming from inland areas. It can be concluded that because of the lower level of familiarity, or information about sailing as a sport, inland living examinees showed better result than those living in the coastal area. It is evident that life on the coast ensured better formed attitude towards sailing in those examinees, than in examinees with residence in inland areas. It can be interesting to notice that inland residence examinees showed not only greater difference in the change of attitude, but also significantly more positive attitude towards sailing in the end than examinees living on the coast (Table 3).

It can be concluded that by conducting the sailing school it is possible to significantly affect more positive attitude towards sailing in young adults (Table 2). Also, that in inland living examinees (it can be assumed that their attitude is less formed) it is easier to affect the change of attitude by education ($p \leq 0.02$) than in examinees living in a coastal area ($p \leq 0.83$) for whom it can be assumed to have more formed attitude towards sailing (Table 2).

By changing the attitude of young adults toward sailing in positive direction, one can also create more quality staff that will find their professional interest in nautics, and with that, help in increasing of quality offer of nautical tourism in Croatia and in the World.

References

1. Allen, J.B., De Jong, M. R. (2006). Sailing and sports medicine: a literature review. *Br J Sports Med*, 40, March 17, 587-593.
2. Aranson, G., Wilson, T. D., Akart, R. M. (2005). Socijalna psihologija. Zagreb: Mate.
3. Bosnar, K., Sertić, H., Prot, F. (1996). Konstrukcija skale za procjenu stava o borilačkim sportovima. U: V. Findak (ur.), *Zbornik radova 5. ljetne škole pedagoga fizičke kulture Republike Hrvatske "Društveni status tjelesne i zdravstvene kulture, sporta i sportske rekreacije"*, Rovinj, 1996 (pg. 73-75). Zagreb: Savez pedagoga fizičke kulture.
4. Bosnar, K., Sertić, H., Prot, F. (1999). Razlike u stavu prema borilačkim sportovima djevojčica i dječaka, učenika viših razreda osnovne škole. U: D. Milanović (ur.), *Zbornik radova "Kineziologija za 21. stoljeće"*, Zagreb, 1999 (pg. 123-125). Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu.
5. Christodoulos, A.D., Douda, H.T., Polykratis, M., & Tokmakidis, S.P. (2006). Attitudes towards exercise and physical activity behaviors in Greek schoolchildren after a yearlong health education intervention. British Journal ofSports Medicine, 40(4), 367-371.
6. Cigrovski, V., Radman, I., Matković, B., Gurmmet, S., Podnar, H. (2014). Effects of alpine ski course program on attitudes towards alpine skiing. // Kinesiology : international journal of fundamental and applied kinesiology. 46, Suppl.1; 46-51
7. Krouscas, J. A. (1999). Middle school student's attitudes toward a physical education program. (Unpublished doctoral dissertation, University of Virginia) Blacksburg: University of Virginia.
8. Kumar Tyagi, A., & Kumar, A. (2013). Students' attitude towards physical activity: A study of gender and caste differences. Journal of Indian Research, 1(2), 133-138.
9. Legg, S. J., Miller, A. B.,Slyfield, D., Smith, P.,Gilberd, C., Wilcox, H., Tate,C. (1997). Physical performance of elite New Zealand Olympic class sailors. The journal of sports medicine and physical fitness, 37, 41˝49.
10. Luke, M.D. & Sinclair, G.D. (1991). Gender Differences in adolescents' attitudes toward school physical education. Journal of Teaching in Physical Education, 11, 31-46.
11. Milligan, R.A., Burke, V., Beilin, L.J., Richards, J., Dunbar, D., Spencer, M., Balde, E., & Gracey, M.P. (1997). Health-related behaviours and psycho-social characteristics of 18 year-old Australians. Social Science and Medicine,45(10), 1549-1562.
12. Oreb,G., Kostanić,D., Prlenda, N. (2010). Differences between male and female students in their attitude toward sailing. In: Proceeding book "2nd International scientific conference Anthropological aspects of sports, physical education and recreation". (Eds. S. Simović), Banja Luka, 05.-06.11.2010. pp. 259-266. Banja Luka: Faculty of physical education and sports University of Banja Luka.
13. Prlenda, N., Oreb, G., Kostanić,D. (2010). Konstrukcija skale za procjenu stava prema jedrenju. Zbornik radova 19. Ljetne škole kineziologa republike Hrvatske. Poreč, 2010. (282-287), Zagreb, Hrvatski kineziološki savez.
14. Rikard, G.L., & Banville, D. (2006). High school student attitudes about physical education. Sport, Education and Society, 11 (4), 385-400.
15. Trudeau, F., & Shephard, R.J. (2005). Contribution of school programs to physical activity levels and attitudes in children and adults. Sports Medicine, 35(2), 89-105.
16. URL:http://www.discoverboating.com/resources/worlds-top-charter-destinations.aspx
17. URL:http://net.hr/ostalo/stipanovic-i-kljakovic-gaspic-prvi-na-svjetskim-ljestvicama/
18. Vlašić, J., Oreb, G. & Katović, D. (2012). Dance attitude difference between female and male students. *Ovidius University annals series physical education and sport*, *12(suppl.2)*, 417-421.

WHY? A QUESTION BEHIND EVERY OUTCOME FINALLY ANSWERED

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Abstract

Purpose: Attribution theories investigate the reasons behind the outcomes in order to understand the processes people use to describe what caused the behavior (Aronson, Wilson & Akert, 2002). The goal of this study was to investigate how athletes from different sports explain the reasons behind their most and least successful performance in sport. Furthermore, we investigated how these reasons differ between success and failure, male and female athletes, as well as individual and group sports.

Methods: The sample was composed of 194 student-athletes from the Faculty of Kinesiology, University of Zagreb. We used Weiner attribution model and Croatian version of CDS II scale (McAuley, Duncan & Russell, 1992).

Results: The athletes in this study made attributions that were more internal, stable and personally controllable for success than for failure, which is in line with previous studies (Hamilton & Jordan, 2000). Furthermore, female athletes attributed their failures significantly more to internal factors than did male athletes. There were no differences in making attributions between individual and team sport athletes. When analyzing the reasons stated by the athletes, we concluded that over 55% of the reasons for both successes (59%) and failure (56%) were connected with mental preparation.

Conclusions: These results can help further understand athlete's perceptions about the reasons connected with their success and failure and the value of the mental preparation in sport performance.

Key words: *reasons, attributions, success, failure*

Introduction

In order to develop and improve the athlete's individual ability, it is essential to explain and understand their past successes and failures as well as the reasons behind them (Allen, Jones & Sheffield, 2009). It is especially important to understand the athlete's perception because it can determinate their behavior in similar future situations, influence their emotions, motivation, expectations of future success etc. This is why attribution research is extremely useful in a sports context. Attribution theories investigate the reasons behind the outcomes in order to understand the processes people use to describe what caused their own or other people's behavior (Aronson, Wilson & Akert, 2002) as well as the effect that these different interpretations can have on person's future expectations, emotions, performance, effort, self-confidence, motivation etc. We use attributions to identify possible causes of the outcomes and because our strong need to explain, understand and predict behavior. We can also use them to justify our procedures, feel better or present ourselves in a better light. There are numerous theories which are trying to explain how and why people make attributions since this was the favorite area of experimental research in social cognition between the 1960s and 1970s and the "hot topic" in sports psychology soon after that (Biddle, 1999; Rogers, 2003). It is still considered as an extremely important theoretical field which has considerable value in the applied, especially sports, settings.

In 1985., Weiner developed distinction of the causes based on characteristics in their background and suggested three attribution dimensions: locus of causality, stability, and controllability. Locus of causality refers to person's belief about whether the reason is inside or outside of the person. When the attribution is internal, people tend to believe that the reasons are coming inside of them while people with external attributions believe that the causes of the outcomes are coming from outside of them (destiny, luck, other people etc.) Stability refers to the temporal nature of the causes which can be stable or unstable and controllability refers to the degree of control which can be related to the cause (Cox, 1998). In later studies conducted by McAuley, Duncan & Russell (1992) the controllability dimension was divided into personal and external, and those were the dimensions used in our research. Several studies investigated differences in attributions between winners and losers as well as successful and unsuccessful performances in sport and concluded that winners tend to make more internal, stable and personally controllable attributions than losers (McAuley & Gross, 1983; Tenenbaum & Weingarten, 1983; Hanrahan & Biddle, 2008). De Michele, Gansneder & Solomon, (1998) in their study on wrestlers, concluded that winners make more internal, stable, personally and externally controllable attributions than losers. In the study, similar to ours, Hamilton & Jordan (2000), concluded that athletes tend to make more internal, stable and controllable attributions for their best performances than for their worst performances. Furthermore, Furst & Santamaria (1994) showed the differences in the same directions but only on the locus of causality and personal controllability dimensions. There are some suggestions that attributions can differ with regard to age, gender and type of sport (White, 1993; Beyer, 1998; Hanrahan & Cerin, 2009) but other studies didn't confirm these findings (Hanrahan & Biddle, 2008; Hamilton & Jordan, 2000; Hanrahan & Gross, 2005). Because of that, the goal of this study was to investigate how student athletes explain the causes of their most and least successful performance in their sports career and do these reasons differ for success and failure, between male and female students and with regard to the type of sport (individual vs. group).

Methods

This study was conducted on 194 students from Faculty of Kinesiology, the University of Zagreb in May 2015. The average age of the participants was 21 years (min=20; max=27). There were 117 male (60%) and 77 female (40%) athletes from individual (37%) and team (63%) sports. In order to measure attributions that student-athletes made for their most and least successful competition performances, we used Causal Dimension Scale (CDS-II; McAuley, Duncan & Russell, 1992) translated into Croatian. This scale is based on Weiner's model of attributions (1985) and measures 4 attributional dimensions: locus of causality, stability, personal and external controllability. In total, the scale has 12 questions, 3 for each dimension. Participants gives their answers on a bipolar scale ranging from 1 to 9 so results on each dimension can range from 3 to 27. Higher values represent more internal, stable and controllable attributions. Cronbach α coefficient of the subscales in previous studies was: locus .60-.71, stability.66-.68, personal controllability .72-.90 and external controllability .71-.92. In our study, participants firstly had to fill several demographic questions (gender, age, type of sport) and then they were asked to recall the most and least successful competition performance of their career. After that, they had to shortly describe the main reason they believe have led to this outcome. (e.g. *"Please try to remember the competition in which you had your most successful performance. In the space below please enter what you think is the main reason for your success in this competition.")*. Than they filled the CDS-II questionnaire twice according to the reasons they wrote: once for their most successful and once for their least successful competition performance. The instructions were based on previous studies which also used most and least successful performances (Furst & Santamaria, 1994).

Results

Firstly, we analyzed athletes' answer to a question about the reasons for their most and least successful performance. The frequency of reasons was counted separately for success and failure and the answers were divided into several categories. Some of the athletes wrote down more than one reason so we analyzed all of them. Results (*Table 1*; *Figures 1 and 2) show that 59*% of the reasons can be categorized as mental preparation, 24% can be categorized as physical preparation, 8% of the reasons are related to support from others (coach, teammates…), 1% are to good luck and 3% can be categorized as other reasons. For the least successful competition performance, 56% of the reasons can be categorized as mental preparation, 11% as lack of support/pressure from others, 10% were related to fatigue/injury/sickness, 9% were about physical preparation, 3% were connected to having a bad day, 2% to inexperience and 9% of the reasons can be categorized as other.

Table 1: Reasons for the most and least successful competition performance stated by the athletes (N=194)

REASONS FOR SUCCESS	N	REASONS FOR FAILURE	N
Physical preparation	61	Anxiety, stress	54
Motivation	49	Lack of concentration	34
Self-confidence	35	Pressure/ lack of support from others	24
Concentration	22	Lack of/ bad physical preparation	19
Effort	20	Lack of self-confidence	16
Feeling relaxed	14	Lack of motivation	15
Emotion control	18	Other	16
Support from others	13	Fatigue	12
Mental preparation	7	Lack of physical preparation	13
Other (not so strong opponents)	6	Injury/sickness	10
Luck/good day	3	Lack of luck/ bad day	7
		Not enough effort	5
		Inexperience	4
		Mental preparation	3

Earlier studies (Furst & Santamaria, 1994), which also used most and least successful performances, pointed out the deviations from normal distributions on attribution subscales and this was confirmed in our study as well. Because of that, we used non-parametric tests for our analysis. In order to investigate whether student athletes make different attributions for their most and least successful performances, we used nonparametric Wilcoxson test of matched pairs. The results (*Table 2)* showed a significant difference on three out of four dimensions of attribution: locus of causality, stability, and personal control. Participants in this study made more internal, stable and personally controllable attributions for their most successful performance than for their least successful performance. These results confirm our original hypothesis.

Table 2: Descriptive statistics and results of Wilcoxson test of matched pairs for attribution dimensions

	Success		Failure			
	M	**SD**	**M**	**SD**	**Z**	**p**
Locus	21,366	4,430	16,994	5,211	-8,339	, 000
Stability	15,309	4,931	10,170	4,683	-9,005	, 000
Personal control	21,097	4,904	16,886	6,062	-7,819	, 000
External control	11,788	5,998	11,659	5,940	-,745	, 456

Within the second research problem, we examined whether athletes make different attributions according to their gender and type of sport. Results (Table 3) of non-parametric Mann-Whitney U-test showed that there was a significant difference only on the locus of causality for the least successful performance between male (M=16,418; SD=4,801) and female (M=17,870; SD=5,699) athletes. These results suggest that female athletes made more internal attributions for their failures than did male athletes. There were no significant differences between male and female athletes on other dimensions nor between individual and group sports on any dimension.

Table 3: Descriptive statistics and results of Mann-Whitney U-test for locus of causality/ failure dimension according to gender of the participants

	Gender	**N**	**MR**	**M**	**SD**	**U**	**Z**	**P**
Locus for failure	M	117	90,64	16,418	4,801	3702,000	-2,104	,035
	F	77	107,92	17,870	5,699			

Discussion

There have been several arguments about different percentages of mental, physical, tactical in technical preparation and their importance in comparison to one another. Some authors (Krane & Williams, 2006) stated that coaches and athletes believe that at least 40% to 90% of success in sports is due to mental factors, especially for the high-level competitors when they are all prepared and ready. Although the exact percentages can be argued about, there is no doubt that it is very important for the athletes to be mentally, physically, technically and tactically ready to achieve their full potential. Based on the results of our study, we can conclude that the athletes (who are also the future coaches) believed mental preparation was the most frequently stated reason behind their most and least successful performances. This is not the evidence that mental preparation is more important than physical, but these results clearly show us how athletes think and what they possibly need. If we consider the fact that mental preparation is still not so broadly used in Croatia, we can conclude that it is extremely important to start including this part of the preparation in athletes' everyday training. Sports psychology offers tools and training methods in all of the areas stated by athletes, as well as much more.

Furthermore, we wanted to examine whether athletes make different attributions for their most and least successful performances. The results of this study confirmed the hypothesis as well as results of previous studies (Hamilton & Jordan, 2000) because athletes made more internal, stable and personally controllable attributions for their most successful than for their least successful performance. Furthermore, when we analyze the arithmetic means of the attribution subscales, we can conclude that, although there was a significant difference on the locus of causality dimension, the athletes made internal attributions for both success and failure. They also made stable attributions for success and unstable for failure as well as personally controllable and externally less controllable attributions for both outcomes. It is considered more desirable for sports performers to make stable, controllable, and global attributions following competition success, and unstable, controllable, and universal attributions following competition failure (Allen, Jones & Sheffield, 2009) and this way of making attributions is confirmed in our study. However, considering the internal/external dimension of attribution, the results of previous studies are not so clear. Generally, it has been found that success is usually internalized and failure externalized (Hamilton & Jordan, 2000). On the other hand, Grove, Hanrahan & McInman (1991) found that competitors attributed outcomes to internal factors regardless of whether winning or losing outcomes occurred, which was also confirmed in our study. This means that athletes tend to take responsibility for both their successes and failures although it can be potentially harmful to their self-esteem (Hewstone, 1998). However, it is possible that dimensions of stability and controllability help them preserve their self-esteem and the expectation of success in the future. Athletes in our study indeed believed that their success was more stable than their failure which is considered desirable and can lead to expectancies of success in the future (Weiner,1985; 2000). Furthermore, our participants believed they have control over their outcomes in both situations which are considered desirable in sports situations (Allen et.al.2009).

Research analyzing effects of gender on attributions in both non-sport and sports situations has produced conflicting data. Although some sports studies found no gender differences (Morgan, Griffin & Heyward, 1996; Mark, Mutrie, Brooks, & Harris, 1984; Hanrahan & Gross, 2005), some (e.g.White,1993) found differences in several dimensions. In our study, females made more internal failure attributions than males which are in line with some non-sport studies (D'Amico, Baron & Sissons, 1995).

In their study, Hanrahan & Cerin (2009) concluded that individual sports athletes made more internal, stable and global and less externally controllable attributions for positive events and more internal attributions for negative events than team sports athletes. Tenenbaum & Weingarten (1983) found that attributions from winners and losers from both individual and team sports were the same. Our result is in line with these findings because there was no difference between athletes participating in individual and team sports.

Conclusion

The aim of this study was to investigate how student athletes explain the causes of their most and least successful performances and how these reasons differ for success and failure, between male and female students and according to the type of sport (individual vs. group). The results showed that over 55% of the reasons for both successes (59%) and failure (56%) were connected with mental preparation. Furthermore, athletes made more internal, stable and personally controllable attributions for their success than for failure which is in line with previous studies in this area. Female athletes made more internal attributions for their failure than male athletes, but there were no differences between male and female athlete on other attribution dimensions nor between athletes participating in individual and team sports. These results are extremely useful in further investigating the area of attributions in sport and understanding the athletes' perceptions about the reasons they believe have led to the greatest success as well as the greatest failure in their sports career. Considering that these perceptions can influence their self-esteem, motivation, emotional reaction, the expectation of success in the future etc. it is important for all the people involved in athletes preparation, as well as the athletes themselves, to acknowledge and understand them.

References

1. Allen, M.S., Jones, M.V. & Sheffield, D. (2009). Causal attribution and emotion in the days following competition. *Journal of Sports Sciences*, 27(5), 461–468.
2. Aronson, E., Wilson, T. D. & Akert, R. M. (2002). *Social Psychology.* 4th ed. Prentice Hall: Pearson Education, Inc.
3. Beyer, S. (1998). Gender Differences in Causal Attributions by College Students of Performance on Course Examinations. *Current Psychology: Developmental, Learning, Personality, Social*, 17 (4), 346-358.
4. Biddle, S.J.H. (1999). Motivation and Perceptions of Control: tracing Its Development and Plotting Its Future in Exercise and Sport Psychology. *Journal of Sport and Exercise Psychology*, 21, pp.1-23.
5. Cox, R.H. (1998). *Sports Psychology: Concepts and Applications*. 4th ed. WCB/McGraw-Hill.
6. D'Amico, M., Baron, L. J., & Sissons, M. E. (1995). Gender differences in attributions about microcomputer learning in elementary school. *Sex Roles, 31,* 353-385
7. De Michele P.E., Gansneder, B. & Solomon G.B. (1998). Success and failure attributions of wrestlers: Further evidence of the self-serving bias. *Journal of Sport Behavior* 8.
8. Furst, D.M. & Santamaria, V.L. (1994). Distance runners causal attributions for most successful and least successful races. *Journal of Sport Behavior* 17 (1),43
9. Grove, J. R., Hanrahan, S. J. & McInman, A. (1991). Success/failure bias in attributions across involvement categories in sport. *Personality and Social Psychology Bulletin*, 17, 93-97
10. Hanrahan, S.J. & Biddle, S.J.H. (2008). Attributions and perceived control. In T.S. Horn, ed. *Advances in sport psychology.* 3rd ed. Human Kinetic Inc. pp.99-114.
11. Hanrahan, S.J. & Gross, J. (2005). Attributions and goal orientations in masters athletes: performance versus outcome. *Revista de Psichologia del Deporte*, 14(1), 43-56
12. Hanrahan, S.J. & Cerin, E. (2009). Gender, level of participation, and type of sport: Differences in achievement goal orientation and attributional style. *Journal of Science and Medicine in Sport* 12, 508–512.

13. Hamilton, P.R. & Jordan, S.J. (2000). Most Successful and Least Successful Performances: Perceptions of Causal Attributes in High School Track Athletes. *Journal of Sport Behavior, 23(3), 245.*
14. Hewstone, M. (1998). *Causal Attribution: From cognitive processes to collective beliefs.* Oxford: Blackwell Publishers Ltd.
15. Krane, V. & Williams, J.M. (2006). Psychological characteristics of peak performance. In J.M. Williams, ed. *Applied sport psychology:personal growth to peak performance*. 5th ed. McGraw Hill. pp.207-28.
16. Mark, M. M., Mutrie, N., Brooks, D. R., & Harris, D. V. (1984). Causal attributions of winners and losers in individual competitive sports: toward a reformulation of the self-serving bias. *Journal of Sport Psychology*,6,184-196.
17. McAuley, E., Duncan, T. E., & Russell, D. (1992). Measuring causal attributions: The revised Causal Dimension Scale (CDSII*).* *Personality and Social Psychology Bulletin*, 18, 566–573.
18. McAuley, E., & Gross, J. B. (1983). Perceptions of causality in sport: An application of the Causal Dimension Scale. *Journal of Sport Psychology*, 5, 72-76.
19. Morgan, L.K., Griffin, J. & Heyward, V.H. (1996). Ethnicity, Gender, and Experience Effects on Attributional Dimensions. *The Sport Psychologist* 10, 4-16.
20. Rogers, W. S. (2003). *Social Psychology : Experimental and Critical Approach*. Berkshire: McGraw-Hill Education .
21. Tenenbaum, G., & Weingarten, G. (1983). External vs. internal attribution in team and individual athletes: Measured by the Wingate Athletic Achievement Responsibility Inventory. *Paper presented at the Fifth Annual Meeting of the European Federation of Sport Psychology*
22. Weiner, B. (1985). An Attributional Theory of Achievement Motivation and Emotion. *Psychological Review*, 92(4), 548-573.
23. Weiner, B. (2000). Intrapersonal and Interpersonal Theories of Motivation from an Attributional Perspective. *Educational Psychology Review*, 12(1), 1-14
24. White, S. A. (1993). The effect of gender and age on causal attribution in softball players. *International Journal of Sport Psychology*, 24, 49-58

BEHAVIOR OF CZECH FOOTBALL SUPPORTERS: THE CASE OF SK SLAVIA PRAGUE

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Purpose: The goal of this paper is to analyze the relationship between supporters' verbal and other expression and their violent behavior at selected football stadiums in the Czech Republic.

Methods: Primary data were collected by a questionnaire survey (PAPI method) mainly at the Eden stadium in 2015 and 2016. A total of 158 respondents (aged 23.01 ± 10.11 years old) participated in this research and all of the respondents were attending in a stand of home team supporters.

Results: We found that expressions of demolishing the stadium and other disturbances are considered the most serious expression of violent behavior by 56.96% of the supporters. On the other hand, 15.19% of the supporters had some experience with demolishing stadium. Furthermore, 87.34% of the supporters stated that boo is the least serious problem and almost each supporter (94.94%) had an experience with boo the referee.

Conclusions: Based on the results of the research, we find that supporters under 23 years of age are more tolerant of negative social phenomena in the surroundings of the stadium.

***Key words**: English disease, negative phenomena, questionnaire survey, violence*

Introduction

Stroeken (2002) states that nowadays football is more than just sport. It has become a public entertainment, in TV broadcasting it gets more and more space and time, especially when two nations compete with each other. This beautiful game has a dark side: corruption, homophobia, violence, and racism.

For many years, behavior of football fans has been the main subject of interest across Europe, especially in Germany, the Netherlands, Italy, and Belgium as well as in Great Britain. Violent and antisocial behavior among football fans can be also labeled as a British or English disease (Frosdick & Marsh, 2005; Williams, 2013; Cashmore & Cleland, 2014). Therefore, it is important to distinguish individual visitors to football matches (spectators, fans, supporters, and hooligans). In this paper, we shall focus on supporters. These can be characterized as highly homogenous diehard supporters who spare no effort in doing the course of the match as spectacular as possible and at the same time avoid direct conflicts, violence, and vandalism. They are the bearers of choreography in a match, use pyrotechnics to support their teams, banners, singing (Sekot, 2013). One of the mistakes which spread about the supporters was that they were something more than human beings and outside the society (Ashton, 1989). They take every match too seriously and are interested in club life. During the match, they can be found in side terraces behind the goals which are meant mainly for standing (kettles). Nearly every fan is dressed in a club uniform, T-shirt, or at least owns a scarf of their favorite club.

Hunt et al. (1999) state that supporters typically identify with the club. Some supporters with a strong bond to the club show signs in their behavior which can be assessed as inappropriate, illegal, and even can lead to death (Wakenfield & Wann, 2006). In such displays of behavior, some form of aggression can be identified as well as a willingness to take part in aggressive behavior. It can be said that the greater the identification with the club, the more aggression is associated with supporters on their part (Wann & Branscombe, 1993). If a favorite team is losing and supporters are not satisfied with the performed game, they entertain the idea of anonymous acts of aggression or acts of violence (Wann et al., 2003; Wann et al., 2005).

Czech football has no history of widespread or serious violence, but there are several reports of incidents (they were mainly a street brawl after derby) during the eighties and early nineties, including predominantly fans of Sparta Prague. This team dominated in the former Czechoslovakia in the mentioned period which caused euphoria among the fans. However, with a growing number of fans, the displays of violent behavior went up. Young people, especially the working class, were not satisfied with their social status and began to vent their frustrations during football matches. The incidents happened inside stadiums and included attacks on players of the other team, although fans of Sparta also caused damage to the trains (broken windows and doors, cut seats, damaged toilets, sinks, throwing glass bottles out the windows during the ride etc.), which carried them to the outside matches, and threatened the guards and passengers (Duke, 1990; Mareš et al., 2004). Just such a train trip of Sparta fans form Prague to Banská Bystrica (1985) can be seen as the very beginning of football hooliganism in Czechoslovakia (only a few weeks after a tragedy in Brussels). In the new millennium, several games were interrupted due to the ravages of active fans directly in the terraces, e.g. Baník Ostrava-Sparta Prague (2014), brawls of fans with the police and riot police during the derbies of the Prague´s (Slavia Prague-Sparta Prague in 2008), but the matches were always completed. On the contrary, in the semi-finals of the domestic cup between Slavia Prague a Sigma Olomouc (2011), home supporters invaded the football field at half-time. Subsequently, they were calmed down by the riot police, the match was not finished, and the rival won the match by default. In the UEFA Cup (now the UEFA Europa League), during the match Sparta Prague-Spartak Moscow (2007), the Russian supporters caused considerable damage to the stadium and city center. Further, in a rematch of the UEFA Europa League between Slovan Bratislava and Sparta Prague (2014), the match was interrupted several times due to disturbances of supporters and hooligans in terraces.

Also, graffiti can be observed as a manifestation of supporters. These can be seen mainly on railway bridges, stations, buildings, but also in the immediate vicinity of a stadium where there is, e.g. next to the training ground, a team logo painted with a spray, or the year when the team was established, etc. Often, there is an agreement between the clubs that the graffiti in the immediate vicinity of the stadium should not be devalued by another club, which happened in the past. In addition to these displays, we can see the popular pasting stickers which, are used mainly during trips abroad as well as during holidays.

Methods

The goal of this paper is to analyze the relationship between supporters' verbal and other expression and their violent behavior at football stadiums in the Czech Republic. Primary data were collected by a questionnaire survey mainly at the Eden stadium and other football stadiums in the Czech Republic in 2015 and 2016. The research is focused on the oldest football club (est. 1892) in the Czech Republic. The next reason for choosing this football club was finding that stands of the stadium (end) are the most occupied by football supporters. The stand of the stadium for the home supporters is called the end, with the capacity of 3.065 seats. It consists of 5 sectors with 25 seats in 28 rows each. The end is mostly filled up to 2/3, and sold out during matches with attractive away teams e.g. Sparta Prague or Plzeň.

The selection of respondents was based on carefully pre-defined factors; e.g. seats 1, 3, 5, 7 in the first row; seats 2, 4, 6, 8 in the second row etc. from all the rows. The respondents were informed about the research and anonymity of the questionnaire. Once they answered the questionnaires, each of them received a small Slavia club badge. They had also the opportunity to contact the interviewer on the email stated on the questionnaire list and get themselves informed about the research results. Filled in questionnaires by 158 supporters were selected of the total 720 questionnaires. Six questionnaires from supporters were answered incorrectly and incompletely, therefore, they were not included in the research. Surveyed supporters aged 23.01 ± 10.11 years old participated in this research, all of them were attending in the end.

The questionnaire consisted of twenty-nine questions; some of them were scalable, where respondents rated on Likert scale (1-5) individual verbal and other expression and also their violent behavior speeches. The least serious activity was rated 1, the most significant activity received the highest grade, i.e. 5. This paper uses quantitative research, methods of analysis, mathematical and statistical methods. For the evaluation of the results, Statistica program was used.

Results

a) Supporters´ participation on the activities during the football matches.

Almost each supporter (98.73%) owned a scarf, jersey or T-shirt. Regarding the emotional response of the watched game, the results were as follows: over one third of the supporters (84.81%) were excited throughout the football match, next 15.19% were excited occasionally.

Negative feelings frequently evoke the level of football match (78.48%), controversial decisions of referees (69.62%), unsporting behavior of spectators (11.39%), and unsporting behavior of players and coaches (11.39%). Over one third of the supporters (37.97%) regretted the loss of the club only immediately after the end of the match, only 5.06% of the supporters did not care about the loss of the club. If the match is broadcast on TV, over 2/3 of the supporters (70.89%) opted for watching it at the football match at the stadium. The rest of the supporters (29.11%) sometimes visited the football match; sometimes they watched the football match from the sofa. The reasons for not going to the football stadium are the lack of money, afternoon or night shift at work, and the lack of time. Over 3/4 of the supporters (75.95%) consciously never took an object to the football stadium which could be used as a weapon. Only 20.25% of the supporters had a different opinion about this activity and some objects used as weapons (e.g. a flag stick, bottle of water or even a brick from the newspaper – known as a "Millwall brick"). Almost 1/2 of the supporters (49.37%) sometimes participated in firing of pyrotechnics. They agreed with the expression of the supporters "no pyrotechnics, no party". The same percentage of the supporters did not participate in pyrotechnics, and the rest of the supporters (1.26%) had a different point of view and used the pyrotechnics every match. Over one half of the supporters (54.43%) sometimes expressed vulgarly.

Almost one half of the supporters (44.31%) used vulgar expressions every football match. Such expressions are mostly addressed to the Head of the Football Association of the Czech Republic and the Head of referee committee; also to the referees and some players of the rival team, who react negatively to Slavia Prague. Vulgarisms are part of the behavior typical for supporters. Only 1.26% of the supporters did not use vulgarisms.

Over 1/4 of the supporters (26.58%) never drink alcohol before or during the football match. Over 1/3 of the supporters (40.51%) sometimes drink at the football stadium and the rest of the supporters (32.91%) always drink alcohol. Currently, the stadiums only sell non-alcoholic beer during the matches of European League, derby or other risky matches. Almost one fifth of the supporters (15.19%) had some experience with demolishing stadium and other riots. The rest of the supporters (84.81%) did not have this experience. Racism is one of the most discussed topics all over the world among football managers, top officials, players, fans, etc. Overt one half of the supporters (58.23%) did not shout racist insults at black football players. Almost 1/3 of the supporters sometimes used racist insults during the football matches.

Booing from supporters are for three main reasons: the crowd disagrees with a foul the referee has called or not called; the crowd is holding a grudge against a particular player for some reason and he or she has the ball; and the crowd feels a team is playing cynically through "simulating fouls" by diving or time wasting or playing too passively by passing the ball backwards excessively. Almost each supporter had an experience with boo the referee (94.94%) and 92.41% of the supporters booed on the Head of the Czech Football Association, and 91.14% of the supporters booed on the rival players and club.

Over 1/3 of the supporters (36.71%) threw an object on the pitch. It is mostly caused by the false verdict by the line referee or at the rival´s goal celebration in front of the various kinds of audience. The football pitch is often covered with empty or full plastic beer cups, coins or even lighters. We should consider that the referee decision should catalyze the violent clash, even in the situation when they themselves do not behave in line with the football rules. Almost 1/2 of the supporters (44.31%) had experience with a pitch excursion (historical proceed to Champions League in 2007 and friendly match with the football team Hajduk Split in 2014).

b) Supporters´ expressions on mentioned activities.

The examined group of the supporters showed very similar opinions on the pyrotechnics. 67.09% of them considered using pyrotechnics the least serious problem. Supporters used pyrotechnics in many cases and brought them to the stadiums. As far as the vulgarity of the end and vulgar expressions usage, we reached approximately the same values. Over 1/4 of the supporters (25.32%) considered physical aggression the most serious expression on the stadium. Agreed hooligans fight behind outside the stadium was mentioned by 55.70% of the supporters as the least serious activity. Furthermore, over 1/2 of the supporters (56.96%) stated that the stadium demolition and other riots do belong to the serious problems. It is interesting, that the stadium demolition mostly happens at the rival´s stadium. Only 25.32% of the supporters are persuaded that the objects throwing on the pitch is the most serious activity. Booing was unanimously agreed as the least serious activity (87.34%). Positively is a pitch incursion perceived as a wrong approach on one hand or as a provocation on the other hand. Over 1/5 of the supporters (20.25%) consider the pitch incursion as the most serious expression (table 1).

Table 1: Supporters´ expressions on mentioned activities in percentage

Activities	1	2	3	4	5
firing of pyrotechnics	67.09	21.52	7.59	2.53	1.27
vulgar chants in the stand	62.03	26.58	6.33	5.06	0.00
individual vulgar expression	60.76	11.39	16.46	6.33	5.06
physical aggression against rival fans at the stadium	16.46	11.39	29.11	17.72	25.32
physical aggression against police and riot police	21.52	8.86	20.25	24.05	25.32
arranged hooligan fight outside the stadium	55.70	6.33	12.66	8.86	16.46
throw in the object on the pitch	11.39	18.99	26.58	17.72	25.32
demolishing stadium and other riots	6.33	7.59	12.66	16.46	56.96
boos	87.34	8.86	2.53	1.27	0.00
pitch incursion	24.05	15.19	22.78	17.72	20.25

Note. 1 – the least serious expression, 5 – the most serious expression

Discussion

Nowadays, football clubs try to attract every fan to the football stadium. We can state that supporters´ behavior at the football stadiums is one of the most discussed topics in the Czech Republic. The Football Association of the Czech Republic tries to make football attractive as a product. Football matches should become the social events such as in England and other western countries. But it is necessary to emphasize that this mentioned product will not be as attractive in the Czech Republic as in England. The fact that the stadiums are often almost empty and there are not so many families with children is not caused by fights, pyrotechnics or physical aggression at the stadiums. There are a lot of different leisure activities (theater, cinema, zoo, etc.) instead of football.

Conclusions

We found that expressions of demolishing the stadium and other disturbances are considered the most serious expression of violent behavior by 56.96% of the supporters and 84.81% of the supporters did not have some experience with demolishing stadium. Furthermore, 87.34% of the supporters stated that boo is the least serious problem and almost each supporter (94.94%) had an experience with boo the referee. Over 2/3 of the supporters (67.09%) stated that firing of pyrotechnics is the least serious problem; other least serious activities were vulgar chants in the stand (62.03%), and individual vulgar expression (60.76%). Based on the results of the research, we find that supporters under 23 years of age are more tolerant of negative social phenomena in the surroundings of the stadium.

References

1. Ashton, J. (1989). One disaster after another …. *British Medical Journal. 298*(6668), p. 1261.
2. Cashmore, E. & Cleland, J. (2014). *Football´s Dark Side. Corruption, Homophobia, Violence and Racism in the Beautiful Game*. Basingstoke: Palgrave Macmillan.
3. Duke, V. (1990). Perestroika in progress? The case of spectator sports in Czechoslovakia. *British Journal of Sociology. 41*(2), pp 145-156.
4. Frosdick, S. & Marsh, P. (2005). *Football Hooliganism*. Devon: Willan Publishing.
5. Hunt, K. A.; Bristol, T. & Bashaw, R. E. (1999). A conceptual approach to classifying sports fans. *Journal of Services Marketing. 13*(6), pp 439-452.
6. Mareš, M.; Smolík, J. & Suchánek, M. (2004). *Fotbaloví chuligáni: evropská dimenze subkultury*. Brno: Centrum strategických studií a Barrister & Pricipal.
7. Sekot, A. (2013). Sociologie sportu: aktuální problémy. Brno: Masarykova univerzita.
8. Stroeken, K. (2002). Why ‚The World‘ Loves Watching Football (And ‚The Americans‘ Don‘t). *Antropology Today. 18*(3), pp 9-13.
9. Wakenfield, K. L. & Wann, D. L. (2006). An examination of dysfunctional sport fans: method of classification and relationship with problem behaviors. *Journal of Leisure Research, 38*(2), pp 168-186.
10. Wann, D. L. & Branscombe, N. R. (1993). Sport Fans: Measuring Degree of Identification with Their Team. *International Journal of Sport Psychology. 24*(1), pp 1-17.
11. Wann, D. L.; Haynes, G.; McLean, B. & Pullen, P. (2003). Sport team identification and willingness to consider anonymous acts of hostile aggression. *Aggressive Behavior. 29*(5), pp 406-413.
12. Wann, D. L.; Culver, Z.; Akanda, R.; Daglar, M.; De Divitiis, C. & Smith. A. (2005). The effects of team identification and game outcome on willingness to consider anonymous acts of hostile aggression. *Journal of Sport Behavior. 28*(3), pp 282-294.
13. Williams, A. M. *Science and Soccer. Developing Elite Performers*. (2013). New York: Routledge.

SOCIOLOGICAL ASPECTS OF ACTIVE MODES OF TRANSPORT

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Abstract

Discussing the position and the nature of contemporary sport means to say: Sport is the same as the society. Physical activity in terms of motives, forms of intensity changes considerably, in particular in the context of the phenomenon of post-modern sedentary society. From the perspective of leisure sport activities public health recommendations for physical activity tend to emphasize particularly walking and bicycle riding. Active transport is considered an important source of natural physical activity in all stages of life. The paper illustrates walking and biking as an agent for aquiring invigorating affects of regular, high-quality and life-long physical activities on health, fitness and morals: for wellness. Presented data ilustrate the results of larger survey of participation of adult Czech population in physical activities, including walking and cycling. Survey confirmed general decline in proportion of sport and excercise in leisure time, decreasing importance of walking and cycling as means of transport, higher participation in sport in men, increasing relative proportion of walking in age. On the whole it is confirmed that overal climate of sedentary society in which sport is more of a passively consumed as a form of mass entertainment rather than an actual acvtivity practised as an integral part of people´s life style on permanent lifelong basis.

Key words: *physical activity, active transport, walking, cycling, sedentary society*

Introduction

To understand the nature and the direction of the contemporary world, its individual societies and cultures without taking into consideration and giving a proper attention to the role of sportive physical activities is virtually impossible. The thing is we are living in sedentary society characterised with fading away the requirement of physical activities in most professions, in households and in individual ways of transport (Sekot, 2015, p. 13 – 17; Weber & Horst, 2011). The development of a sedentary lifestyle is the set of a socialization process towards physical inactivity developed in youth and continued into adulthood (McElroy, M. (2002). In addition very important fact plays role in this context: People are more and more individualized, losing benefical impacts of community activities, are involved in passive ways of life lacking proper level of physical activity and active sport. The nature of sport and physical activities is part of typical essence of given society. Depending on a given socio-cultural setting and the values appreciated in such setting, physical activities are discussed in perspective of sociology with a number of questions regarding the role of sport in defining a person lifestyle and forming the nature of a society, with a challenge to create a suitable approach to the imbalanced relation between the leisure a physical activities as a part of active responsible health attitude to the life.

We are living a time, when our society, culture and science have become increasingly aware of the great importace od regular sportive whole life activities, broadly understood, for individual and social health and well-being. Physical activity of people plays an increasingly important role in scientific interest regarding the way of life of contemprary society, and it is a very important factor in the process of advocating the level of healthy and active lifestyle, quality of life and health in general. The indispensable role of physical activity in the course of human life is permanently confirmed scientifically in the context of health, personal physical and psychical shape, obesity and broader economic impact as well (Pratt, p. 38).

Sporting physical activities are developed in certain cultural chlimate and are a result of a socially conditioned value orientation, and formation of behavioural patterns. This fact may bring about number of dressing questions regarding the importace of active regular physical activities and their role in socialization and shaping of individual lifestyle or direction in life. On the level of mass sportive leisure activities our society is strongly influenced by the existence of a new developments of the city structure with plenty of administartive buildings and shoping facilities , including fitness centres, cycle paths, roller skate stadiums, beach wolleaball playing fields, and golf courses. Outdoor facilities, as a convenient setting for walking and biking, are all provided to the public for free (Staněk & Flemr, 2007).

Aim and results

The Faculty of Sports Studies of Masaryk University performed a larger survey of participation of adult population in physical activities. It focused on the basic demographic criteria: gender, age, marital status, size of the place of residence, level of education; as well as other relevant criteria such as profession, smoking, alcohol consumption, frequency of participation in leisure physical activities, level of organization of sporting activities, preferred sport, and health condition. The following paragraphs summarize the results of the survey, providing a view of the level of the respondents' participation in physical activties depending on their profession, gender and age. Comparison of these data with those obtained in other surveys shows the following trends: a general decline in the proportion of sport and exercise in leisure time, decreasing importance of walking and cycling as means of transport, higher participation in sport in men, increasing proportion of walking in the structure of physical activities with age. On the whole, the results reflect the overall climate of a sedentary society in which sport is more of a passively consumed form of mass entertainment rather than an actual activity practised as an integral part of people's lifestyle on permanent lifelong basis.

Question no. 1: Nature of work in job or during studies

Criterion	**Group**	**Physical work**	**Sedentary job**	**Physical and sedentary**	**Not working**
Gender	Men	13.66%	41.39%	33.47%	11.49%
	Women	9.15%	35.78%	33.82%	21.24%
Age	Up to 29	11.59%	39.02%	38.11%	11.28%
	30 to 39	12.64%	45.98%	34.10%	7.28%
	40 to 49	10.36%	45.60%	41.45%	2.59%
	50 to 59	12.93%	42.86%	38.10%	6.12%
	60 to 69	7.03%	18.75%	18.75%	55.47%
	Over 70	10.00%	8.33%	3.33%	78.33%
Men	Up to 29	15.34%	36.81%	38.04%	9.82%
	30 to 39	13.68%	53.85%	31.62%	0.85%
	40 to 49	15.73%	42.70%	38.20%	3.37%
	50 to 59	11.48%	50.82%	37.70%	0.00%
	60 to 69	9.62%	28.85%	25.00%	36.54%
	Over 70	8.70%	8.70%	0.00%	82.61%
Women	Up to 29	7.88%	41.21%	38.18%	12.73%
	30 to 39	11.81%	39.58%	36.11%	12.50%
	40 to 49	5.77%	48.08%	44.23%	1.92%
	50 to 59	13.95%	37.21%	38.37%	10.47%
	60 to 69	5.26%	11.84%	14.47%	68.42%
	Over 70	10.81%	8.11%	5.41%	75.68%
Total		**11.19%**	**38.32%**	**33.66%**	**16.83%**

The nature of work in terms of proportion of physical activity is an important indicator of contemporary post-industrial sedentary society – the survey the total of 1,117 respondents over 18 years of age (505 men, 612 women) of which less than 14% and 10% of men and women respectively claimed to have a job in which physical activity predominates. Some 41% of men claimed to have a sedentary job which is more than in the case of women (some 36%). Approximately one third of the respondents, both men and women, declared to have a balanced job in terms of proportion of physical activity/inactivityhe physical activity in job is relatively pro portionately distributed in all surveyed age groups (10–30%), except for seniors where the proportion is lower. Similar proportionate distribution applies also to the category of "sedentary job", which shows to be largest (40–46%), where age is a negligible factor (except for the elderly). An undoubtedly interesting fact is that over 11% of the respondents up to 29 years have no job. This group includes in particular women in households and unem- ployed fresh graduates, primarily from secondary schools. In the 60–69 age group, which is a crucial age for the currently considered topic of pension reform, there is a higher num- ber of professionally active men, primarily in sedentary jobs; women on the other hand are more frequently in jobs combining physical and sedentary work.

Question no. 2: How much time IN TOTAL did you spend by performing a moderately demanding physical activity (e.g. carrying of light loads, bicycle riding at a normal speed, a tennis double; walking excluded) in the last seven days?

Criterion	Group	Absence of activity	Less than 1 hour	1–3 hours	3–6 hours	Over 6 hours
Gender	Men	7.33%	19.21%	34.85%	18.81%	19.60%
	Women	9.64%	28.27%	35.46%	14.87%	11.44%
Age	Up to 29	6.10%	21.95%	35.37%	17.99%	18.60%
	30 to 39	8.43%	24.52%	34.10%	18.77%	14.18%
	40 to 49	9.33%	20.73%	40.93%	16.58%	12.44%
	50 to 59	5.44%	25.17%	37.41%	14.97%	17.01%
	60 to 69	14.06%	31.25%	28.91%	12.50%	13.28%
	Over 70	16.67%	28.33%	28.33%	13.33%	8.33%
Education	No education	0.00%	0.00%	0.00%	100.00%	0.00%
	Basic	8.57%	40.00%	22.86%	8.57%	20.00%
	Vocational	14.17%	19.17%	32.50%	15.83%	17.50%
	Secondary	8.63%	23.01%	35.62%	17.48%	15.04%
	University	7.10%	25.44%	36.49%	16.57%	14.40%
Total		**8.52%**	**24.22%**	**35.25%**	**16.68%**	**15.16%**

The largest number of respondents declared to engage in a moderately demanding physical activity for some 1–3 hours a week, while the absence of any physical activity was declared by less than 10%. Men engage in physically demanding activity significantly more often than women. What is greatly interesting is the data regarding the third and sixth decade of life which show the highest proportion of demanding physical activity and, logically, the lowest percentage of its total absence. As regards seniors, the level of engagement in physical activities naturally declines with growing age. There is a clear direct proportion between the level of education and engagement in more demanding physical activities. The medium level of engagement is typical of individuals with a secondary and university education.

Question no. 3: How much time on average do you spend walking (at work, school and home, as means of transport, or performed solely for recreation, as sport or exercise or during leisure time)?

Criterion	Group	Absence of activity	Less than 1 hour	1–3 hours	3–6 hours	Over 6 hours
Gender	Men	1.19%	28.91%	36.83%	23.56%	9.50%
	Women	0.65%	18.14%	41.83%	24.84%	14.38%
Age	Up to 29	0.30%	19.82%	42.99%	24.70%	12.20%
	30 to 39	0.77%	22.99%	36.78%	26.82%	12.64%
	40 to 49	1.55%	25.39%	39.90%	22.80%	10.36%
	50 to 59	0.00%	24.49%	38.78%	21.77%	14.97%
	60 to 69	1.56%	21.88%	35.16%	28.13%	13.28%
	Over 70	3.33%	31.67%	43.33%	13.33%	6.67%
Education	No education	0.00%	100.00%	0.00%	0.00%	0.00%
	Basic	2.86%	25.71%	31.43%	22.86%	17.14%
	Vocational	0.00%	21.67%	30.00%	26.67%	21.67%
	Secondary	1.55%	21.68%	40.04%	23.67%	13.05%
	University	0.39%	24.06%	42.21%	24.46%	8.88%
Total		**0.90%**	**22.96%**	**39.64%**	**24.30%**	**12.20%**

In a sedentary society walking is the most accessible and most frequent physical activity of everyday life; its importance grows with increasing age, particularly with view to its health enhancing effects and safety. In fact, in the most frequent category of 3–6 hours a week it is the respondents of the 60–69 age group who are most numerous; for older respondents the importance of regular walking declines. Sedentary way of life and the lack of active modes of transport are apparently reflected also in the relatively low proportion of walking in the structure of activities of the middle age professionally active groups who are characterized by everyday use of car as means of transport. As regards the level of education, the proportion of walking is logically higher in manual professions.

The results of the survey may be summarized as follows:

1. The criterion of the size of the place of residence points to the highest proportion of men (some 40%) in smaller towns with the population of up to 30,000; and to a similar proportion of women in big cities with the population over 100,000.
2. As regards marital status there is a high proportion of single men (some 43%), a negligible proportion of married men below 29 years (3%), and the highest proportion of married men and women of the 40–60 age group; also in this age group there is 20% of divorced women.
3. As regards the level of education the most numerous category is respondents with secondary and university education of the 30–39 age group (almost 90% for women!); basic education is declared marginally (some 6%) in the youngest and oldest age groups, that is, below 30 and over 60 years of age.
4. The partial results of the survey confirmed the predominating trend of the decline in the proportion of physical work in favour of sedentary jobs. Sedentary job is typical particularly for men from 50 to 60 years of age; conversely, it is least frequent in seniors of both genders.
5. Jobs involving physical work are most frequent (some 14–16%) in men below 50 and women of the 50–59 age group. Therefore it seems that in professions both genders above 50 years of age meet physically in senior positions of men.

As regards the research hypotesis the partial results of an ongoing survey which is supposed to include some 4,000 respondents indicate a higher degree of leisure physical activities in individuals with a higher education and a sedentary job, an increasing frequency of walking as the main physical activity with growing age, the highest popularity of cycling among younger age groups and a generally low level of participation in sports clubs and organizations, which reflects a generally comparable situation in the Czech Republic (Sekot, 2015, p. 37 – 54).

Discussion

Public health recommendations for physical activity tend to emphasise ordinary physical activities, particularly walking and bicycle riding as means of active transport. *Active transport* is considered an important source of natural physical activity in all stages of life, especially at a young and old age when there are suitable economic and legal conditions: children and youth do not dive cars yet and for senior citizens *walking* is one of the most beneficial forms of physical activity. Hence walking is recommended to Czech pupils and students as the most suitable mode of transport to school; an average student should make 10 to 11 thousand steps each day on average (Chmelík et al., 2010, p. 37). In this context it is not possible to ignore the empirical finding of a recent survey among Czech secondary school students that "overweight and obese individuals do significantly less of walking than their peers with an optimum weight (Mužík & Vlček et al., 2010, p. 149).

Walking is one of the best forms of physical activity. It does not require any special equipment or skill. This activity may essentially be performed anywhere and at any time, with family or friends. Walking has been rather neglected recently. In the past people used to walk several kilometres a day, nowadays it is often just several tens of metres. Actually, fast walking is relatively demanding of energy. Brisk walking, that is, at a faster pace when one slightly perspires but can still engage in a conversation without gasping for breath, enables them to relax in fresh air and after some time releases the "good mood" hormone. Its major benefit is that it strengthens the heart, helping it to stay healthy. It also strengthens other muscles and bones and thereby reduces the risks of the occurrence or aggravation of osteoporosis, improves movement coordination and promotes blood circulation in the brain.

Walking is an ideal choice for individuals with hypertension, joint disorders or older people (for whom some other sport, new for them, would mean an unhealthy overloading of joints and ligaments). A person who engages in walking regularly will probably liver longer, and has lower risk of health and mobility disorders even at an old age. Also swimming is a form of physical activity which places almost no load on joints as it is performed in water. Swimming is therefore one of the few physical activities suitable for the elderly or people with a health disability. But it is popular with all age groups. The amount of the calories burnt depends to a large extent on the swimming style and speed. And what is important for fitness: swimming is one of the activities most beneficial for hearth rate because it activates and exercises almost all muscle groups including arms, back, chest, buttocks and legs.

Walking makes up the largest part of physical activities in adolescence, some 60%, and is considered worth of support by creating a pedestrian friendly environment. This can be achieved most effectively by ensuring varied landscape and close opportunities for walking (to work, shops or leisure centres). Particularly the availability of comfortable, safe and reasonably planned pedestrian routes reachable within 5–10 minutes from one's place of residence is an important prerequisite for walking to be preferred both as an active form of transport and a leisure physical activity (Neuls, 2010, p. 38).

Similarly, the availability of a sufficient number of “green” bicycle paths is an impor- tant factor influencing the preference of bicycle riding as an active form of transport (Charriere et al., 2010, p. 28). Bicycle touring has become the major topic of the 2010 European Mobility Week in Denmark, the European leader in bicycle riding, whose motto “Travel Smarter, Live Better”, promoting regular physical activity and healthy lifestyle, is undoubtedly highly inspiring for us as well. Also in Great Britain, in the context of the Cycling Demonstration Town programme, there are indications of an increased interest in cycling as a means of cost-effective transport particularly to school and work (Cahill et al., 2010, p. 105). Czech literature on this topic points out the increasing popularity of cycling primarily as a form of recreational weekend activity and a competitive sport. The use of cycling as a means of transport, so far unsuccessfully competing with the enormous preference of cars, will hopefully come in the near future, with view to the high effectiveness of the programmes promoting an active lifestyle and participation in physical activities by creating open access bicycle paths and pedestrian routes and opportunities for local sporting activities. Bicycle touring trails in the Czech Republic are use for recreational activities while bicycle paths are more often used as transport infrastructure for everyday practical use (Schwarzhoffová, 2010, p. 39). Let’s hope that making them safer by clearly separating it from the road will draw more and more people to this cheap, eco-friendly and health promoting activity.

Bicycle riding is actually gaining popularity all over Europe. In the Czech Republic as a leisure recreational activity during weekends, as mentioned above, and in Western Europe traditionally also as a means of transport to school, work, friends, shops or leisure centres. The overall standard of bicycle tracks is also increased by a special emphasis on safety to ensure a smooth traffic for as wide range of users as possible, particularly in countries which are especially favourable to cycling (Janežič et al., 2010, p. 49).

We usually walk to get from place a to place B. However, apart from being the most elementary way of changing position, walking is also a source of pleasant experience, a way to compensate for a sedentary lifestyle, an opportunity to be with friends, a mean- ingful leisure activity, a way to calm down the nervous system, clear one’s head, and raise the spirit, and a form of physical activity promoting fitness and physical and mental well- being. Relaxation walking is especially beneficial for the social life of senior citizens as a way to prevent their social isolation, cardiovascular diseases, overweight and obesity and improve their health condition in general (Morris & Hardman, 1997, p. 320).

The use of walking as an elementary form of transport may play an important clinical role during patient rehabilitation, particularly for older people and physically or psycho- logically disadvantaged individuals. The benefits of regular walking can also be seen some professions such as postmen and women who happen to have a lower prevalence of cardio- vascular diseases and hypertension than, for instance, typical sedentary professions such as officers or assembly line workers (Morris & Hardman, 1997).

Conclusion

In our cultural setting two groups of factors impact on development trends of sports and physical activities in the context of changing peoples´ lifestyles: One group are factors resulting from the changing social structure, in particular the newly established middle class (broader impact of the lates economic development, tendencies in education, affluence, employment structure, changing character of labour, etc.), while factors in the other group stem mainly from cultural changes (prevalent system of values, dominant ideas, behaviour patterns, social control, public opinion, cultural pressure, strong impact of mass media, etc.). Rapid housing and industrial development has resulted in the field of sportive leisure activities in numerus urban-architectural and sociological issues as well. Sport facilities planning, design, development and operation should be considered on both local and national levels. The sole fact of sedentary nature of contemporary society makes sportive leisure activities to be growing importance of critical policy area. But at the same situation we face the dropping interest of the youngest generation in physical educational lessons, on the declining level of physical fitness of children and youth, on increasing obesity in pupils and students and on general reluctance of the young to regular physical activity (Mužík, (ed), 2007). Laziness manifests itself not only in the aversion to a fitness-focused physical activity but also aversion to active means of transport, walking, regular biking or swimming (Telama et al,. 2007; Sekot, 2015). At the same time, however, the numbers and the quality of various fitness and wellness facilities and centres, aquaparks or bicycle paths grown. On the one hand, there is relatively consistent smallish group of systematically sporting individuals who use primarily the commercial sporting facilities; on the other hand, there is growing number of those who perform any physical activity only when it is absolutely necessery or when pressed by others. A passive, sedentary, consumption oriented style of spending leisure time is more frequent than the active universaly harmonising creative forms: even young people view sport more as a top-level mass entertainment spectacle ether than as an integral, indispensable and invigorating form of personal development. Development of physical fitness and a way to improve one´s health, establish new relationshops and achieve an overal comfort. Physical insufficiency (physical inactivity) in such perspective may be specified as individual behaviour characterizedd by a very low volume of common everyday physical activities and an absence of structured physical activities focusing on skill (Mužík & Vlček, 2010).

Physical activity in terms of motives, forms of intensity changes considerably, in particular in the context of the phenomenon of post-modern sedentary society. Nevertheless it still plays an important role in people´s life even today.

Apart from its inseparable connection to physical work, it helps to keep the human body in good health and physical and mental fitness. The human body is very well adjusted to physical activity and it is not used it loses muscle mass which is then easily substituted with fat. Physical activity is a form of person´s movement in time and space, based on muscle work associated with an increased output and assuming, in different context, a vide range of forms, including in particular basic everyday form activities leading to health promotion, enhancing personal fitness, performance and skills.

Walking at all levels of intensity means energy output and therefore it is an unfailing method of weight and obesity reduction. Moreover, it is the most natural way of maintainig the function and strength of skeletal muscles and energy exchange. There are two types of effects of walking: 1) short-term and 2) long-term which become apparent in weeks, months or years as a result of a regular habitual physical activity (Morris & Hardman, 1997, p. 307).

Walking is usually described as natural physical activity preventing many health disorders even though there is not many empirical laboratory studies that would prove such effects. There is, however, sufficient evidence on the benefits of regular walking, includ- ing prevention of myocardial infraction, respiratory disorders and muscle illnesses, reduction of hypertension and during rehabilitation of cardiovascular and respiratory illnesses. According to newer medical recommendations boys from 6 to 17 years of age should make 13,000 steps per day. For girls of the same age it is 11,000 steps. The recommendation for adults is 10,000 steps per day (Tudor-Locke et al., 2002). The recommended number of steps per minute is some 130 steps, depending on age, terrain and particular situation. It has been observed that people who spend 130 to 150 minutes each day walking or 90 minutes each day jogging or doing aerobic exercises are exposed to much lower risk of dying prematurely. In older people such health benefits can be seen already after 2.5 kilometres a day (Hendl & Dobrý, 2011). In accordance with the HEPA recommendations it is necessary to point to other everyday physical activities: housework, gardening, walking the dog, upstairs walking.

Walking is the most natural physical activity which may be practiced on daily basis and which does not require any special skills, preparation or equipment. Walking may be practices in leisure time as well as during work time: instead of waiting in a traffic jam in a long slowly moving queue of cars, each carrying just one passenger, it is often much more beneficial, financially, environmentally and in relation to one's health, to take a half-hour walk from work rather than wasting time in a car or waiting for public transport. Walking, contrary to other means of transport, enables an individual to easily regulate its intensity, duration and frequency and, in addition, it unquestionably is one of the safest forms of transport. And contrary to other physical activities it is not limited to any significant degree by age, it may be adapted to seasonal changes of weather, it is independent on the will of the surrounding environment, and may be practiced almost anywhere and at any time. If it becomes an integral part of everyday life and individual's lifestyle it brings many unquestionable benefits, ones that are obvious and fully realized as well as latent ones. Walking is probably the most readily available and at the same time highly effective means to prevent the malign consequences of a sedentary lifestyle, because it can, inter alia, induce a strong feeling of well-being. Regular walking and well-being are two interrelated phenomena.

Naturally, the positive effects of walking depend on the environment and above all the intensity with which such activity is performed. According to experts, for a healthy individual walking is beneficial if performed for at least 30 minutes most days a week at a speed of some 6.5 km/hour. One can surely imagine the individual and society-wide positive health effects of such activity if practised on a massive scale and thereby reproduce their weight and health issues which then become an "argument" against walking. It is indisputable that walking should be part of the lifestyle of a healthy, normal and rational individual concerned with the financial and environmental impacts of his behav- iour. A strongly contaminated environment, polluted air, a poisonous mist of a traffic jam – all this makes cities hardly walkable in many respects. It is therefore no accident that more and more experts start to focus on active forms of transport – beginning with the construction of pedestrian zones and ending with the expansion of the bicycle path net- work. Walking and cycling thus become increasingly more popular as sporting and physi- cal activities which do not place almost any financial, material or organizational demands on an individual (contrary to, for instance, downhill skiing, exercising in fitness centres or playing tennis or ice hockey). Nevertheless, even in this case regular engagement in such activity requires from an individual personal initiative, determination to change his or her sedentary lifestyle, consider active ways of spending leisure time, strong resolve and will to continue to be physically active (Morris & Hardman, 1997, p. 327). As a reward he or she will experience a unique feeling of relief and vigour and meaningfulness which later becomes a permanent state, usually called *well-being*.

Reference

1. Cahil, N. et al. (2010). Increasing cycling in six towns in England. A cost-effective investment. *Gymnica*. Vol. 40, no. 30. p. 105. Olomouic: Univerzita Palackého.
2. Hendl, J. & Dobrý, L. (2011). *Zdravotní benefity pohybových aktivit.* Praha: Karolinum.
3. Charreire, H. et al. (2010). Neibourhood facilities and the green space are related to walking and cycling in French adults. *Gymnica, vol.* 40, no. 30, p. 28. Olomouc: Universita Palacléhо.
4. Chmelík, F. (2010). Active transport to school in Czech high school students. *Gymnica, vol. 40, no. 30,* p. 37-43. Olomouc: Palacký university.

5. Janežič, M. et al. (2010). Safety cycle training course in the Framework of European project Life cycle. *Gymnica*. Vol. 40, no. 30, p. 49. Olomouc: Universita Palackého.
6. McElroy, M. (2002). *A Social Analysis of Inactivity.* Champaign: Human Kinetics.
7. Morris, J. N; & Hardman, A. E. (1997). Walking to health. *Sports Medicine. May, vol. 23.* no. 5, p. 306-332
8. Mužík, V. (ed). (2007). *Výživa a pohyb jako součást výchovy ke zdraví na základní škole.* Brno. Masaryk university and MDS.
9. Mužík, V., & Vlček, P. (2010). Škola, pohyb a zdraví. Výzkumné výsledky a projekty. Brno: Masaryk university and MDS.
10. Neuls, F. (2010). Walking and reffered correlates in Czech adolescent girls. *Gymnica, vol. 40,* no. 30, p. 38. Olomouc: Palacký university.
11. Pratt, M. (2010). Physical activity and its economic impact on public health. *Gymnica, vol. 40,* no. 30, p. 38. Olomouc: Palacký University.
12. Sekot, A. (2015). *Pohybové aktivity pohledem sociologie.* Brno: Masarykovauniverzita.
13. Schwartzhofová, E. *(2010). Cykloturism in the Czech Republic.* Gymnica. *Vol. 40, no. 30, p. 39-46*.
14. Telama, R. et al. (2007). Determinants and correlates of physical activity among European children and adolescents. *Obesity in Europe. Young People´s physical activity and sedentary lifestyles.* London: Routledge.
15. Tudor-Locke, C. et al. (2002). Taking steps towards increased physical aktivity: Using pedometrs to measure and motivate. *President´s Council on Physical Fitness and Sport Research Digest.* 3. (17).
16. Weber, K. & Horst, S. (2011). *Desertificationand Livelock Gazing. The Rolesof Sedentary Lifestyles*. p. 119-133. Berlin & Oxford: Peter Lang.

Kinesiology and Social Sciences

GOAL ORIENTATION AND WEIGHT CYCLING IN WRESTLING

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Abstract

Body mass (BM) reduction in wrestling is a procedure devised to gain an advantage in mass and strength over one's opponents. The mentioned procedure primarily fits the concept of goal orientation towards the result (ego orientation goals) than towards the assignment (task orientation goals). The aim of this research was to determine the differences in goal orientation between wrestlers who practice body mass reduction in relation to wrestlers who do not. The sample of 61 senior male wrestlers was divided into two groups (BM reduction and no BM reduction) and the Task and Ego Orientation in Sport Questionnaire (TEOSQ) was used. The results demonstrate that there is no difference between the two groups in relation to their ego orientation goals (reduction 3.33±0.49; no reduction 3.33±0.45). On the other hand, in relation to their task orientation goals, wrestlers who did not reduce their BM achieved higher results, however, the difference was not statistically significant (reduction 3.30±0.71; no reduction 3.43±0.56). The high level of homogeneity of the overall sample is a potential reason that there were no statistically significant differences in the obtained results.

Key words: *psychology, combat sport, body mass reduction*

Introduction

Body mass (BM) reduction with the aim of performing in a competition in a lighter weight class is a common phenomenon in wrestling, as well as in most combat sports. BM is typically reduced to allow the wrestler to compete in a lighter weight class, In order to to avoid "stronger" contenders. The wrestlers in the lighter weight class are physically weaker, as weight gain in wrestling proportionally indicates greater strength as well (Song and Garvie, 1980; Yoon, 2002). In case there is sufficient time between the weighing and the fights (e.g. weighing in the evening and fights in the morning the next day), then the wrestler who reduced his BM shall be able to recover part of the weight and thus be heavier than other wrestlers. The mentioned strategy is also known in literature as weight cycling (Barcal et al., 2016; Gann et al., 2015; Lingor and Olson, 2010) and it provides the wrestlers physical, and according to some authors, even mental advantage over the opponents (Pettersson et al., 2013; Karnincic et al., 2016). The above-described phenomenon is quite present in numerous combat sports, however, the potential heath complications (due to the combination of acute dehydration and weight training) make it a phenomenon of specific importance (Artioli et al., 2010; Kiningham and Monseau, 2015). The correlation between acute dehydration (as a result of BM reduction) and cognitive conditions has already been recorded in literature (Choma et al., 1998), as well as negative effects of rapid BM reduction on psychological conditions and the development of numerous psychological disorders (Khodaee et al., 2015; Degoutte et al., 2006; Steen and Brownell, 1990). Psychological studies in relation to BM reduction in combat sports generally deal with the consequences of rapid BM reduction. A study by Pettersson (2013) presents some of the motives because of which fighters decide to attempt large BM reductions and claims that insight into the causal mechanism of this phenomenon is possible. It is therefore necessary to collect as many information as possible on the motivational aspects of problematic BM reductions in order to enable preventive action instead of repairing consequences.

Motivation is one of the key factors in any sport. It is a prerequisite for completing all that is required to accomplish the desired goals. Motivation and individual behaviour are closely connected with goals. The social-cognitive model of achievement motivation suggests that there are two types of goal orientation (Nicholls, 1992; Roberts, 1993; Duda, 1992). The first one is orientation towards the assignment, learning and improvement (task orientation goals). This type of goal orientation implies that the athlete evaluates his competence in relation to his previous performance, while his criteria is based on a subjective perception. The second type of goal orientation is directed towards performance and result (ego orientation goals). In this case, progress and improvement are not sufficient for the athlete to feel successful, and he must be better than others. In theory, the second type of orientation is considered to be inferior compare to orientation towards the assignment. In this case, the athlete can set goals that are lower than his abilities in order to avoid failure. Wrestlers who practice BM reduction do not attempt to defeat the best opponent; they avoid him and they seek highest possible result in lower weight category. In accordance with the above-mentioned goal orientation theories, using BM reduction to avoid a strong rival is by no means considered as goal orientation towards the assignment, learning and improvement (task orientation goal), but it is purely orientation towards the result (ego orientation goal). Based on all the above-mentioned, the aim of this research was to determine the differences in goal orientation between wrestlers who reduce their BM and wrestlers who do not. The hypothesis is that the wrestlers who reduced more BM are statistically significant different in the goal orientation in contrast to the wrestlers who do not reduce their BM.

Methods

The sample of examinees was composed of 61 senior male wrestlers divided into two groups out of which one group (n=21) did not practice BM reduction (<1 kg reduction), whereas the second group (n=40) reduced their BM before competitions (≥1 kg reduction). It can be said that this is a representative sample of senior male wrestlers as this research covered over 80% of senior wrestlers who compete at National Championships in Croatia. The general characteristics of the examinees are presented in Table 2.

The sample of variables was composed of 10 variables, out of which 6 variables describe the sample: age, body mass, body height, body mass index, experience and national championship ranking; 2 variables are related to body mass reduction: body mass reduction (variable for group definition) and urine specific gravity (USG); and there are 2 motivation variables (ego – task). The Task and Ego Orientation in Sport Questionnaire (TEOSQ) was used (Duda, 1989) in the translated and adapted version (Barić et al., 2002). The questionnaire consisted of 13 questions which are specific for one of the goal orientation dimensions. The answers were presented as a Likert scale as follows: 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree, while the results were calculated according to the following formula: Ego Orientation (q1 + q3 + q4 + q6 + q9 + q11) ÷ 6; Task Orientation (q2 + q5 + q7 + q8 + q10 + q12 + q13) ÷ 7.

Description of the experimental procedure. All the examinees arrived to the National Wrestling Championship where before the weighing, they all gave urine samples which were used to calculate the urine specific gravity (USG) by using the refractometer method. Prior the fights, examinees were given detailed instructions for fulfilling the questionnaire after which they completed both the anamnestic and motivational questionnaire. After the competition, the final ranking of the examinees at the National Championship was also recorded.

Ethical Standards. Each procedure performed in this study in relation to human research was conducted according to the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Institutional Ethics Committee. All the examinees signed written consent forms for voluntary participation in this research.

Data processing methods. All the obtained data was statistically process by using the STATISTICA ver. 12 software programme (Statsoft, Inc., Tulsa, OK, USA) and with the level of significance of $p<0,05$. All the variables were processed with the use of descriptive statistics (arithmetic mean and standard deviation), while the normal distribution was assessed by using the Kolmogorov-Smirnov test. In order to assure the reliability of the questionnaire, the Cronbach's Alpha and the Average Inter-Item Correlation were calculated. The differences between the groups were tested with the one-way analysis of variance (ANOVA) test, while the Man-Whitney U test was used to check the difference in variables that were not normally distributed.

Results

Table 1 presents the questionnaire's reliability parameters (Cronbach's alpha and Average Inter-Item Correlation) for both groups, as well as for each group separately

Reliability/Item	All groups (n=61)		BM reduction (n=40)		No BM reduction (n=21)	
	Ego	Task	Ego	Task	Ego	Task
Cronbach's alpha:	0.77	0.84	0.82	0.69	0.88	0.88
Average Inter-Item Correlation:	0.35	0.48	0.44	0.27	0,58	0.53

The results in Table 1 clearly indicate that the reliability criteria, both for the entire sample as well as for both groups, were met for each of the two motivational aspects, although the value of the Cronbach's alpha in the BM reduction group was borderline in relation to the task variable.

Table 2 contains descriptive statistical parameters (arithmetic mean and standard deviation), normal distribution (Kolmogorv-Smirnov test) and the differences between the groups (one-way ANOVA). The differences between the variables that were not normally distributed went through additional analysis by using nonparametric statistics (Man-Whitney U test).

	All groups (n=61)		BM reduction group (N=40)		No BM reduction group (N=21)			
Variables	mean±SD	K-S	mean±SD	K-S	mean±SD	K-S	ANOVA	MW-U test
Age (years)	21.62±4.00	p<0.15	21.10±4.52	p<0.10	21.90±3.73	p>0.20	F=0.55	p=0.46
Body weight (kg)	76.41±14.81	p<0.10	79.16±16.57	p>0.20	74.98±13.80	p<0.15	F=1.10	p=0.30
Body height (cm)	176.88±9.41	p>0.20	178.50±9.09	p>0.20	176.03±9.58	p>0.20	F=0.95	p=0.33
BMI	24.27±3.17	p>0.20	24.60±3.16	p>0.20	24.10±3.20	p>0.20	F=0.34	p=0.56
Experience (years)	10.65±4.49	p>0.20	11.24±4.54	p>0.20	10.34±4.49	p>0.20	F=0.55	p=0.46
Championship ranking	6.64±4.32	**p<0.05***	5.76±3.63	p>0.20	7.10±4.61	p>0.20	F=1.33	p=0.25
							Z=-0.90	p=0.37
BM reduction (kg)	2.55±2.17	p>0.20	0.19±0.37	**p<0.01***	3.80±1.60	p>0.20	F=102.69	**p<0.001**
							Z=-6.34	**p<0.001**
USG	1.029±0.004	p>0.20	1.026±0.004	p>0.20	1.030±0.004	p>0.20	F=12.98	**p<0.001**
Ego	3.33±0.46	p>0.20	3.33±0.49	p>0.20	3.33±0.45	p>0.20	F=0.004	p=0.95
Task	3.38±0.62	p>0.10	3.30±0.71	p>0.20	3.43±0.56	p>0.20	F=0.66	p=0.42

BMI –body mass index; USG – urine specific gravity

The values in Table 2 clearly indicate that the groups were statistically significantly different only in the variables related to BM reduction and urine specific gravity (USG). The variables on Championship ranking and BM reduction were not normally distributed.

Discussion

Almost 2/3 of the wrestlers in this research use BM reduction. Even though this was never precisely determined, speculations suggest that approximately 60% of athletes in combat sports practise BM reduction (Gann et al., 2015). This research supports such speculations, despite the fact that in some cases the presumed percentage goes up to 85% (Artioli et al., 2010). Table 2 clearly demonstrates that these were two extremely homogeneous groups. Numerically speaking, wrestlers who do not reduce BM are generally somewhat taller, heavier (and consequently have a higher BMI) than wrestlers who reduce BM, however, this can be explained by the fact that BM reduction is usually more often present in lighter weight classes (Zubac et al., 2016). Although the group that reduced BM invested much more effort into their preparation for the competition, there was no statistically significant difference in terms of achieving higher final ranking positions. Some authors managed to demonstrate correlations between weight cycling and success (Wroble and Moxley, 1998; Alderman et al., 2004), however, others failed to do the same (Horswill et al., 1994), so that studies show conflicting results in relation to weight cycling and various types of sports performance (Gann et al., 2015). As one of the basic methods in BM reduction in combat sports is the restriction of fluid intake (Lingor and Olson, 2010), it is not uncommon that there is significant difference in the results for urine specific gravity. Although wrestlers who reduce BM are significantly more dehydrated than wrestlers who do not reduce BM, it should be mentioned that the value of USG in wrestlers who do not use BM reduction is 1.026. The reference value for normal hydration is <1.020, so that the group that which did not report BM reduction was also in the state of mild acute dehydration. Wrestlers who do not practice BM reduction methods are often very close to the limit weight for their weight class, and therefore, due to the fact that by fluid intake they risk going into the higher weight class, such wrestlers also avoid fluid intake right before a competition which can be the reason for the mentioned results in their USG values. In terms of goal orientation towards the result (ego orientation goals), there was no difference between the two groups (reduction 3.33±0.49; no reduction 3.33±0.45). Evidently, all wrestlers who compete at National Championships are result oriented regardless of BM reduction. Ego oriented athletes are more likely to use “illegal” methods for achieving results (Duda and Saly, 1992). Although BM reduction is not an illegal method, it however does presents a way of gaining advantages over other opponents, as well as a type of rule manipulation (the rules require that the opponents should be equal in relation to their weight). Weight cycling is not an illegal strategy in combat sports, however, it is questionable both due to health and ethical reasons because it can present a perplexing factor in relation to goal orientation. Another reason for the above-mentioned results can also be the high level of homogeneity of the overall sample in this research. All the examinees have been in wrestling for over 10 years and as BM reduction represents a standard method in the sport, during the mention period wrestlers come to accept “weight cycling” as a normal and usual strategy (Khodaee et al., 2015). On the other hand, even though the results of the task variable demonstrate that there are no statistically significant differences between the two groups (reduction 3.30±0.71; no reduction 3.43±0.56), the no reduction group still showed higher results for this variable. The assumption is that the difference between the groups would have been statistically significant if it were not for the strongly homogeneous group of wrestlers. This study does not support the thesis that wrestlers who do not use BM reduction are much more goal oriented toward the assignment (task orientation goals), however, the assumption can be made that the mentioned hypothesis wold be confirmed in a less homogeneous sample. Due to the fact that weight cycling is considered a standard strategy, wrestlers might take the following standpoint on it: “Since heavier wrestlers are coming down to my weight class, I also must go down to a lighter weight class if I want to compete with equal opponents”. In the above-mentioned system of abnormal values, wrestlers who reduce their BM are only striving towards a fair fight and those who refuse to do the same are not ready to do everything it takes to succeed. This system of abnormal values can further result in goal orientation disorders (Schwartz and Sagiv, 1995) which can also be the reason why the tested groups showed no statistically significant differences.

Conclusion

This research was conducted with the aim to determine the differences between two groups of wrestlers (BM reduction before competitions or no BM reduction) in relation to their goal orientation type. As a result of this research, the conclusion can be made that there are no differences in relation to their goal orientation towards the result (ego orientation goals) or in their orientation towards the assignment (task orientation goals), even though the wrestlers who do not practice BM reduction are more task oriented. A high level of homogeneity or an abnormal value system are both potential reasons for the fact that the two groups showed no statistically significant differences. The BM reduction phenomenon in sports with weight classes requires further analysis, both from the psychological and sociological aspect, as the mentioned problem is widespread and includes numerous possible health complications.

References

1. Alderman, B., Landers, D. M., Carlson, J. & Scott, J. R. (2004). Factors related to rapid weight loss practices among international-style wrestlers. Medicine and Science in Sports and Exercercise, 36, 249-52.
2. Artioli, G. G., Franchini, E., Nicastro, H., Sterkowicz, S., Solis, M. Y. & Lancha, A. H. (2010). The need of a weight management control program in judo: a proposal based on the successful case of wrestling. Journal of the International Society of Sports Nutrition, 7.
3. Barcal, J. N., Thomas, J. T., Hollis, B. W., Austin, K. J., Alexander, B. M. & Larson-Meyer, D. E. (2016). Vitamin D and Weight Cycling: Impact on Injury, Illness, and Inflammation in Collegiate Wrestlers. Nutrients, 8, 15.
4. Choma, C. W., Sforzo, G. A. & Keller, B. A. (1998). Impact of Rapid Weight Loss on Cognitive Function in Collegiate Wrestlers. Medicine and Science in Sports and Exercise, 30, 746-749.
5. Degoutte, F., Jouanel, P., Begue, R. J., Colombier, M., LAC, G., Pequignot, J. M. & Filaire, E. (2006). Food restriction, performance, biochemical, psychological, and endocrine changes in judo athletes. International Joural Sports Medicine, 27, 9-18.
6. Duda, J. L. (1992). Motivation in Sport Settings : A Goal Perspective Approach. In: ROBERTS, G. C. (ed.) Motivation in Sport and Exercise. Champaign, IL. Human Kinetics Publishers.
7. Duda, J. L. & Saly, A. W. (1992). Goal Orientations and Beliefs About the Causes of Sport Success Among Elite Skiers. The Sport Psychologist, 6, 334-343.
8. Gann, J. J., Tinsley, G. M. & La Bounty, P. M. (2015). Weight Cycling: Prevalence, Strategies, and Effects on Combat Athletes. Strength and Conditioning Journal, 37, 105-111.
9. Horswill, C. A., Scott, J. R., Dick, R. W. & Hayes, J. (1994). Influence of rapid weight gain after the weigh-in on success in collegiate wrestlers. Medicine and Science in Sports and Exercise, 26, 1290-1294.
10. Karnincic, H., Baic, M. & Slacanac, K. (2016). Mood Aspects of Rapid Weight Loss in Adolescent Wrestlers. Kinesiology, 48, 229-236.
11. Khodaee, M., Olewinski, L., Shadgan, B. & Kiningham, R. R. (2015). Rapid Weight Loss in Sports with Weight Classes. Current Sports Medicine Reports, 14, 435-441.
12. Kiningham, R. & Monseau, A. (2015). Caring for Wrestlers. Current Sports Medicine Reports, 14, 404-412.
13. Lingor, R. J. & Olson, A. (2010). Fluid and Diet Patterns Associated with Weight Cycling and Changes in Body Composition Assessed by Continuous Monitoring Throughout a College Wrestling Season. Journal of Strength and Conditioning Research, 24, 1763-1772.
14. Nicholls, J. G. (1992). The General and the Specific in the Development and Expression of Achievement Motivation. In: Roberts, G. C. (ed.) Motivation in Sport and Exercise. Champaign, IL: Human Kinetics Publishers.
15. Pettersson, S., Ekstrom, M. P. & Berg, C. M. (2013). Practices of Weight Regulation Among Elite Athletes in Combat Sports: A Matter of Mental Advantage? Journal of Athletic Training, 48, 99-108.
16. Roberts, G. C. (1993). Motivation in Sport: Understanding and Enhancing the Motivation and Achievement of Children. In: Singer, R. N. & Muhphey, M. (eds.) Handbook of Research in Sport Psychology,. New York: Macmillian Publ. Company.
17. Schwartz, S. H. & Sagiv, L. (1995). Identifying culture specifics in the content and structure of values. Journal of Cross-Cultural Psychology, 26, 92–116.

18. Steen, S. N. & Brownell, K. D. (1990). Patterns of weight loss and regain in wrestlers: has the tradition changed? Medicine & Science in Sports & Exercise, 22, 762-8.
19. Wroble, R. R. & Moxley, D. P. (1998). Weight loss patterns and success rates in high school wrestlers. Medicine and Science in Sports and Exercise, 30, 625-628.
20. Zubac, D., Karnincic, H. & Zaja, M. (2016). Hydration status assessment among elite youth amateur boxers. Journal of Sports Medicine and Physical Fitness, 56, 731-736.

Authors note: Data in this paper is based on research for PhD thesis (unpublished and undefended at time of submission of paper) by Kristijan Slačanac, one of the authors.

ASSESSMENT OF TRAIT ANXIETY LEVELS ON ELITE JUNIOR AND U23 CROATIAN WRESTLERS

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Abstract

Purpose: Athletes are faced with competitive surrounding all the time where they are required to perform at high levels in high-pressure situations. This can often lead to anxiety so the aim of this study was to investigate levels of trait anxiety among elite, national team Croatian junior and U23 male wrestlers and to examine differences in trait anxiety between national team members in 2010 and 2017.

Methods: The study was conducted on two different groups of athletes, each tested at one time period (one group was tested in 2010 and the other in 2017). The participants were Croatian junior and U23 greco-roman national team members at the time when testing was conducted (N2010=16; N2017=9). We used a theory of competitive anxiety (Martens, Vealy, and Burton, 1990) and Croatian version of SCAT questionnaire (Sport Competition Anxiety Test, Martens,1977) to measure levels of trait anxiety in elite wrestlers. Descriptive statistics, as well as Mann-Whithey U-test, were used to examine the levels of trait anxiety and the difference between two groups of national team members.

Results: There was no difference in trait anxiety levels between members of junior and U23 wrestling national team in 2010 and 2017 suggesting these two groups experienced similar levels of pre-competition anxiety.

Conclusions: These results can help in further understanding which are the levels of trait anxiety for elite wrestlers.

Key words: *stress, high level, Greco-roman, national team*

Introduction

Sport represents competitive surrounding filled with stressful situations where athletes usually have to perform at optimum levels in high-pressure circumstances. This can, consequently, influence their performance. The common reaction to stressful situations is anxiety which can be defined as "negative emotional state characterized by nervousness, worry, and apprehension and associated with activation or arousal of the body" (Weinberg and Gould, 2011). Anxiety can be analyzed as trait or state and is viewed as a multidimensional construct made of the cognitive and somatic component. Martens, Vealy, and Burton (1990) defines state anxiety as "existing or current emotional state characterized by feelings of apprehension and tension and associated with activation of the organism", while trait anxiety can be described as "predisposition to perceive certain environmental stimuli as threatening or non-threatening and to respond to these stimuli with varying levels of state anxiety". Cognitive anxiety represents the mental component of anxiety which is caused by negative expectations about success or by negative self-evaluations while somatic anxiety refers to both physiological and affective elements which are developed directly from arousal in autonomic nervous system (Martens et al., 1990).

A theory of competitive anxiety (Martens et.al. 1990) suggests that sport competition is an evaluative process which creates some kind of uncertainty about the outcome before the actual competition has occurred. The greater this uncertainty and the importance of the competition is, the greater threat is perceived. This perception of the threat in competitive situations varies as a function of individual's previous experiences and qualities as well as their individual level of trait anxiety.

The idea of optimal anxiety states developed very early, when Spielberger in the 1960s first introduced the state-trait approach and concluded that both high and low levels of state anxiety interfere with performance (Spielberger, 1989), thus connecting this theory with optimal arousal theory. This tends to be true for somatic anxiety but not for cognitive because increasing this dimension of state anxiety usually result in performance decline (Weinberg and Gould, 2011; Cox, 1998). Research which further investigated temporal patterning of somatic and cognitive anxiety concluded that cognitive anxiety remains relatively stable prior to competition while somatic tends to rapidly increase as the start of the event becomes closer (Jones, 1995) and then decrease once performance begins (Martens et al.,1990). However, although the intensity of cognitive anxiety remains relatively stable prior to competition, frequency in which the athletes experience the symptoms of it increases substantially and progressively during pre-competition period (Swain and Jones, 1993). During the competition, it's levels can vary depending on subjective probability of success (Martens et al.,1990). Also, there is an argument that anxiety can have debilitating (harmful to performance) and facilitating (helpful to performance) consequences for the performance. This refers to "direction" athletes label the cognitive and somatic symptoms experienced as a function of interpreting the meaningfulness of experienced symptoms following earlier appraisal about the congruence between demands of the situation and the one's ability to meet them (Jones, 1995). This means that two athletes who are equally concerned and physiologically aroused prior to their upcoming performance can have completely different interpretations of those symptoms based on the perceived level of control, perceived level of ability to face this situation and goal attainment. This idea is confirmed in several studies such as the study conducted by Jones, Hanton and, Swain (1994), which found that elite performers interpreted cognitive and somatic anxiety as being more facilitative to performance than non-elite performers.

Although there are numerous theories and studies about competitive anxiety in sports, only a few of them are conducted on elite, national team wrestlers and none on Croatian wrestlers. Considering there are still some debates about desired levels of anxiety as well as the way anxiety influences performance, the aim of this study was to investigate levels of trait anxiety on elite male Croatian wrestlers. Furthermore, we wanted to examine whether levels of trait anxiety were different between junior and U23 national team members in 2010 and 2017. Generally, it is argued that knowing an athlete's level of trait anxiety can usually be helpful in predicting his reaction to competition, evaluation, and threatening situations (Weinberg and Gould, 2011).

Methods

The study was conducted on 25 male Croatian junior and U23 greco-roman national team wrestlers. First testing was conducted in 2010 when we tested the current members of U23 and junior national wrestling team (N=16). 7 years later, in 2017, we tested new current members of U23 and junior national wrestling team (N=9), so the study was conducted on two different samples. All the participants in both samples were members of Croatian national team at the time of the testing and some of them have won medals at European and World championships. The average age of all the athletes was M=19,4; SD= 1,607 (min=17; max=22). The athletes were actively wrestling for M= 9,6 years; SD= 2,466 (min=4; max=16). In 2010 we tested 16 national team members (age M=18,88; SD= 1,61; years of wrestling M= 9,88; SD=3,059). In 2017 we tested 9 different wrestlers, current members of national team (age M=19,68; SD=1,51; years of wrestling M= 9,437; SD=2,159). In order to measure trait anxiety, we used Croatian version of SCAT questionnaire (Sport Competition Anxiety Test; Martens, 1977). The questionnaire is designed to measure levels of trait anxiety in athletes and has 15 questions on which participant has to choose between three answers (rarely, sometimes, often). 5 of these questions are spurious statements added to reduce response bias and are not scored. Results can be ranged between 10 and 30, where higher results indicate higher levels of trait anxiety. Authors of the original version reported a high degree of reliability and good validity of the scale (Martens et al., 1990).

Results

In order to investigate trait anxiety levels of elite Croatian wrestlers, we calculated the result on SCAT scale for all participants (Table 1).

Table 1: Descriptive statistics for trait anxiety (N=25)

	N	M	SD	min	max
Trait anxiety	25	18,760	3,789	13	30

Within second research problem, we examined whether junior and U23 national team wrestlers in 2017 have different levels of trait anxiety compared to their 2010 colleagues. Based on the arithmetic means of the groups, we can see that 2017 group had lower levels of trait anxiety (M=17,67) compared to 2010 group (M=19,36) but non-parametric Mann-Whitney U test (Table 2) showed that these results didn't reach the level of statistical significance.

Table 2: Descriptive statistics for each group and results of Mann-Whitney U-test for trait anxiety

	generation	N	MR	M	SD	U	Z	P
Trait anxiety	2010	16	13,63	19,375	4,287	62	-,573	,598
	2017	9	11,89	17,666	2,549			

Discussion

The aim of this study was to investigate differences in trait anxiety levels between junior and U23 national wrestling team members in 2010 and 2017. Although the results suggest a slight decline in trait anxiety levels in 2017 sample, the results didn't reach the level of statistical significance suggesting that both groups have the same levels of general predisposition to perceive certain environmental stimuli as threatening and to respond to these stimuli with varying levels of state anxiety. Furthermore, results in our study showed that elite, national team wrestlers, have the levels of trait anxiety which are lower than those suggested in norms proposed by authors of the SCAT scale (Martens et.al. 1990, p.57-58). The norms are made on the sample of 239 wrestlers from youth sports and high school (M=20,91; SD=4,43) while the wrestlers in our sample represent the elite Croatian top level athletes which were current members of the Croatian national team at the time when the testing was conducted. Also, amongst them, there were some former and current World and European championships medalists.

Results on SCAT questionnaire in our study are also lower than those obtained by Gould, Horn, and Spreemann (1983) who conducted the study on 458 elite junior wrestlers (age 17-19; M=21,98; SD=4,40). Results in their study also showed that wrestlers who were low on SCAT (18 or below) rated themselves higher in perceived ability, predicted better result in the tournament, were more confident in their tournament prediction, worried in a fewer number of matches, felt that nervousness less often hurt their performance, had less trouble sleeping, and thought it was more important to their parents that they wrestle well, compared to wrestlers who was high on SCAT (26 or above). They also experienced less anxiety in the different time points before and during competition as well as when fighting against the toughest opponent. However, authors claimed that they found no difference in precompetitive and competitive anxiety between more and less successful as well as more and less experienced wrestlers. This should be further investigated on Croatian sample in future research.

According to Martens et.al. (1990), numerous research has concluded that athletes with higher levels of competitive trait anxiety tend to perceive competitive situations as more threatening than athletes with lower levels of competitive trait anxiety. It seems that individuals with high trait anxiety have some sort of cognitive bias which allows them to pick out more threat-related information (Weinberg and Gould, 2000). However, several theories suggest that some people perform best when their state anxiety is low, while some people prefer higher levels of state anxiety (Weinberg and Gould, 2011). This can also be different based on whether we are considering somatic or cognitive levels of anxiety. Based on the results of their study, Gould, Horn, and Spreemann (1983) concluded that elite junior wrestlers indicated that they became nervous in 66% of their matched and that this nervousness helped slightly more than it hurt their performance.

The research conducted on 1988 U.S. Olympic wrestling team (Gould, Eklund, and Jackson, 1992a, 1992b) found that, among other things, heightened arousal and intensity, as well as high confidence, were related to athletes' best performances while over and under arousal, irrelevant or negative thoughts as well as worries about losing were associated with worst performances. Eklund (1996) on his research of wrestlers found that low-level performances were associated with feeling listless and lethargic, moderate performance was associated with state described as normal nervousness while high levels of performance were associated with high levels of positive activation and intensity. Furthermore, competition anxiety can be interpreted as helpful of harmful to performance depending on the athletes' perceptions in the competition situation. Some recent studies even concluded that athletes can be taught to view anxiety as facilitative (Wadey and Hanton, 2008; Hanton and Jones, 1999a, Hanton and Jones, 1999b) with the training in basic psychological skills such as goal setting, self-talk, imagery, and relaxation. According to theories mentioned before, the training in athletes' perception of control and increasing self-confidence can also have a great impact on levels of perceived threat before the competition. These kinds of skills can successfully be trained and implemented in everyday practices using psychological skills training. In line with this suggestion is the fact that all the participants in this study who filled the questionnaire in 2017 stated that they would like to work with sport psychologist. It is also suggested that coaches should try to help athletes to view increased anxiety states as an indicator of readiness and excitement rather than fear (Weinberg and Gould, 2011).

Conclusion

The results of this study can help further understand the complex nature of pre-competition anxiety as well as how it influences the different level athletes. It is extremely useful to know which are the levels of anxiety in elite athletes from different sports in order to investigate which is the optimal level for that particular sport. It is important to further investigate this area comparing the elite level athletes to non-elite athletes in different sports as well as comparing the athletes from different sports, different age groups and between genders.

References

1. Cox, R.H., (1998). *Sports Psychology: Concepts and Applications*. 4th ed. WCB/McGraw-Hill.
2. Eklund, R.C. (1996). Preparing to compete: A season-long investigation with collegiate wrestlers. *The Sport Psychologist*, 10, 111-131
3. Gould, D., Eklund, R.C. & Jackson, S.A., (1992a). 1988 U.S. Olympic wrestling excellence: I Mental preparation, precompetitive cognition, and affect. *The Sport Psychologist*, 6, 358-382
4. Gould, D., Eklund, R.C. & Jackson, S.A., (1992). 1988 U.S. Olympic wrestling excellence: II Thoughts and affect. *The Sport Psychologist*, 6, 383-402
5. Gould, D., Horn, T., & Spreeman, J. (1983). Competitive anxiety in junior elite wrestlers. *Journal of Sport Psychology*, 5, 58-71
6. Hanton, S. & Jones, G. (1999a). The acquisition and development of cognitive skills and strategies: I. Training the butterflies to fly in formation. *The Sport Psychologist*, 13, 1-21
7. Hanton, S. & Jones, G. (1999b). The acquisition and development of cognitive skills and strategies: II. Training the butterflies to fly in formation. *The Sport Psychologist*, 13, 22-41
8. Jones, G. (1995). More than just a game: research developments and issues in competitive anxiety in sport. *British Journal of Psychology*, 86, 449-478
9. Jones, G., Hanton, S. & Swain, A.B.J. (1994). Intensity and interpretation of anxiety symptoms in elite and non-elite sport performers. *Personality and Individual Differences*, 17, 657-663
10. Martens, R. (1977). *Sport Competition Anxiety Test.* Champaign, IL: Human Kinetics
11. Martens, R., Vealy, R. S. & Burton, D. (1990). *Competitive anxiety in sport.* Champaign, IL: Human Kinetics
12. Spielberger, C.D. (1989). Stress and anxiety in sports. In D.Hackfort & C.D. Spielberger (Eds.), *Anxiety in sports: An International Perspective.* New York: Hemisphere.
13. Swain, A.B.J. & Jones, G. (1993). Intensity and frequency dimensions of competitive state anxiety. *Journal of Sport Sciences*, 11, 533-542
14. Wadey, R. & Hanton, S. (2008). basic psychological competitive anxiety responses: perceived underlying mechanisms. *Research Quarterly for Exercise and Sport*, 79, 363-373
15. Weinberg, R.S. & Gould, D. (2011). *Foundations of sport and exercise psychology.* 5th ed. Champaign, IL: Human Kinetics.

SPORTS ETHICS vs. FAIR PLAY

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Abstract

Fair play in the field of sport means: respect to *rules*, which constitute the basic guidelines in each sport and any competition, upholding the *sport spirit*, that is, respecting unwritten rules, which are generally equivalent to polite behavior manner of thinking and code of conduct embedded in values and presented in all life situations. It is the specific form of *life attitude* rent ideal of performance and productivity has damaged the validity and significance of the *fair play* principle. In performance-oriented sport, fair play or, in other words, conduct which respects the principles of politeness in sport, is sometimes considered a weakness, a redundant obstacle for the desired performance.

Undoubtedly, an extremely serious issue relating to sport ethics with implications for fair play is *doping*, first and foremost in top level performance-oriented sport. Drug addiction as a socio-pathological phenomenon and doping are closely related phenomena with a common historical background; however, their motivations are as a rule very different.

Key words: *fair play; top sport; leisure sport; violence*

Socially pathological behavior in and around sport is a phenomenon which can conventionally be considered immoral and undesirable for sport and society in general because it contains elements of a dangerous, even deviant behavior of athletes or spectators. The Czech sociological literature uses in this respect the general term "*hostility*" to denote expressions of hostile behavior connected with aggression. In this context it is also useful to mention hidden forms of hostile behavior such as *hazing* as a way in which one can gain control or power over another person or certain advantages, mostly in direct communication and through physical or psychological mistreatment.

In sport, such behavior is a gross violation of the fair play principles because it is aggressive, often illegal, but tolerated and frequently deliberately supported. Also in sport the victims of hazing usually are individual with some king of handicap. Feelings of superiority and envy may create situations when weaker players are humiliated while at the same time elitist manners are fostered in the stronger or more successful ones. Hazing stands in sharp contrast to the feeling of safety, which is an indispensable factor necessary for the integration of the inalienable rights of all participants in sport. Hazing largely undermines the physical and psychological resilience particularly of young athletes. Taunting and persecution of a "rookie" by team mates or even coaches may be especially hurting and have highly negative impacts.

The examples of sport-related brutality, which is linked to sport sectarianism and sports crowd psychology and for which "flag bearers" as the most ardent fans are responsible, indicate what practices could by used by a *crowd deprived of rationality* if it held a real power.

The negative tendencies in sport and their consequences on the morals of a society are newly studied also by *sports ethics* which also points out the already mentioned fact that contemporary society values performance in which the stress is on quantity and that "the ethical dimension of an athlete was pushed aside as something that cannot be measures" (Hogenová, 1997, p. 105). Sports ethics is a set of norms generally accepted in the top level performance-oriented sport as means for achieving maximum success and as an expression of identification of the top level athlete who is fully devoted to the values of performance, victory and reward. In practice, so defined ethical dimension is manifested in sport on the part of the top level athlete as follows (Coakley, 2001, pp. 146–147):

- athlete is ready to sacrifice his or her non-sport interests to the imperative of success in sport and unconditionally accepts the demands of the competition
- priority is given to the effort to achieve quality, fame and success
- acceptance of risks and the possibility of injury, health damage and pain in the name of success in sport
- unlimited success – sport is viewed as a domain where everything is possible if an individual is willing to give it what it takes to reach the highest goals

In relation to the current developments in sport the following questions may be asked: Why does top level competitiveness dominate over simple pleasure from physical activity? Why do we prefer maximum physical performance to universal development of the body? The reason probably is that the human body becomes a form of merchandise marketable on the mass culture market. The culture of sport, with its positive and negative aspects, profits and loses and the obsession with extreme performance, is deprived of the individualized alternative of physical movement which in itself is a goal, not means to achieve further goals by way of a narrowed single-purpose specialization. Sports sciences are thus confronted with increasing urgency with the category of "sports ethics". Ethics in sports is not some isolated abstract academic concept. It reflects how sport actually works and the practices current used in it. These practices, together with the highly sophisticated sports sciences, are the requirements for and also the consequences of the achievement of maxi- mum results "at all costs" in top level sport.

Extreme demands and goals coming along with the adoption of the principles of sport ethics require the application of extreme measures to achieve such goals: cheating, specific nutrition practices and use of prohibited stimulating preparations. In practise this gives rise also to the never ending debates on the nature, admissibility or *perspectives of doping* not only on the top levels of sport. Moreover, sports sciences as well as practical sport will probably have to deal with gradually crystallizing phenomenon of genetic engineering which the World Anti-Doping Agency (WADA) has included in its agenda with full seriousness.

As a rule, the issues of the possibilities and boundaries or extreme limits of the human body are presented through the prism of medicine and psychology, while the no less important social aspects are off the center of attention. The Olympic motto "*Faster, Higher, Stronger*" contains an implicit assumption of imperfection which must always be improved: athletes have to indefatigably strive for perfection and it is their duty to try to outperform themselves. In close cooperation with coaches and sport sciences, they are required to strictly respect the principle of an effective performance-oriented model of training. This leads to the creation of a *sports-industrial complex* containing a structural, institutional, ideological and cultural dimension (Maguire, 2005, p. 162), which includes the key entities such as national agencies, international corporations, non-governmental organizations and sport associations. As regards its institutional base, there are at least three key pillars: sports medicine, practical implications of sports sciences, and regional/national top level sport centres. A science-based preparation of coaches and the application of miscellaneous information provided by sports sciences and sports medicine contribute to the achievement of "success" in sport. In this respect, there were opinions appearing particularly during the 1980's that international sport was ruled by the "iron laws of totalization", meaning that increasingly higher demands were placed on athletes in the competing dominant political systems.

The fundamental imperatives and norms of contemporary top level performance-oriented sport can also be identified in other areas where the primary value is an extreme dedication to a certain matter or goal. These are situations in which the unrelenting desire for the perfection of a maximum performance is accompanied with the willingness to take risks, repeatedly overcome obstacles, endure pain and hardships, and pursue tirelessly and with persistence one's dream. It is this extreme *conformity* to the ideas presented by contemporary top level sport as the highest goals what makes sport such a unique and fascinating activity and such a singular form of spectacle. However, problems arise when the fundamental norms defined by sports ethics are even in their extreme forms adopted and accepted uncritically, without asking any questions, without critical evaluation and consideration and without setting any limits, particularly the natural limits of the human body.

Probably the most extreme form of sport ethics and method of achieving success in sport is the Chinese *juguo tizhi* – a system of training of top level athletes which is based on uncompromising military practices emphasising "strictness, discipline, intensive training and real fight exercises". They are also trained in getting rid of concerns or fears of suffering, difficulties and injuries, and there is also focus on the resilience of spirit and body, skills, training and competition (Hong Wu Xiong, 2007, p. 17).

More and more often, the critics of contemporary top level sport point out that the cur- rent ideal of performance and productivity has damaged the validity and significance of the *fair play* principle. In performance-oriented sport, fair play or, in other words, conduct which respects the principles of politeness in sport, is sometimes considered a weakness, a redundant obstacle for the desired performance. What is forgotten in this context is the idea of Olympism which goes beyond fair play no only with its stress on respecting of rules but also by carrying values such as friendship, recognition of other person's uniqueness and, above all, the wide concept of *sport spirit*. B. Hodaň correctly states: "It is a way of thinking, not only behavior" (Hodaň, 2000, p. 10). It is a concept that includes the aversion to cheating, doping, physical and verbal violence, inequality of chances, corruption and excessive commercialization and respect to the rules of a sport contest. In this sense, *fair play* means:

- respect to *rules*, which constitute the basic guidelines in each sport and any competition
- upholding the *sport spirit*, that is, respecting unwritten rules, which are generally equivalent to polite behaviour
- manner of thinking and code of conduct embedded in values and presented in all life situations as *life attitude* (Hodaň, 2000, p. 10).

What makes the topic of sports ethics even more interesting is the fact that participation in sport is voluntary and that participants in sport voluntarily accept the relevant rules and principles. Hence sport, as a significant socialization environment, by fostering the fair play principle should contribute in its specific way to the harmonization of interpersonal and social relations.

Top level sport contributes, in a specific and relativized manner, to the creation of the social criteria of *success, wealth and prestige*. In this context one can observe another impact of the interrelatedness of top level sport and the mass media: increasingly more space in sport news is given to striking headlines and loud comments regarding the commercial side of the *transfers of sport celebrities* from one sport club to another. A Czech sport enthusiast is thus immediately and accurately informed by the TV, radio and press on all the details, above all the financial and possibly other aspects, of exclusive contracts of Czech ice hockey, football, basketball or volleyball players particularly those who play abroad (the more so if they play overseas, let alone the Russian clubs which currently are most interesting commercially). Of course, the same goes for Czech coaches.

Adoration of top level athletes by the media is evident in the content of entertainment magazines or the entertainment supplements of many popular dailies. The life style of top level sport celebrities is depicted also in interviews or tendentious enquiries, which also reflect, directly or indirectly, intentionally or unintentionally, the diversity of the values professed by sport idols and which provides at least a partial insight into the principles of the media-presented top level sports and sport idols. Naturally, with regard to the nature of sport models and, in this context, also value models.

The common denominator of the top level media-admired sport celebrities is *success, wealth and physical beauty*. These individuals are presented to the public as virtually unattainable model which, however, is admirable and worth following. They constitute one of the indispensable pillars of top level sport based on the achievements of success at all costs and on an incessant satisfaction of the public demand for stunning performances beyond the limits of the human organism. It is the interplay of these attributes what draws the *attention of mass media, sponsors and general public*. Only so defined sport may bring all the stakeholders – sponsors, marketing and advertising agencies, the media as well as athletes – such wonderful profits.

Also in sport, the consumption-oriented market culture today is linked to the growth of individualistic narcissism, obsession with authenticity and blind admiration of celebrities and obsession with consumption. From the perspective of sport celebrities and the values of a consumption-oriented society, these are in fact two sides of one coin. *Sport celebrities* frequently catch the attention of mass audience not by their performance or acts, in the first place, but by their media image which is a product of the changing world of unstable values and relativized moral principles. What is more, the desire to keep the attention of the audience and retain all the privileges of popularity leads to the use of negative promotion as well: “To be hated means to be more real and ubiquitous. To be deviant means to be unforgettable” (Blackshaw & Crabbe, 2004, p. 75). The principle “to be hated is better than to be forgotten” applies to sport celebrities as well: the highly controversial boxing phenomenon Mike Tyson or the “unstable” football idol Diego Maradona definitely know better than anyone!

The increasing interconnectedness of some top level sports with mass culture point to the complexity and therefore the inconsistency of the two notable phenomena of contemporary society. Both, elite top level sport and mass culture apply the common denominator of entertainment, excitement and sensationalism. They create images of “other world” which is miles away from the real everyday world, in terms of values. Through electronic media, they attract huge masses of indirect audience and enter with great effect the domain of advertisement. In the incessant cycle of mass entertainment, sport audience becomes part of the *market mechanism* of supply and demand.

The risks of negative effects of sport are necessarily considered also in connection with the already mentioned process of *commercialization of sport*, a phenomenon that has been on the increase since the 1980’s. Market mechanisms gradually affect each aspect of sport. Being massively advertised by the media, “*fitness industry*” changes the usual understanding of terms like exercise, fitness activities and health. Attendance to specialized fitness facilities is increased by the publication of expert manuals and guidebooks. Physical regeneration thus very often becomes a highly organized market-regulated process. What is worse, however, that it sometimes involves the use of health damaging and performance and muscle growth stimulating preparations. *Doping* in recreational sport in the name of “body shaping” which copies the models of masculinity and femininity presented in actions films or magazines thus becomes a pressing health issue, even in comparison with the doping in top level sport (Nekola, 2000, pp. 18–21). It has also been observed that in market-oriented societies, sport participation necessarily leads to the estrangement of athletes from their own body. The *medicalization of sport*, which is related to doping, is a consequence of the situation in which the human body is seen primarily as a technical instrument or means for the production of a maximum sport performance and energy. The body no longer is a source of pleasant feelings and self-fulfilment – self-satisfaction is derived not from a simple enjoyment of physical activity but from performance and results achieved in competition (Hodaň, 2000, pp. 31–32).

This dark side of sport in contemporary society together with the phenomenon of hostility forms the separate chapter of socio-pathological behavior in sport which stands out particularly in confrontation with the original ideals of modern Olympism.

The dynamic development and changes in sport is also driven by the increase in the significance of professional sport through mass media. Sport, physical activities and the *culture of the body* are used as metaphors for a wider area of social values. Hence, the advertising industry, when promoting especially non-alcoholic beverages or sport equipment, uses media-attracting sport events and plays on national sentiment.

The relationship to the broad domain of sport is also reflected in the changeable and constantly relativized values. The values, as subjective guiding principles co-determining individual's orientation in his or her activities, that are directly or indirectly associated with sport are harmony, elegance, athletic body, performance or resilience. This simplified and distorted relationship between sport activities and values thus leads to ambiguous and confusing practical consequences. A reasonable and critical assessment may generate a positive impulse and motivate an individual to start to engage in various forms of physical activities. On the other hand, masses of passive consumers of media broadcast sports are lost in an idle waiting for a positive change which, however, will never come because even sport celebrities had to pay a high price for their success in the form of hard systematic physical activity.

The progressing individualization of sport where emphasis is placed on physical fitness, the impact of government regulation of physical education and sport, and its medialisation and politisation is manifested in a number of ways. These processes are present to a different degree in individual sport disciplines, recreational forms of exercising and can also occur in connection with individual sport events. The nationalistic aspects of top level sport events could be observed in 2002 in Moscow during a public screening of matches which was accompanied by an unusually high level of vandalism. There was even a murder committed during this event. There was also another unprecedented situation: during the 2002 football championship, when the U.S. national team was eliminated from the tournament, Americans were seriously called on to boycott South Korean goods for a period proportionate to the number of goals scored by South Koreans!

From the market-regulated media sector, top level sport enters the realm of politics and stretches into the domain of consumer market. Where exactly the original mission of sport is lost on this complicated and controversial path is difficult to say. Partially this may be explained by stating that the increasing interest in spectacular sport events broadcast by the media leads to the increase in passive consumption of sport at the expense of actual participation in any leisure sport activities. It is hardly possible to acknowledge the hypothesis of a direct correlation between the volume of sport programmes broadcast by electronic media and actual participation in real sport activities. An activity as time-consuming as watching of sports may, ironically and contrary to the logic of the matter, become an obstacle to an active participation in physical activities and sport.

An important aspect of the top level sport is the need to keep meticulous account of victories and records. Ancient Olympic Games which were based in an oral culture placed emphasis on rituals, ceremonies, physical fitness and spectator participation, but kept no account of the best results or records. Conversely, the contemporary obsession with records assumes that the performance will be carefully measured, accurately recorded and published. Written culture also accents lists and dates of sport events, autobiographies of athletes, or interviews with important figures of sport. The normative principles of ethics give way to a colorful depiction of a specific sport event whit the stress on action, performance and mass attractiveness. Competition in sport does not leave much space for a strict adherence to ethical norms. Instead, significance is attributed to a system of rules and regulations determining the line between what is and what is not permitted. This creates opportunities for a subjective interpretation of the rules of a game in a particular game situation where the rules are understood differently by different parties and therefore different sanctions are expected.

Increasing professionalization of top level sport brings better training, higher performance, and stress on speed and action. So there is an increase in the importance of an offensive, aggressive playing style when each member of a team at the same time accepts more and more responsibility for the course of a match. But game rules do not define exactly the essence or spirit of a game. As a rule the goal of a game to the gain advantage over the opponent in order to achieve victory. One can also fine many examples of significant changes in rules adopted in the course of time, for instance in athletics where technical innovations of style and material (e.g. the Fosbury flop in high jump, use of laminate poles, etc.) or training methods provide advantages where it was possible to apply such changes as effectively and quickly as possible. In most situations the following statement applies: "In ordinary situations, athletes compete under the same conditions as their rivals, however, they egocentrically look for the most favorable situation that can provide an advantage" (Gebauer, 2012, p. 1).

Undoubtedly, an extremely serious issue relating to sport ethics with implications for fair play is *doping*, first and foremost in top level performance-oriented sport. Drug addiction as a socio-pathological phenomenon and doping are closely related phenomena with a common historical background; however, their motivations are as a rule very different. Drugs are taken either as a sort of a painkiller and, more often, as an expression of the inability to cope with the real world from which an individual wants to escape at least for a while. Doping, that is, the use of prohibited performance stimulating preparations, especially in top level performance-oriented sport, fundamentally breaches the written as well as unofficial rules of performance is achieved in sport, which rules apply to all participants. Due to its complexity, this problem concerns not only athletes, but also their coaches, sport managers and, above all, physicians whose interest is to develop illegal performance stimulation means that would be as far ahead of the existing methods of doping detection as possible. In connection with this moral issue, questions are asked of how this matter was dealt with in the past, what anti-doping means and instruments are available today and what other possible forms of violating the fair play principle may be expected in future. In addition, at the university level of sport pedagogy this issue is discussed and examined marginally, as a phenomenon which definitely is contemptible but which is view as a "necessary evil" from the perspective of an effective prevention. Ethical, philosophycal, psychological, sociological or economic studies, articles or debates continue to stay out of the centre of attention and become a topic only in connection with high-profile cases of doping particularly during the Olympic Games, the most prestigious bicycle races or track and field contests. What is still missing is a systematic interdisciplinary approach accenting generally recognized moral principles, aiming to clearly identify the sources of this vice in sport and defining a non-compromising repression policy. One thing, how- ever, becomes clear: in the cultural domain of which the Czech Republic is part, the top level sport with all the grand events, impressive performances and extraordinary personal careers, is part of a world where social recognition is among the highest personal ambitions and where performance is the decisive criteria of success. And even in sport, where this principle works most justly, it may be a "performance at all cost", including prohibited means such as doping or unfair behavior. This runs counter to the fair play principle, meaning the openness of a competition under the same strict conditions and respect to the binding conditions of a tournament.

Sport as a phenomenon having the potential to offer many socially positive possibilities and opportunities is based on recognized positive values. Therefore public recognition and political support should only be given to an attractive and demanding sport fair in every respect, satisfying individual as well as collective interests and also contributing to the cultivation of population along the lines of the humanistic ideas of a democratic society.

Reference

1. Blackshaw & Crabbe, 2004. *New Perspective on Sport and "Devioance".* London: Routledge.
2. Coakley, J. (2001). *Sport and Society: Issues and Controversies.* New York: McGraw-Hill. 2001,
3. Gebauer, G. (2012). Citius-Altius-Fortius and the Problem of Sport Ethics: a Philosopher's View- point. *Play Fair (Academic Supplement). The official publication of the European Fair Play Movement.* Issue No. 9, 2011/2–2012.
4. Hodaň, B. (2000). Fair play: teorie a skutečnost. *Fair Play v postmoderním světě.* Olomouc, Czech
5. Republic: Hanex, 231–235 Hogenová, A. (1997). *Etika a sport.* Praha, Czech Republic: FTVS UK.
6. Hong F; Wu, O.Wu Xiong, 2007. Beijing Ambitions: An Analysis of the Chinese Olympic Sports systém and its Olympic Strategy for the 2008 Olympic games. *Modern Sport: The Global obsesion.* Lomdon: Routlůedge.
7. Maguire, J. (2002). Sport and Globalization. *Handbook of Sport Studies.* London: Sage.
8. Maguire, J., & Falcous, M. (2005). Making touchdowns and hoop dreams. *Power and global sport. Zones of prestige, emulation and resistance.* New York: Routledge. Nekola, J. 2000. Doping a sport. Praha: Olympia.

THE ATHLETIC RATING SYSTEM FOR ATHLETES IN GAMES, SPORT, AND CONTESTS: A THEORETICAL MODEL TO QUANTIFY FIVE COMMON FACTORS IN SPORT

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Abstract

The purpose of the study was to create a model and too measure five theoretical constructs developed from the literature to help students better understand that all games, sports, and contests have a structure that can be defined by the rules that govern the activity, the performance factors that lead to successfully play, and to demonstrate that the five common factors inherent to all games, sports, and contests can be quantified. The five inherent factors include; the level of *play* in a sport, the level of *physical effort* required to perform the sport, the level of *athleticism* needed to perform the sport, a measure of the *union with equipment* and or a *mastery over the environment* needed to perform the sport, and a level of *strategic cognition* needed to perform the sport successfully. To measure the above factors, a theoretical model entitled *The Athletic Rating System for Athletes in Games, Sport, and Contest* was devised. Students from eight section of a core kinesiology majors' course entitled; The Socio-Cultural Dynamic of Kinesiology were surveyed. Each section surveyed produced a composite mean score for the 25 sports evaluated in the study. Descriptive statistics measuring the composite scores were then used to rank order the sports. The results demonstrated that the model could differentiate between sports, however, the variance between section mean composite scores may indicate a lack of knowledge subjects (n=110) had on such a large variety of sports, many of which are given little exposure in the United States. This limiting factor could be overcome in a future study if the design of the study would limit subjects to athletes in their respective sports.

Introduction

The purpose of the study was to create a model and measure five theoretical constructs common to all games, sports, and contest for athletes. The common factors are; levels of *play* in a sport, the level of *physical effort* needed to perform the sport, the level of bodily excellence or *athleticism* needed for the sport, a measure of the *union with equipment* and or a *mastery over the environment* for the sport, and a level of *strategic cognition* required to successfully perform the sport. The primary purpose of the model was to help kinesiology majors understand that all sports have a structure and that the common factors that characterize all games, sports, and contests can be quantified and measured. A preliminary study to test the model was conducted using student enrolled in a Kinesiology majors' course entitled*, The Socio-Cultural Dynamic of Kinesiology* at Penn State University over an eight semester period. All the students taking the survey were presented the philosophical background needed to understand the five factors presented in the survey.

Philosophical background

The concept of *pure play* (Huizinga, 1950) is described as a free activity, standing quite consciously outside "ordinary life", as being "not serious", but at the same time absorbing the player intensely and utterly. It is an activity connected with not material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules in an orderly manner. Pure play emphasizes the process through the play, not the outcome of the play.

Games, sports, and contests (Weise, 1969) defined these forms of activity as requiring concerted physical effort, bodily excellence (athleticism), a union with equipment and or a mastery over the environment, in a situation that is competitive and tests the player both physically and mentally **-** strategic cognition.

Weise, also states that the difference between a game having the above characteristics and a sport is that a sport has a historic set of rules codified over time. The first game of basketball played in 1891 was not a sport until an historic set of rules was codified for it over time.

A contest can be a sport but unlike a game where players have a role and often have built in periods of relaxation, a contest demands that an athlete completes a task rather than fills a role, and a contest rarely provides pleasure or fun. Running a marathon is a contest where basketball is a game.

Description of common factors for games, sports, and contests

Play: Because games, sport, and contests have an element of play associated with them, we are said to be playing in a game, sport or contest. Play in games, sport, and contests can range from the joy of play by a child or low level amateur to the play in a sport of a professional athlete approaching the concept of work.

Physical Effort: In all games, sports, and contests, a level of physical effort is required to perform the sport successfully. The level of the physical effort however may vary greatly dependent of the nature of the sport.

Athleticism: Athleticism can be described as the ability to move at a high level of athletic performance characterized by exhibiting strength, power, speed, agility, endurance, flexibility, and coordination of the movement within the sport or physical activity. A ballet dancer can exhibit athleticism but because they are not performing in competition, they are not playing in a game, sport, or contest.

Union with Equipment and/or Mastery over the Environment: Many games, sports, and contest require a high level of mastery over equipment used for the sport or in some cases a mastery over both the equipment and the environment. Sports like indoor bowling and rhythmic gymnastics require a high level of mastery over the equipment used, whereas, sports like golf, skiing, and sailing require a mastery over both equipment and the environment.

Strategic Cognition: Strategic Cognition (Swalgin, 2010) is the ability to make strategic decisions within the context of playing a sport that leads to successful play. Due to the nature of some sports; these strategic decisions must be made in the course of play, many times at split second speed, i.e. basketball, hockey or association football/soccer. Some sports however can allow for much greater strategic consideration, i.e. golf. Whether in the flow of a contest, between set plays in American football, or between shots in golf, most situations require a high level of strategic cognition to be successful.

Method

Over eight semester students from sections of a core kinesiology major' course entitled; *The Socio-Cultural Dynamic of Kinesiology* were asked to use *The Athletic Rating System for Athletes* see Appendix A, to grade athletes in 25 sports or contests on the five common factors established from philosophical constructs established in the literature presented in the course. The factors include; level of play, physical effort, athleticism, union with or mastery over equipment/ environment, and strategic cognition.

In each section of the course, students were put into groups of four to five with both genders presented in each group; this so that each genders perspective could be represented. Students were instructed to come up with a consensus score on each of the common factors for each sport. The five common factor scores for each sport were then used to determine a mean score for the sport in respective groups. The mean scores for each group were then combined to establish a class scores for each sport. Within the eight sections, subjects (n=110) used this method to establish scores, the scores were then use to establish descriptive statistics for each sport.

Limitations of the Study

The study was limited partially due to the knowledge base of the subjects who may have had an in-depth knowledge of their own sport, but not all of the 25 sports presented to them in the study. Also, sports not commonly played in the U.S. would be even more problematic as they would have very little exposure to them, such sports as team handball, water polo, and cycling are examples. Another limitation related to the knowledge of the subjects, is that many of the sports presented required knowledge of a particular position within the sport. For example, two positions for American football were presented; one position quarter back (QB) is a highly visible position and most students understand what it takes to be a successful QB in American football. For the position of a football lineman however, the position is much more obscure and few students would understand the position unless they played it.

Data Analysis

In Table 1, the group composite mean scores for the eight sections are presented for the 25 sports rated by the students subjects (n=110). The sports are presented in alphabetical order. The survey entitled *The Athletic Rating System for Athletes in Games, Sports, and Contests* was used to grade each of the five common factors for each sport. See Appendix A. In Table 2, descriptive statistics are presented for each sport in rank order of the high composite score for each sport. Here, as it might be expected, some sports like lacrosse (M=37.83, SD=1.97) that are familiar to American subjects have a low standard deviations indicate little variance between the groups, and may indicate a higher level of knowledge for the sport and position that was rated. In other sports such as cycling (M=32.94, SD=4.41), the standard deviation shows greater variance between group and may indicates a lower knowledge of the sport related to the five common factors.

Table 1: Group Composite Mean Scores by Section
The Athletic Rating System for Athletes in Games, Sports, and Contests

	Sport	Section 1 (n=30)	Section 2 (n=10)	Section 3 (n=14)	Section 4 (n=10)	Section 5 (n=16)	Section 6 (n=5)	Section 7 (n=10)	Section 8 (n=15)
1	American Football (lineman)	33.5	27.7	27.0	21.3	25.0	26.5	30.0	23.3
2	American Football (quarter back)	35.3	35.7	34.0	33.0	33.8	36.5	32.3	35.7
3	Archery	29.3	27.7	25.7	31.3	28.8	34.0	26.3	32.8
4	Baseball (shortstop)	31.3	31.3	31.0	33.0	31.5	30.0	32.0	34.5
5	Basketball (small forward)	34.0	38.0	37.0	33.0	40.3	33.5	36.3	36.3
6	Boxing	35.5	35.1	34.0	36.0	34.0	30.0	30.3	32.8
7	Cycling (tour de France)	35.0	31.8	31.3	39.3	32.6	38.2	26.3	29.0
8	Field Hockey (mid field)	31.8	35.8	33.0	41.7	35.0	35.0	33.6	34.0
9	Figure Skating (individual)	37.0	37.3	33.3	35.7	37.5	31.5	30.3	35.0
10	Golf	31.5	31.2	33.3	28.3	32.0	32.0	29.6	34.0
11	Gymnastics (all around)	36.3	41.9	36.7	37.3	41.0	29.5	33.0	32.8
12	Ice Hockey (center)	35.3	32.0	34.7	39.0	41.8	35.5	34.6	38.5
13	Javelin	26.3	23.2	26.7	27.3	26.3	34.5	28.3	30.0
14	Lacrosse (mid field)	35.3	38.0	37.3	39.7	41.0	37.5	35.3	38.5
15	Marathon	27.5	26.0	23.0	27.7	22.8	26.0	24.0	25.3
16	Polo	29.3	29.0	28.7	34.3	30.0	29.5	28.3	32.0
17	Ski Jumping	32.8	32.9	31.6	36.3	33.0	30.5	31.3	33.0
18	Snowboard (halfpipe)	35.8	35.9	35.7	36.3	36.0	27.5	35.0	34.5
19	Soccer (mid field)	35.5	37.0	38.0	40.7	37.5	31.0	36.3	37.5
20	Swimming (10,000m)	31.8	30.3	30.0	32.7	28.8	34.0	27.0	30.8
21	Team Handball	29.0	33.3	27.3	34.7	26.5	31.5	26.0	28.3
22	Tennis (singles)	32.8	34.7	35.3	39.0	36.3	34.0	34.6	34.8
23	Water Polo	37.5	36.3	33.7	40.3	32.5	39.5	32.0	33.3
24	Wrestling	31.3	32.0	34.7	31.0	29.5	30.0	32.0	29.5
25	X-Country Ski (biathlon)	32.8	32.0	35.0	35.33	36.3	38.0	32.6	27.3

Table 2: Descriptive Statistics for each Sport in Rank Oder

	Sport	N=Sections	Mean	St. Dev.
1	Lacrosse (mid field)	8	37.83	1.97
2	Soccer (mid field)	8	36.69	2.76
3	Ice Hockey (center)	8	36.42	3.11
4	Gymnastics (all around)	8	36.06	4.21
5	Basketball (small forward)	8	36.05	2.48
6	Water Polo	8	35.63	3.23
7	Tennis (singles)	8	35.18	1.84
8	Field Hockey (mid field)	8	34.99	2.99
9	Figure Skating (individual)	8	34.70	2.74
10	Snow Board (half pipe)	8	34.59	2.92
11	American Football (quarter back)	8	34.54	1.48
12	X-Country Ski (biathlon)	8	33.66	3.30
13	Boxing	8	33.46	2.28
14	Cycling (tour de France)	8	32.94	4.41
15	Ski Jumping	8	32.68	1.74

16	Baseball (shortstop)	8	31.83	1.38
17	Golf	8	31.49	1.85
18	Wrestling	8	31.25	1.72
19	Polo	8	30.14	2.02
20	Team Handball	8	29.57	3.24
21	Archery	8	29.48	2.99
22	Swimming (10,000m)	8	29.42	3.76
23	Javelin	8	27.83	3.32
24	American Football (lineman)	8	26.79	3.81
25	Marathon	8	25.28	1.88

Recommendation and Conclusions

The purpose of the study was to create a model based on five theoretical constructs developed from the literature to help students better understand that all games, sports, and contest have a structure that can be defined by the rules that govern the activity, the performance factors that lead to successful play, and a qualitative understanding of the five common factors that are inherent to all sport. The model demonstrated that with the use of *The Athletic Rating System for Athletes in Games, Sport, and Contests*, the five common factors could be quantified to produce scores that helped to define each sport's structural characteristics. In this study however, the knowledge base of the subjects was a limiting factor when asked to judge such a wide range of sports. A better design would be to survey athletes in their respective sports as they would have a more complete qualitative understanding of each of the five common factors being rated. This approach would produce score for each sport that may be more reliable and valid when tested. This study demonstrates that a model can be created to help students understand the structure of any sport and quantify the five common factors that characterize all sport. However, the data collected in this preliminary study are problematic due to the knowledge base of the subject.

Bibliography

1. Huizinga, J. (1955) Homo Ludens*, a study of the play elements in culture*. Boston. MA, Beacon Press
2. Weiss, P. (1969) Sport: *a philosophic inquiry*. Carbondale, Ill., Southern Illinois University Press
3. Swalgin, K. (2010) Unpublished lecture entitled; Strategic Cognition, a lecture on a theoretical
4. model to quantify the five common factors in sport, games, and contests.

Appendix A
The Athletic Rating System for Athletes in Games, Sports, and Contests

Work 1 2 3 4 5 6 7 8 9 10 Play

Least Physical Effort 1 2 3 4 5 6 7 8 9 10 Most Physical Effort

Least Athleticism 1 2 3 4 5 6 7 8 9 10 Most Athleticism

Least Mastery over Equip/Env 1 2 3 4 5 6 7 8 9 10 Most Mastery over Equip/Env

Least Strategic Cognition 1 2 3 4 5 6 7 8 9 10 Most Strategic Cognition

	Sport	Play	Physical Effort	Athleticism	Mastery Equip/ Env	Strategic Cognition	Total
1.	American Football (lineman)						
2.	American Football (quarterback)						
3.	Archery						
4.	Baseball (shortstop)						
5.	Basketball (small forward)						
6.	Boxing						
7.	Cycling (tour de France)						
8.	Field Hockey (mid field)						
9.	Figure Skating (individual)						
10.	Golf						
11.	Gymnastics (all-around)						
12.	Ice Hockey (center)						
13.	Javelin						
14.	Lacrosse (mid field)						
15.	Marathon						
16.	Polo						
17.	Ski Jumping						
18.	Snow Boarding (halfpipe)						
19.	Soccer (mid field)						
20.	Swimming (10,000m)						
21.	Team Handball						
22.	Tennis (singles)						
23.	Water Polo						
24.	Wrestling						
25.	X-Country Ski (biathlon)						

CONSTRUCTING THE ATHLETIC INJURY SOCIAL SUPPORT SCALE

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Abstract

Purpose: Injuries are known to have negative effects on various physiological aspects of athletes. Injuries can also be detrimental to the psychosocial functioning of athletes because they engender anxiety concerning the ability to continue doing sports, or about the loss of position in the team hierarchy, or a future role. In order to examine effective psychological interventions for injured athletes, it is necessary to develop a scale for assessing social support received by injured athletes. The purpose of this study was to construct an “Athletic Injury Social Support Scale” (AISS-S) to assess social support received by injured athletes.

Methods: Athletes (N = 180) that had experienced an athletic injury (Mean age = 20.27 years, SD = 1.02; Mean days required for complete cure = 30.62 days, SD = 22.43 days) participated in this study. They were asked to complete a provisional version of the AISS-S that was developed based on open-ended question items and by testing for content validity by physical therapists.

Results: Item discrimination power of the provisional AISS-S (12 items) was confirmed by Good - Poor analysis and Item - Total correlation analysis. Then, Exploratory factor analysis was identified “Listening, sympathy and acceptance (4 items)”, “Offering advice on rehabilitation information (4 items)” and “Social respect and acceptance (4 items)” as three factors of the provisional AISS-S. The fit indices of the three-factor model by Confirmatory factor analysis were χ^2 (51) = 130.783 (p = .000), GFI = .897, CFI = .949, and RMSEA = .093. The Cronbach’s alpha was used to assess the internal consistency of the scale, which confirmed the reliability of the scale (α = .85―.91).

Conclusion: AISS-S is a reliable and valid scale composed of three subscales.

RELATION BETWEEN PERSONAL CHARACTERISTICS AND EXPERIENCE OF BULLYING AMONG ATHLETES AND NON-ATHLETES ADOLESCENTS

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When determining the influence on behavioral problems of children, researchers have found that the temperament of its biological basis reflects the sequence of behavior and personality and emotion predicts, among other factors, the performance behavior of a personality, psychopathology and personality traits forecasts (Compas, Connor–Smith, Jaser, 2004). Also, a correlation was found between temperament and character of the child's perception of health, motivation, skills and social functioning - children who have strong personality, characterized by an increased resistance to psychological and social difficulties (Hutchinson, Stuart, Pretorius, 2010). **Purpose –** to determine the relations of experience bullying athletes and non-athletes adolescents with their personal characteristics - extroversion, introversion, neuroticism.

Methods: The study involved of 802 adolescents of Lithuania, aged 12-17 years in 2016. G.Eysenck Personality Inventory (57 questions), which allows using the basic indicators (extraversion-introversion and neuroticism) was used. Also respondents received the Bullying Questionnaire (based on the Bullying Questionnaire of the British city of York), wich was adapted in Lithuania.

Results: It was established that the neuroticism of adolescents was connected with their susceptibility to bullying, and participation in bullying at others more correlated with extroversion of young people. Participation in bullying of athletes was significantly interconnected with their extroversion and introversion, and neuroticism level – with experiences of being bullied. Participation in bullying of non-athletes was interconnected with their introversion and extroversion, and it did not correlate with neuroticism at all.

Conclusions: In general adolescents describing their experiences of bullying noted that they sometimes bullied others, and also sometimes were exposed to bullying, but significant differences in these indicators between athletes and non-athletes were not revealed. Significant differences were observed between young non-athletes‘ and athletes' personal features: the introversion and neuroticism significantly prevailed among athletes adolescents.

References

1. Compas B.E., Connor–Smith J., Jaser S. S. (2004). Temperament, Stress Reactivity, and Coping: Implications for Depression in Childhood and Adolescence. *Journal of Clinical Child and Adolescent Psychology*, 33 (1), 21-31.
2. Hutchinson A. M. K., Stuart A. D., Pretorius H. G. (2010). Biological contributions to well–being: The relationships among temperament, character strengths and resilience. *Journal of Industrial Psychology*, 36 (2),1-10.

MINDFULNESS AS A MEANS TO ENHANCING WELL-BEING AND PERFORMANCE

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Purpose: With increasing pressures to perform, many athletes are experiencing tremendous amounts of stress as well as disruptions in various aspects of their lives. It is therefore important to find effective interventions that would increase performance without sacrificing athletes' mental and emotional well-being. One technique that has shown to be effective in reducing stress, improving overall psychological well-being and performance across various populations, including athletes, is the practice of mindfulness (e.g., Gardner & Moore, 2012; Keng, Smoski, & Robins, 2011). The purpose of this presentation is to report on research results from mindfulness-based interventions with two collegiate sport teams (i.e., women's basketball and men's soccer) in the USA. In addition, this presentation will include a practical component consisting of an explanation and demonstration of the key components of the mindfulness process.

Method: This study conducted a mindfulness-based intervention with collegiate women's basketball (n=13) and men's soccer teams (n=18) over the course of 10 and 6 sessions respectively. Participants completed pre-, mid- (basketball team only) and post-test measurements of stress and athletic coping skills, as well as weekly journals from which qualitative data was obtained.

Results: Quantitative results demonstrated a number of positive, statistically significant effects of mindfulness-intervention as evidenced by decreases in stress and increases in athletic coping skills over the course of the intervention. Qualitative results indicated that mindfulness intervention was beneficial across various aspects of the athletes' lives in the form of improved awareness, control, focus, relaxation, increased calmness, and being more in the present moment.

Conclusions: The findings of this study suggest that a systematic mindfulness training has the potential to be an effective approach to assisting athletes derive and implement positive changes in their athletic performances, psychological well-being, and life in general.

References

1. Gardner, F. L., & Moore, Z. E. (2012). Mindfulness and acceptance models in sport psychology: A decade of basic and applied scientific advancements. *Canadian Psychology, 53*, 309-318.
2. Keng, S.L., Smoski, M.J., & Robins, C.J. (2011). Effects of mindfulness on psychological health:a review of empirical studies. *Clinical Psychological Review, 31(6):* 1041-56.

FEAR OF CRIME AND VICTIMIZATION AMONG THE ELDERLY PARTICIPATING IN THE SELF-DEFENCE COURSE

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Abstract

Purpose: Self-defence training could enhance seniors' defensive skills and fitness (Boire, 2014). There is lack of evidence about fear and concerns of seniors participating in the self-defence course.

Methods: 18 elderly persons (16 female, 1male; age 66.2 ± 5.86) participated in the self-defence course lasting 8 training units (each unit 60 minutes). Standardized tool for fear of crime and victimization analysis previously used in Euro-Justis project in the Czech Republic (2011) was used in pretest and posttest.

Results: We explored the highest fear of crime by participants in their residence area after dark ($\bar{x}$ =2,77; median=3; SD=0,80), lower fear at the night in their homes ($\bar{x}$ =2,29; median=2; SD=0,75) and in their residence area at the daytime ($\bar{x}$ =2,00; median=2; SD=0,77) at the beginning of the course. We noticed certain decrease of fear of crime after the intervention. Participant were less afraid of crime in their residence area after dark ($\bar{x}$ =2,38; median=2; SD=0,77), they felt lower fear of crime at the night in their homes ($\bar{x}$ =2,00; median=2; SD=0,48) and in their residence area at the daytime ($\bar{x}$ =1,82; median=2; SD=0,63).

Conclusions: The approach to self-defence teaching for elderly should be focused not just on the motor development, but also on their emotional state, fear of crime, perception of dangerousness of diverse situations and total wellbeing. Fear of crime analysis can contribute to create tailor made structure of the self-defence course for specific groups of citizens.

Key words: *combatives, self-protection, security, victimology, crime prevention, wellbeing*

Introduction

The importance of self-defence training is increasingly discussed topic (Cynarski, 2016; Kalina et al., 2005; Kalina et al., 2007). Some groups of citizens such as elderly, disabled persons, children, etc are in greater risk of crime and victimization because of their higher vulnerability (Boire, 2014; Cihounkova, Skotakova, Kohoutkova, & Bugala, 2016). Elderly people are one of the most vulnerable group of citizens because of their decreased motor ability to defend themselves, their loneliness and trustfulness. Ceccato & Bamzar (2016) described paradox of elderly fear of crime and the actual level of victimization – although those who are 65 years and older run less risk of being victimized, they are more likely than the rest of the population to declare being fearful. The ability to prevent, solve and cope with the real self-defence situations is limited not only by physical fitness and technical skills (psychomotor domain), threat assessment and decision making process (cognitive domain), but also by optimal psychological state, which enables good level of wellbeing simultaneously with good readiness (affective domain). Self-defence training could enhance seniors´ defensive skills, fitness and mental readiness (Boire, 2014). Fear of crime among the elderly is researched from different points of views (Akers, La Greca, Sellers, & Cochran, 1987), on the other hand, there is lack of evidence about fear of crime among elderly people participating in the self-defence courses. The analysis of fear level before and after the self-defence training has two aims. First one is explanatory – we are describing how seniors feel when they enter the course, which depends mostly on their personality and life experience. Second aim is evaluation oriented – we are exploring the difference between emotional state of self-defence course participants before and after the intervention. This knowledge is important for creation of tailor made courses for specific citizens group. We assume lower fear of crime by elderly after completion the course.

Methods

Participants: Total number of 18 elderly persons from the Czech Republic (16 female, 1male; Age 66.16 ± 5.86) participating in the self-defence course was involved in the research.

Procedure: The intervention lasted 8 training units (each unit 60 minutes) with focus on common attacks of thieves or aggressors. Defensive actions with use of body, improvised weapons or non-lethal weapons (personal alarm, OC spray, self-defence stick) were practised.

Methods: Standardized tool for fear of crime and victimization, previously used in Euro-Justis project in the Czech Republic (2011), was employed in the pretest and posttest (Moravcová, 2014). Tested persons answered two basic questions: "How safe do you feel …" using the scale 1=very safe, 2=safe, 3=unsafe, 4=very unsafe and question "How often have you felt threatened in the past year…" using the scale 1=never, 2=once or twice, 3=three to five times, 4=six to ten times per year, 5=once or twice a month, 6=almost every week, 7=almost every day. We focused on fear of crime and security feelings among seniors from the environmental perspective – in their residence area after dark/at the daytime and at the night in their homes and situational perspective – theft and physical violence threat.

Measures: We used basic descriptive statistics methods, Mann-Whitney U Test, Wilcoxon Matched Pairs Test and Cohen's d for practical significance analysis.

Results

In the first step of the analysis we provided descriptive statistics of all variables included in the questionnaire. We were interested about prior experience of participants with crime. From the whole number of participants N=18 just two women (11,1%) were victimized in the past. We explored that before the self-defence course participants felt the highest fear of crime in their residence area after dark ($\bar{x}$=2,77; median=3; SD=0,80) in comparison with lower fear at the night in their homes ($\bar{x}$=2,29; median=2; SD=0,75) and in their residence area at the daytime ($\bar{x}$=2,00; median=2; SD=0,77). With regard to the median value we can conclude, that elderly people in our research felt unsafe outdoor after dark, safe indoor in the night and safe outdoor at the daytime. We noticed certain decrease of fear of crime after the intervention. Participant were less afraid of crime in their residence area after dark ($\bar{x}$=2,38; median=2; SD=0,77), they felt lower fear of crime at the night in their homes ($\bar{x}$=2,00; median=2; SD=0,48) and in their residence area at the daytime ($\bar{x}$=1,82; median=2; SD=0,63). With regard to the median value we can draw conclusion, that the feeling of security improved by elderly people in the outdoor environment from "unsafe" to "safe". Evaluation of security feeling in indoor environment in the night and outdoor at the daytime remain the same (safe). Participants experienced the feeling of threat ones or twice per year (median=2) after the dark in the residence area, never (median=1) threat of theft in their homes, threat of physical violence never (median=1) on the street. All variables are displayed in the Table 1. where the sign 1 stands for pretest and the sign 2 for posttest.

Table 1: Descriptive statistics of variables in pretest and posttest

Variable	Descriptive Statistics					
	Valid N	Mean	Median	Minimum	Maximum	SD
Age	18	66.16	65.00	57.00	82.00	5.86
Victimization	18	0.11	0.00	0.00	1.00	0.32
Fear of crime after dark in the residence area -1	18	2.77	3.00	2.00	4.00	0.80
Fear of crime at the night at home -1	18	2.27	2.00	1.00	4.00	0.75
Fear of crime at the daytime in the residence area -1	18	2.00	2.00	1.00	4.00	0.76
Number of perils outdoor in the last year-1	17	3.00	2.00	1.00	8.00	1.90
Number of concerns at home -1	18	0.55	1.00	0.00	1.00	0.51
Number of concerns on street -1	17	0.70	1.00	0.00	2.00	0.58
Fear of crime after dark in the residence area -2	18	2.38	2.00	1.00	4.00	0.77
Fear of crime at the night at home -2	18	2.00	2.00	1.00	3.00	0.48
Fear of crime at the daytime in the residence area -2	17	1.82	2.00	1.00	3.00	0.63
Number of perils outdoor in the last year -2	17	2.05	2.00	1.00	4.00	0.74
Number of concerns at home -2	18	0.50	0.50	0.00	1.00	0.51
Number of concerns on street -2	18	0.61	1.00	0.00	1.00	0.50

For more detailed analysis of differences in fear of crime before and after the intervention we employed Wilcoxon Matched Pairs Test. Results are presented in the Table 2.

There is statistically significant difference (level of significance $p <.050$) between pretest and posttest in three variables: Fear of crime after dark in the residence area ($p=0.017$, $d=0.43$), Fear of crime at the night at home ($p=0.043$, $d=0.38$), Number of perils in last year ($p=0.043$, $d=0.57$). The difference was confirmed also by middle size effect according to Cohen´s d. In these three variables fear of crime or number of perils feeling was decreased after the intervention.

Table 2: Differences in fear of crime in pretest and posttest

Pair of Variables	Wilcoxon Matched Pairs Test Marked tests are significant at p <.05000				
	Valid N	T	Z	p-value	Cohen's d
Fear of crime after dark in the residence area - 1&2	7	0.00000	2.366432	0.017961	0.43
Fear of crime at the night at home 1&2	5	0.00000	2.022600	0.043115	0.38
Fear of crime at the daytime in the residence area -1&2	4	0.00000	1.825742	0.067890	0.22
Number of perils in last year 1&2	5	0.00000	2.022600	0.043115	0.57

Discussion

Victimized person (N=2) felt higher fear of crime in comparison with nonvictimized person (N=16). This finding is limited by number of persons in the compared groups. Our findings are in accord with the literature which claims, that the previous victimization is a strong predictor of fear of crime, regardless of age and higher fear of crime is perceived by elderly outdoor in public spaces, lower in their homes (Ceccato & Bamzar, 2016). On the other hand just 11,1% of elderly persons entering the self-defence course were victimized in the past. This finding confirms, that most of elderly persons entering the self-defence course were not overly fearful in our research. On the contrary it was shown that persons participating in the self-defence course were generally less afraid of crime after the intervention.

Conclusion

Our study provided evidence about fear of crime and security concerns in different environments among elderly persons participating in one specific self-defence course. The hypothesis that the fear of crime by elderly will be decreased after completion the course was confirmed. Although in our case approx. 89% of participants were not victimized in the past, instructors should pay higher attention to concerns of victimized persons participating in the course. They should be given by an opportunity to speak about negative experience with crime but not be supported to be excessively immersed in the self-defence situations. The goal of self-defence course is to calm down and decrease fear of crime by enhancement of defensive skills. It seems logical that elderly are more afraid of crime in public spaces especially after the dark than in their homes. On the other hand situations such as housebreaking shouldn´t be underestimate as well as situations at home at the daytime. The reason is that common modus operandi of criminals is to enter the house or flat under false pretences and then rob elderly (criminals usually work in pairs). Self-defence instructors should be aware about elderly feelings, concerns and emotional state to deal with clients professionally and empathetically. The knowledge about emotional state of participants is important for building correct structure of self-defence courses especially from the situational point of view.

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References

1. Akers, R. L., La Greca, A. J., Sellers, C., & Cochran, J. (1987). Fear of Crime and Victimization among the Elderly in Different Types of Communities. *Criminology*, *25*(3), 487–505.
2. Boire, K. (2014). *Self defense for seniors: a special self defense system for seniors*. [S.l.]: Outskirts Press.
3. Ceccato, V., & Bamzar, R. (2016). Elderly Victimization and Fear of Crime in Public Spaces. *International Criminal Justice Review*, *26*(2), 115–133.
4. Cihounkova, J., Skotakova, A., Kohoutkova, J., & Bugala, M. (2016). Evaluation of self-defence for people with visual impairments - methodology aspects. *Archives of Budo*, (12), 275–285.
5. Cynarski, W. (2016). The meaning of self-defence: an expert definition. A contribution to the theory of self-defence and combat. In *10th International conference on Kinantropology 2015: Sport and quality of life* (s. 463–474). Brno: Masaryk University. Získáno z http://conference.fsps.muni.cz/media/8152/book_of_abstract_isbn.pdf
6. Kalina, R. M., Chodala, A., Dadelo, S., Jagiello, W., Nastula, P., & Niedomagala, W. (2005). Empirical basis for predicting success in combat sports and self-defence. *Kinesiology*, *37*(1), 64–73.
7. Kalina, R. M., Jagiełło, W., & Wiktorek, P. (2007). Motor competence in self-defence of students of a detectives' school during their course of studies. *Archives of Budo*, *3*(0). Získáno z http://archbudo.com/view/abstracts/issue_id/10715
8. Moravcová, E. (2014). Indikátory obav z kriminality v českých sociálněvědních výzkumech. *Sociologický ústav AV ČR, v.v.i.*, 121–141.

SPORTS STUDENTS CRITICAL THINKING AND STRATEGIC LEARNING COMPETENCES

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Abstract

Purpose: The purpose of this paper is to suggest that what is needed for ESP (English for specific purposes), is a different orientation to English study.

Results: The reform in teaching and curriculum involves not only the teaching content, but more so the teachers' methodology, the students' strategic learning competences and the changed relationship between students and teachers in the classroom setting. There is a shift of the focus of attention from the grammatical to the communicative properties of language, since sports students will need them when they enter job searching arena. Difficulties students encounter arise not so much from a defective knowledge of the system of language but from the unfamiliarity with English use. Having in mind that they will need English language to transfer and transmit their expertise knowledge of sport and physical education locally and internationally as well, it is quite obvious that teaching ESP learning strategies and strategic learning competences should be in focus in every sports class.

Conclusions: Autonomous-strategic learning and metacognitive strategies formation and later on acquisition, are suggested as basic essentials for teaching and learning when teaching any subject and ESP in sport as well. This is a continuous process but also a final product that we as teachers should strive for if we want our sports students to be competitive at the labor market, and pursue their sporting careers.

Key words: *Strategic learning, Metacognition, Product, Process, ESP-sport*

References

1. Baker, L. and Brown, A. L. (1984). Metacognitive skills and reading. In P.D. Pearson (Ed.), Handbook of Reading Research Vol. 1, (pp. 353-394) New York: Longman.
2. Duell O.K. (1986). Metacognitive skills. In G. Phye, and T. Andre (Eds.), Cognitive Classroom Learning. Orlando, FL: Academic Press.
3. Flowerdew, J. and Peacock, M. (eds) (2001). The EAP curriculum: issues, methods and challenges. Cambridge: Cambridge University Press, pp.177-194.

Kinesiology in Physical Conditioning

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MANIPULATING RESISTANCE TRAINING VARIABLES FOR MAXIMAL MUSCLE GROWTH

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The manipulation of resistance training program variables is considered important to maximizing muscular adaptations. Variables that can be manipulated include resistance training volume, frequency, tempo, rest interval length and intensity of load. Emerging research provides the basis for developing guidelines how these variables can be best integrated into resistance training program design.

Resistance training volume is largely predicated on the total number of weekly sets performed per muscle group. Some researchers have speculated that a low volume approach is sufficient to bring about a maximal hypertrophic response (1). However, a recent meta-analysis from our lab showed a clear dose-response relationship between volume and hypertrophy (9). A graded response was seen whereby < 4 weekly sets per muscle translated to a 5.4% increase in muscle mass; 5-9 weekly sets per muscle translated to a 6.9% increase, and; 10+ weekly sets per muscle translated to a 9.8% increase. A paucity of data on higher volume routines prevented determination of an upper threshold for beneficial effects of further increases in training volume. Given the potential for overtraining with repeated use of high volume routines, it can be hypothesized that periodizing volume over the course of a training cycle would help to optimize results.

Training frequency can either represent the number of training sessions over a given time period (usually a week) or the number of times a given muscle is trained on a given basis (again, usually weekly). Acute data show that the time course for muscle protein synthesis following a resistance training bout lasts approximately 48 hours (4), which seems to indicate that the anabolic response is maximized by training each muscle group at least every other day. However, other physiological factors may confound beneficial effects of higher training frequencies. A recent meta-analysis from our lab found a superiority to performing at least 2 weekly sessions per muscle group (8); data were insufficient to determine if more frequent sessions enhanced results. It should be noted that these findings were specific to volume-equated programs. A potential benefit to using a split routine is that intra-session volume can be increased so that total weekly volume is greater compared to total body approaches normally associated with higher training frequencies. Given the previously mentioned dose-response relationship between volume and hypertrophy, the interaction between volume and frequency must be considered in program design.

The tempo at which repetitions are performed is an often overlooked variable that may impact muscle growth. Tempo is frequently expressed in a three digit arrangement where the first number is the time (in seconds) to complete the concentric action, the second number is the isometric transition phase between concentric and eccentric actions, and the third number is the time to complete the eccentric action (2). Meta-analytic data from our lab show that a wide variety of tempos can be employed to promote muscle hypertrophy with similar responses seen across total repetition durations of 1 to 6 seconds (7). It is unclear how tempo affects eccentric versus concentric actions from a hypertrophic standpoint. Training with durations of greater than 10 seconds appears to be suboptimal for achieving maximal muscular gains.

The time taken between sets, commonly referred to as the rest interval, has been shown to impact the acute resistance training response. It has been proposed that shorter rest intervals promote greater increases in hypertrophy, a hypothesis largely based on heighted post-exercise elevations in anabolic hormones associated with such training (3). Contrary to this hypothesis, however, recent research from our lab found that resting 3 minutes between sets promoted greater muscular adaptations compared to resting 1 minute (5). It is conceivable that combining shorter and longer rest intervals based on whether exercises are multi- versus single-joint might enhance the hypertrophic response.

Finally, intensity of load is thought to be a primary stimulus for gains in muscle mass. It had previously been thought that training loads of >65% 1RM were required to achieve optimal increases in growth. However, a meta-analysis from our lab found that marked increases in hypertrophy can be achieved across a wide spectrum of loading zones in untrained individuals (6). We recently showed that low-load (~30RM) training produced similar hypertrophic increases to training in the so-called “hypertrophy range” (10RM) in resistance-trained men. The totality of findings provide compelling evidence that low-load training is a viable strategy for building muscle. Given the possibility that the hypertrophic response of low- and high-load training is specific to type I vs type II fibers, respectively, it can be speculated that combining these strategies may optimize gains in muscle mass.

References

1. Fisher, J, Steele, J, Bruce-Low, S, and Smith, D. Evidence-based resistance training recommendations. Med Sportiva 15: 147-162, 2011.
2. Headley, SA, Henry, K, Nindl, BC, Thompson, BA, Kraemer, WJ, and Jones, MT. Effects of lifting tempo on one repetition maximum and hormonal responses to a bench press protocol. J. Strength Cond Res. 25: 406-413, 2011.
3. Henselmans, M, and Schoenfeld, BJ. The effect of inter-set rest intervals on resistance exercise-induced muscle hypertrophy. Sports Med. 44: 1635-1643, 2014.
4. Phillips, SM, Tipton, KD, Aarsland, A, Wolf, SE, and Wolfe, RR. Mixed muscle protein synthesis and breakdown after resistance exercise in humans. Am. J. Physiol. 273: E99-107, 1997.
5. Schoenfeld, BJ, Pope, ZK, Benik, FM, Hester, GM, Sellers, J, Nooner, JL, Schnaiter, JA, Bond-Williams, KE, Carter, AS, Ross, CL, Just, BL, Henselmanns, M, and Krieger, JW. Longer inter-set rest periods enhance muscle strength and hypertrophy in resistance-trained men. Journal of Strength and Conditioning Research 30: 1805-1812, 2016.
6. Schoenfeld, BJ, Wilson, JM, Lowery, RP, and Krieger, JW. Muscular adaptations in low- versus high-load resistance training: A meta-analysis. Eur. J. Sport. Sci. : 1-10, 2014.
7. Schoenfeld, BJ, Ogborn, DI, and Krieger, JW. Effect of Repetition Duration During Resistance Training on Muscle Hypertrophy: A Systematic Review and Meta-Analysis. Sports Med., 2015.
8. Schoenfeld, BJ, Ogborn, D, and Krieger, JW. Effects of Resistance Training Frequency on Measures of Muscle Hypertrophy: A Systematic Review and Meta-Analysis. Sports Med., 2016.
9. Schoenfeld, BJ, Ogborn, D, and Krieger, JW. Dose-response relationship between weekly resistance training volume and increases in muscle mass: A systematic review and meta-analysis. J. Sports Sci. : 1-10, 2016.

THE MAIN PATTERNS AND ASSOCIATIVE RULES RELATED BETWEEN PLAYERS FUNCTIONAL LOAD INDICATORS, TEAMWORK INTENSITY AND EFFICIENCY IN JUNIOR MALE BASKETBALL

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Purpose: The aim of the current study was to identify the main associative relationships between players Heart Rate, offensive “teamwork intensity” and efficiency at the junior level of male basketball.

Methods: Sixteen elite male junior (age 17,4 ± 1,2 years; height 193,7 ± 7,4 cm; mass 84,4 ± 11,1 kg) Estonian basketball players volunteered to participate in this study. The data were gathered from 197 ball possessions in three competitive games played in division 1 of Estonian Championship. The heart rate values of each player partakes in team ball possession were obtained by the physiological status monitoring device Zephyr™ BioHarness™. The technical/tactical indicators, “teamwork intensity” and outcomes were notated to the Microsoft Office Excel table. The aggregated data were analyzed by the means of Data mining method.

Results: The sample of associative rules for increasing the offensive efficiency highlights the role of the point guardś and forwards high level of heart rate (165-191 BMP) accompanied by a high “teamwork intensity” indicator.

Conclusion: The higher offensive efficiency associates with higher players HR and “teamwork intensity” values.

SELECTION OF CADET BASKETBALL PLAYERS BY POSITION IN THE GAME ACCORDING TO THE FUNCTIONAL MOVEMENT SCREENING TESTS

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Abstract

The aim of this study was to the determine whether and to what extent it is possible, on the basis of the Functional movement screening (FMS) tests, to select cadet basketball players by their game positions. Forty basketball players (guards = 17 players, forwards = 9 players, centers = 14 players) participated in this study. In total 7 tests were applied (deep squat, hurdle step, in-line lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability) in order to obtain statistically significant differences for the variables Deep Squat(Sig. 0.02) and Shoulder Mobility (Sig. 0.01). However, if one is to observe the overall result (max. 21) no significant differences were obtained, which leads to a conclusion that it is very difficult to select basketball.

Key words: *FMS, Deep Squat, Shoulder Mobility*

Introduction

Basketball has become one of the most popular sports in the world due to its dynamic game (Čaušević, 2015). An essential physical quality for athletes from team sports (e.g. the football codes, court sports such as basketball and handball) is multi-directional speed (Robert G. Lockie, Schultz, Jeffriess, & Callaghan, 2012), and this type of speed involves frequent changes of direction, frequent acceleration, deceleration and sudden jumps. For this reason coaches need tests to easily but efectivelly determine athletes' condition and assess the quality of movement. This type of testing relates to functional movement, which has been defined as the ability to perform locomotor, manipulative, and stabilizing actions, while maintaining control along the kinetic chain (Cook, Burton, & Hoogenboom, 2014a; R G Lockie et al., 2015). The Functional Movement Screening (FMS) is designed by Gray Cook and Lee Burton to assess the functionality of movements comprising a total of 7 tests (Cook et al., 2014a; Cook, Burton, & Hoogenboom, 2014b; Minick et al., 2010; NoFrost, Beach, Callaghan, & McGill, 2012). FMS tests are most often used in various sports to detect injury risks(Chorba, Chorba, Bouillon, Overmyer, & Landis, 2010; Sorenson, 2009), as well as for military purposes of predicting injuries(Lisman, O'Connor, Deuster, & Knapik, 2013). These tests were used to obtain adolescents' normative values (Abraham, Sannasi, & Nair, 2015), where it was concluded thatmean composite FMS score was 14.59 (CI 14.43 - 14.74) out of possible 21, indicating a statistically significant difference between men and women. Due to the increasing interest of researchers to use FMS tests, the question is whether they can be used as a tool for the selection of players in terms of the position in the game. The selection includes optimal selection, orientation and training of young talents. Consequently, the aim of this study is to determine whether and to what extent it is possible to select younger and older cadet basketball players by their positions in the game, based on the Functional movement screening tests (FMS).

Methods

The sample and variables

The sample consisted of 40 young players aged 14-16. All players were members of the basketball club KK "Kengur" from Zenica, KK "GEN" from Sarajevo and KK "Kakanj" from Kakanj. The players which played for cadet selection of the aforementioned clubs were subjected to the tests, which along with the good health status was the only condition for their inclusion in the study. Players were clustered in terms of their positions in a game which were determined by the club coaches.Clustered positions were guards (17 players), forwards (9 players) and centers (14 players) (Sampaio, Janeira, Ibáñez Godoy, & Lorenzo Calvo, 2006). In total 7 FMS tests were analyzed (deep squat, hurdle step, in-line lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability).

FMS testing protocol

Testing was conducted in a period of three days, in three clubs. A trained athlete needed about 20 minutes to finalize FMS testing protocol. Testing protocol and each exercise was explained to each subject individually, after which testing was initiated. Each exercise was performed 3 times. Each test was scored on the spot, apart from five of them (hurdle step, lunge, shoulder mobility, active straight leg raise and rotary stability) which were performed and scored separately for the right and left sides of the body (Kiesel, Plisky, & Butler, 2011).The FMS scoring principle was very simple and was performed using the ordinal scale from 0 to 3, which means that the ordinal scale contained four values, 0 (indicates that pain was reported during the movement), 1 (the inability to perform the movement), 2 (minor deficits or perfect performance with modifications) and 3 (perfect performance). For each test three attempts/performances were allowed, taking into account only the highest score. For unilateral tests, where a respondent performs an exercise with one, and then with the other limb, if there was a difference between the results, the worse result performed was taken into account for the final calculation. The maximum score was 21.

Statistical Analysis

In order to compare the results with respect to the position in the game, the descriptive statistical parameters were calculated (mean and standard deviation), and the differences between the arithmetic means of clustered group of basketball players were determined in relation to FMS tests, conducted with the means of univariate analysis ANOVA with the significance level set at $p < 0,05$ (Kiesel et al., 2011). The data was processed using the statistical package SPSS 21.

Results

The means and standard deviations for each group (Guards, Forwards, and Centres) are presented in Table 1, Figure 1. Based on the ANOVA results, a statistically significant difference is evident only for the two treated variables, Deep Squat Sig. 0.02 and Shoulder Mobility Sig. 0.01. In relation to the total score (max. 21) it is evident that there is no statistically significant difference for the groups of basketball players, Guards (mean=18,25), Forwards (mean=17,22) and Centres (mean=17,71).

Table 1: Descriptive statistics and ANOVA

	Functional Movement Screen (FMS)						
	Guards		Forwards		Centres		**Anova**
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Sig.
Deep Squat	2.59	0.618	1.89	0.782	1.93	0.829	**.02***
Hurdle Step (HS)	2.29	0.47	2.22	0.667	1.93	0.616	.20
In-Line Lunge (ILL)	2.41	0.507	2.11	0.782	2.14	0.535	.33
Shoulder Mobility	2.71	0.588	2.44	0.527	2	0.679	**.01***
Active Straight-Leg Raise	2.59	0.618	2.22	0.667	2.21	0.802	.26
Trunk Stability Push-Up	2.53	0.514	2.22	0.667	2.43	0.514	.40
Rotary Stability	2.24	0.437	2.11	0.333	2.07	0.267	.43
Total	18.35	1.539	17.22	1.787	17.71	1.437	.20

p< 0,05

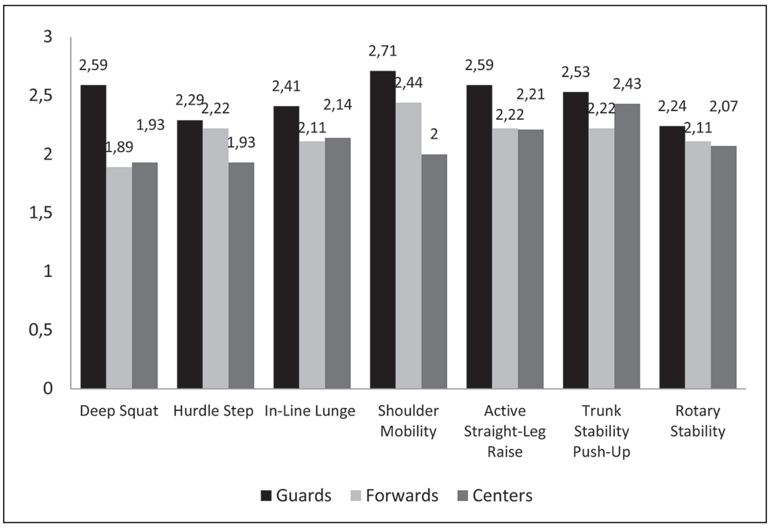

Figure 1: FMS results

Discussion

Based on the analysed data, it is evident that there are statistically significant differences in variables Deep Squat and Shoulder Mobility between the evaluated groups of basketball players. Observing Deep Squat variable, it is evident that the best were performed by the guards which goes along with the nature of their position in the game, requiring a lot of running, jumping, changes of direction, and contacts with the opponents, while centres have some better results compared to the forwards. The deep squat is a closed kinetic chain movement with dorsal bended ankles, bended knees and hips, stretched thoracic spine with bended and abducted shoulders (Foran, 2001). The failure of proper performance and somewhat worse results for the variable Deep Squat for the other two groups can be explained by poor ankle mobility, poor front, side and back muscle flexibility of the upper leg, flexibility of gluteal muscles, the strength of the front lower leg muscles, strength of the upper leg adductor, gluteal muscles strength, thoracic spine mobility, poor mobility of shoulders and scapula, and general motor control of the whole body (Svilar, 2013). Successful performance of this fundamental movement affects the transformation and efficiency of gluteus maximus muscle, which ultimately results in improving movement results like running and jumping (Caterisano et al., 2002). These results, for the most part can be attributed to the fact that the centres are larger and heavier than guards and forwards (Ostojic, Mazic, & Dikic, 2006) and their mobility is therefore limited to a certain extent. Regarding Shoulder Mobility variable, tone can observe that guards have the best results compared to other groups, while forwards have better results in relation to the centres. The shoulder joint is one of the most complex body joints, and its good mobility and stability is necessary to adequately meet the demands of this sport and reduce the potential of injuries. Shoulder injury is a potentially career-ending problem for professional players and represents a significant clinical challenge for health care professionals responsible for prevention, assessment, and rehabilitation (Downar & Sauers, 2005). To perform the Shoulder Mobility test, one requires mobility of the shoulder and elbow joint, which is particularly manifested in movements involving abduction and external rotation, i.e. adduction and internal rotation, as well as the mobility of the scapula and thoracic spine. As one of the main reasons for gaining such results, are the differences in the anthropological characteristics between players in different positions (Ostojic et al., 2006), and relations between angles and speed ejections that are conditioned by the players' height in different playing positions (Miller & Bartlett, 1996). These results ultimately suggest that the guards have developed adequate shot technique independently on the changes in shooting distance. However, when one looks at the total score of FMS tests, it is evident that there is no statistically significant difference between the position in the game, which was to be expected taking into considerations the results of previous studies (Delextrat & Cohen, 2009; Miller & Bartlett, 1996).

Conclusion

This research is an attempt to get to the valuable information which provides an answer to the question of whether and to what extent it is possible, on the basis of functional movement screening (FMS), to select a younger and older cadet basketball player for specific positions in the game. Based on the results, it is evident that there are statistically significant differences in variables Deep Squat and Shoulder Mobility, however, in terms of the overall results of the Functional Movement Screening tests (FMS), one can conclude that there is no statistically significant difference between the stated positions in the game (guards, forwards and centres). FMS tests proved to be very practical and easy to use, by athletes, as well as the general population, however, for the purposes of this research, they did not prove as an adequate tool for player selection in relation to the position in the game. In our opinion, the future research should include FMS tests as a secondary tool and for the sake of better sensitivity, one should take into account the measuring scale up to 100 points as conducted in research by Butler, Plisky, & Kiesel, 2012.

References

1. Abraham, A., Sannasi, R., & Nair, R. (2015). Normative values for the functional movement screentm in adolescent school aged children. International Journal of Sports Physical Therapy, 10(1), 29–36.
2. Butler, R. J., Plisky, P. J., & Kiesel, K. B. (2012). Interrater Reliability of Videotaped Performance on the Functional Movement Screen Using the 100-Point Scoring Scale. Athletic Training & Sports Health Care: The Journal for the Practicing Clinician, 4(3), 103–109.
3. Caterisano, A., Moss, R. F., Pellinger, T. K., Woodruff, K., Lewis, V. C., Booth, W., & Khadra, T. (2002). The effect of back squat depth on the EMG activity of 4 superficial hip and thigh muscles. Journal of Strength and Conditioning Research / National Strength & Conditioning Association, 16(3), 428–432.
4. Chorba, R. S., Chorba, D. J., Bouillon, L. E., Overmyer, C. A., & Landis, J. A. (2010). Use of a functional movement screening tool to determine injury risk in female collegiate athletes. North American Journal of Sports Physical Therapy : NAJSPT, 5(2), 47–54.
5. Cook, G., Burton, L., & Hoogenboom, B. J. (2014a). Functional Movement Screening : The Use of Fundamental Movements as an Assssment of Function- Part 1. International Journal of Sports Physical Therapy, 9(4), 549–563.
6. Cook, G., Burton, L., & Hoogenboom, B. J. (2014b). Functional Movement Screening : The Use of Fundamental Movements as an Assssment of Function- Part 2. International Journal of Sports Physical Therapy, 9(4), 549–563.

7. Čaušević, D. (2015). Game-related statistics that discriminate winning and losing teams from the World Championships in Spain in 2014. Sarajevo: Homosporticus.
8. Delextrat, A., & Cohen, D. (2009). Strength, Power, Speed, and Agility of Women Basketball Players According to Playing Position. Journal of Strength and Conditioning Research, 23(7), 1974–1981.
9. Downar, J. M., & Sauers, E. L. (2005). Clinical Measures of Shoulder Mobility in the Professional Baseball Player. Journal of Athletic Training, 40(1), 23–29.
10. Foran, B. (2001). High-performance sports conditioning (1st ed.).
11. Kiesel, K., Plisky, P., & Butler, R. (2011). Functional movement test scores improve following a standardized off-season intervention program in professional football players. Scandinavian Journal of Medicine and Science in Sports, 21(2), 287–292.
12. Lisman, P., O'Connor, F. G., Deuster, P. A., & Knapik, J. J. (2013). Functional movement screen and aerobic fitness predict injuries in military training. Medicine and Science in Sports and Exercise, 45(4), 636–643.
13. Lockie, R. G., Schultz, A. B., Jeffriess, M. D., & Callaghan, S. J. (2012). The relationship between bilateral differences of knee flexor and extensor isokinetic strength and multi-directional speed. Isokinetics and Exercise Science, 20(3), 211–219.
14. Lockie, R. G., Schultz, A. B., Jordan, C. A., Callaghan, S. J., Jeffriess, M. D., & Luczo, T. M. (2015). Can selected functional movement screen assessments be used to identify movement deficiencies that could affect multidirectional speed and jump performance?J Strength Cond Res (Vol. 29).
15. Miller, S., & Bartlett, R. (1996). The relationship between basketball shooting kinematics, distance and playing position. Journal of Sports Sciences, 14(3), 243–253.
16. Minick, K. I., Kiesel, K. B., Burton, L., Taylor, A., Plisky, P., & Butler, R. J. (2010). Interrater reliability of the functional movement screen. J Strength Cond Res, 24(2), 479–486.
17. NoFrost, D. M., Beach, T. A., Callaghan, J. P., & McGill, S. M. (2012). Using the Functional Movement ScreenTM to evaluate the effectiveness of training. The Journal of Strength & Conditioning Research, 26(6), 26(6), 1620–1630.
18. Ostojic, S. M., Mazic, S., & Dikic, N. (2006). Profiling in basketball: physical and physiological characteristics of elite players. Journal of Strength and Conditioning Research, 20(4), 740–744.
19. Sampaio, J., Janeira, M. A., Ibáñez Godoy, S. J., & Lorenzo Calvo, A. (2006). Discriminant analysis of game-related statistics between basketball guards, forwards and centres in three professional leagues. European Journal of Sport Science, 6(3), 173–178.
20. Sorenson, E. a. (2009). Functional Movement Screen As A Predictor Of Injury In High School Basketball Athletes. East, (December), 1–89.
21. Svilar, L. (2013). Procjena čučnja funkcionalnom analizom pokreta – prikaz u košarkaškoj U-18. Zagreb: Kondiciona priprema sportaša.

ALLOMETRIC SCALING FOR RELATIVE STRENGTH TESTS IN CROATIAN ARMY RECRUITS

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Abstract

Test results for assessment of physical fitness are often being presented as simple performance to mass ratio. The most vivid example of such representation can be seen in expressing maximum oxygen uptake (VO_2max; l·min-1) in relative values according to body mass (ml·min-1·kg-1), and moreover, even greater number of tests results are not being presented in relative manner, for example test of relative strength such as tests supporting and managing body weight like pull-ups, push-ups etc. Such approach is based on a linear relationship between body size and the tested value in case of oxygen uptake or independence of body size in case of the test of relative strength. But such generally accepted relations between body size and human performance variables are inconsistent with theoretically and experimentally determined values, especially as far as relative strength tests were concerned. Therefore, the aim of this study was to explore the nature of relationship between indicators of body size (body mass, fat free mass and body height) and results in tests of relative strength, also determine allometric coefficients (AC) for those tests and compare them with theoretical ones. The study was conducted on a sample of 571 military men, members of Croatian Army aged 19.1 to 51.5 years. The results indicate that experimentally derived AC for relative strength do not significantly differ from theoretical ones when body mass and height are concerned b_{BMav}=-0,99 vs. b_{BM}=-0,33 and b_{BHav}=-2,27 vs. b_{BH}=-1, but for fat free mass b_{FFMav}=-0,13 it significantly differs from the theoretical value b_{FFM}=-0,33. Therefore, this research partially confirmed theoretical predictions and introduced new facts in the field of relative strength which is greatly limited by body size.

Key words: *normalization, relative strength, allometry*

Introduction

Measurement and evaluation of human performance represents the basis of research methodology in kinesiology, and diagnostic tests in the field of sports and in other applied areas such as physical education, military, ergonomics and clinical practice. (Jaric, 2002.; Jarić et al., 2005.; Vanderburgh, 2008.). Testing performance is extremely important to conduct in order to a) determine the levels of biomotor abilities in individuals; b) determine the effects of various programs of physical exercise/training; c) determine a relation between different tests; d) select individuals in specific sports or occupations with high physical demands; e) assess muscle function; f) assess cardiovascular system and g) assess metabolic processes during physical activity (Jarić et al., 2005.). Some of those tests are expressed in direct measures (e.g. maximal force or oxygen uptake etc.) and others specially designed protocols which are merely assessments of certain abilities i.e. indirect measures (1 RM, 3200 m run). Test results are usually expressed as relative measures according to body mass. Best example of relative measure is relative oxygen uptake or absolute value of maximum oxygen uptake (VO_2max; l·min-1) divided by body mass (ml·min-1·kg-1). Even greater number of tests are not adjusted or normalized for body mass – relative strength tests such se pull ups, push-ups, sit ups etc. Approaching the issue as in the first example (division by body mass) is based upon the assumption of linear relationship between body size (mass) and oxygen uptake. As far as the second example is concerned, the reason for no adjustment is the assumption that assessed performance is independent of body size. Such relations are not in line with theoretically or experimentally determined values (Vanderburgh, 2012.). Therefore, greater number of studies in sports and exercise is engaged in determination of the impact of body size, especially body mass on wide range of human performance. Research has also shown that wide range of factors may influence the performance results (e.g. age, gender, training status, body composition) but body size dimensions have been shown to have very large impact (Jarić, 2002.). In other words, different testing results are greatly depending on body size. Actually, body size distorts real value of certain ability. One obtains unreliable results and often overestimates the results of smaller individuals (dividing by body mass) and penalizes larger which, again, leads to the possibilities of incorrect interpretation of the results. In order to get the real value of the ability tested, one must exclude the influence of body size on the obtained, *raw* value. The exclusion of body size influence may be achieved by establishing allometric coefficients (AC) based on a theory of geometric similarity. When assessing relative strength (repetitive strength while managing own body mass/weight), theoretical approach in establishing AC presumes the use of AC b=-1/3 when normalizing with body mass. When normalizing with body height allometric coefficient should equal b=-1. Namely, if we take into consideration that muscle force and therefore strength depend on the physiological cross sectional area of a muscle, then force/strength should scale according to body mass by a coefficient b=2/3. But since we are dealing with test of strength in which one manages one's own mass, then the result is proportional to muscle force, and inversely proportional to body mass. From that assumption the following is derived:

$$RS \sim m^{2/3} \cdot m^{-1}, \text{ that is } RS \sim m^{-1/3} .$$

Table 1: Experimentally derived allometric coefficients for tests assessing relative strength

Authors	Tests	Participants	Sport /occupation	Experimental AC
Crowder & Yunker (1996.)	Push-up	238 M	Army academy cadets	b_{BM}=-0,38 (95% CI: -0.18 do -0.58) b_{FFM}=-0,28 (95% CI: -0.04 do -0.52)
	Sit-up			b_{BM}=-0,22 (95% CI: -0.12 do -0.32) b_{FFM}=-0,21 (95% CI: -0.09 do -0.33)
Crowder & Vanderburgh (1995.)	Pull-up	601 M (18 ± 0,8 god)		b_{BM}=-2,03 (95% CI: 1.76 – 2.30) b_{FFM}=- 1,88 (95% CI: 1.53 – 2.23)
Marković & Jarić (2004.)	Relative strength tests (total average)	77 M (18-26 god)	Kinesiology students	b_{BM}= 0.54 (SD: 0,28) b_{BH}=-1,51 (SD: 0,54
	Sit up			b_{BM}= -0.30 b_{BH}=-0,76
	Push up			b_{BM}= -0.42 b_{BH}=-1,80
	Pull-up			b_{BM}= -1.08 b_{BH}=-2,38
	Single leg squat			b_{BM}=- 0.51 b_{BH}=-1,35
	Hanging leg lift			b_{BM}= -0.38 b_{BH}=-1,35
Vanderburgh et al. (2011.)	Push-up	56 M student age	Military cadets	b_{BM}=0.66 (95% CI: ± 0.46)

Legend: CI – confidence interval; N – number of participants; M – male; b_{BM} – body mass allometric coefficient; b_{FFM} – fat free mass allometric coefficient; b_{BH} – body height allometric coefficient; SD – standard deviation.

Although theoretical value of AC equals b=-1/3, Table 1 shows studies that tried to establish experimentally derived allometric coefficients and had obtained different results. Therefore, the aim of this paper is to explore the relations of body size and the results of tests for assessing upper body relative strength; determine experimental allometric coefficients for those test according to different aspects of body size and compare those coefficients with theoretical ones.

Methods

Participants: 571 healthy, physically active Croatian Army recruits, aged 19,1 – 50,1 participated in this study. All the participants had given their written consent one week prior to testing and were introduced to the aim and details of the research.

Measurement Protocol: Measurement Protocol consisted of 3 body size tests – body height, body mass and fat free mass, and 4 test for assessing relative strength: sit ups performed in one minute (SIT1), pull ups to exhaustion (PULL), push-ups performed in two minutes (PUSH2) and single leg squats performed in one minute (SLSQ1).

Statistical Analysis: Statistica for Windows, version 10.0. (Statistica, Version 6.0, Statsoft Inc., Tulsa, Okla., US) was used to calculate descriptive statistics: M– means, R – range, SD – standard deviation and *skewness* and *kurtosis*. In order to determine the relationship between body size (mass, height and fat free mass) and results in each of the test for relative strength (before and after scaling for body size) correlation analysis was performed, i.e. Pearson correlation coefficient (r) was calculated. In order to determine experimental allometric coefficients for each test according to 3 body size measures, regression analysis was performed on previously logarithmically transformed original data (Batterham & George, 1997; Davies & Dalsky, 1997.).

In short, assumed allometric relationship between original results and body size

$$P_n = P \cdot S^{-b}$$

where P = original result, P_n = normalized result, S = body size measure, and b = allometric coefficient,

is logarithmically transformed and provides with the following equation:

$$\log P = \log P_n + b \log S$$

where $logP_n$ and S represent an intercept and slope of the regression line adapted to log values of experimentally obtained results and certain body size measure. Allometric coefficient b values for each of the body size measure were independently used in further statistical analysis (Marković & Jarić, 2004.). Based on those results one group t-test and population and group difference tests were applied to determine the differences between theoretical and experimental allometric coefficients for each test and average values of experimental allometric coefficients for a group of relative strength tests. Level of statistical significance was set at $p < 0.05$ for all analyses.

Results

Table 2 represents basic descriptive statistic for body size measures and relative strength tests for all 571 participants, showing mean values and standard deviations (M ± SD) as well as a range between minimal and maximal values (max – min).

Table 2: Descriptive statistics

	M ± SD	Range	Skewness	Kurtosis
Age	29,4 (5,82)	51,5 - 19,1	0,55	-0,12
BM	83,8 (11,23)	120,6 - 53,5	0,17	0,04
FFM	69,8 (7,05)	90,6 – 48,0	0,05	-0,07
BH	180,1 (6,62)	201,6 – 160,5	-0,05	0,04
PUSH2	32,24 (18,15)	0,0 – 129,0	1,21	2,09
SIT2	51,55 (19,15)	0,0 – 115,0	0,51	0,39
PULL	4,35 (4,13)	0,0 – 25,0	1,47	2,34
SLSQ1	39,15 (11,28)	0,0 – 70,0	-0,23	0,37

Table 3 shows results of the linear regression analysis on previously log-transformed data of relative strength tests (PUSH2, SIT2, PULL and SLSQ1) and body size measures.

Table 3: Results of the linear regression analysis on previously log-transformed data of relative strength tests. Parameter a stands for the Y-axis intercept, while b stands for the allometric coefficient matching the slope of the regression line log(P) = a + b log(S). t P value stands for the result achieved in a single test, S stands for the body mass, body height or fat free mass. Value r stands for correlation coefficient, CI for confidence interval of the allometric coefficient b with statistical significance of 95%

		PUSH2	SIT2	PULL	SLSQ1
BM	**Loga**	3,28	2,83	3,99	2,79
	b	-0,96	-0,59	-1,79	-0,63
	r	-0,23	-0,19	-0,29	-0,25
	95% CI	-1,3 do -0,61	-0,85 do -0,35	-2,32 do -1,27	-0,84 do -0,43
FFM	**Loga**	1,69	1,72	0,72	2,06
	b	-0,13	-0,02	-0,08	-0,27
	r	-0,02	-0,01	-0,01	-0,08
	95% CI	-0,60 to 0,34	-0,36 to 0,31	-0,79 to 0,62	-0,55 to 0,01
BH	**Loga**	8,91	3,68	7,35	5,81
	b	-3,31	-0,89	-3,01	-1,88
	r	-0,21	-0,08	-0,14	-0,20
	95% CI	-4,58 do -2,04	-0,85 do -0,35	-4,93 do -1,09	-2,63 do -1,12

Legend: BM – body mass; FFM – fat free mass; BH – body height; CI – confidence interval

Table 4: Comparison between experimental (average value for group of relative strength tests) and theoretical allometric coefficients (exponents)

	AC	Relative strength
BM	Average experimental	-0,99
	Theoretical coefficient	-0,33
FFM	Average experimental	-0,13*
	Theoretical coefficient	-0,33
BH	Average experimental	-2,27
	Theoretical coefficient	-1

Legend: AC- allometric coefficient; BM – body mass; FFM – fat free mass; BH – body height; *statistically significant difference in relation to theoretically predicted value ($p < 0.05$); ** statistically significant difference in relation to theoretically predicted value ($p < 0.01$)

Table 5: Correlation coefficients (r) between relative strength test and body mass before and after scaling for body mass (normalization) ($p < 0,05$)

	R before normalization	*R* after normalization
PUSH2	-0,210035*	-0,051226
SIT2	-0,212849*	-0,015445
PULL	-0,316021*	-0,040434
SLSQ1	-0,245391*	-0,042756

* statistically significant difference in relation to theoretically predicted value ($p < 0.05$)

Discussion and conclusions

Results of this study have confirmed that experimentally derived allometric coefficients (exponents) for body mass and height are not significantly different from those assumed theoretically (b_{BM}=*-0,33*). As far as fat free mass is concerned, theoretical assumption wasn't confirmed for the tests. *Average allometric coefficients for body mass in a group of relative strength tests* obtained in this study was b_{BMav}=*-0,99* (*SD=0,56*), which was not statistically different from theoretically predicted value b_{BM}=*-0,33*. In a similar study involving large number of participants and relative strength tests Marković and Jarić (2004.) obtained similar experimental allometric coefficients for body mass to theoretical ones in most of the included tests with average value not significantly different (*b=-0.54*; *SD=0.28*).

Allometric coefficient for body mass in a single upper body test of relative strength *Push-ups performed in two minutes* (PUSH2) was b_{BM} = *-0,96* (*95%CI: -1,3 do -0,61*) and was significantly different from theoretical b_{BM}=*-0,33* ($p < 0.000$). If one observes the confidence interval it is evident that it does not include theoretical coefficient and therefore can be concluded that obtained AC is significantly different from theoretically predicted. Conversely, Marković & Jarić (2004.) obtained higher values b_{BM}=*-0.42 (r=0.20, p>0.05)* which were much closer to theoretical ones, athough their research does not provide information on the differences regarding the theoretical AC. Also, Vanderburgh and colleagues (2011.) obtain a value b_{BM}=*-0,66* (95%CI: ±0,46) somewhat lower than the theoretically predicted (-0,33) and conclude that since the CI contains theoretically predicted value that their finding matches the findings of other studies (Crowder & Yunker, 1986.; Vanderburgh & Mahar, 1995., Marković & Jarić, 2004.)

For normalization of the *Pull-ups to exhaustion* test (PULL) allometric coefficient for body mass was b_{BM}=*-1,79* (*95%CI: -2,32 do -1,27*). As in PUSH2 results were significantly lower than theoretical ones and didn't overlap the theoretical value in confidence interval. Regardless, they are in accordance with the results of Crowder & Vanderburgh (1995.) who obtained a value of *b=-2.03 (95% CI: -1.76 to -2.30)* for the same test. It is evident that the experimental coefficient is quite lower than predicted theoretical (-0.33) and therefore does not confirm theoretical presumptions. Further on, Marković & Jarić (2004.) obtained higher results for the normalization of the same test, b_{BM}=*-1.08 (r=0.27, p<0.05), but also quite different than theoretical one.*

In conclusion, all previous investigations that tried to establish body mass allometric coefficients for the upper body relative strength test – Pull-ups, have not accomplished to confirm theoretically predicted and expected values, but have produced quite higher ones. There were no relevant explanations for the underlying causes. One may assume that one of the potential problems in such exhaustive and difficult test is participants' motivation to give maximum efforts during performace of the test (Jarić, 2002.).

For normalization of the *Sit-ups performed in one minute* test (SIT1L) the results of this research provided AC values for body mass b_{BM}=*-0,59* (*95%CI: -0,85 do -0,35*). Results, although higher than in other test, are still lower than the theoretically predicted and significantly different. They also differ from the results of previous investigations by Marković & Jarić (2004.) (b_{BM}=*-0.30*), and Crowder & Vanderburgh (1995.) [b_{BM}=*-0.22 (95%CI: -0,12 do -0,32)*].

Single leg squats in performed in one minute test (SLSQ1) provided results of AC for body mass b_{BM}=*-0,63* (*95%CI: -0,84 do -0,43*). These results are also significantly different than those theoretically predicted and those od previous research by Marković & Jarić (2004.) (b_{BM}=*-0.51*). When the results of this investigation and the results of the previous ones are taken into consideration it may be concluded that people with larger body mass are significantly handicapped for performing tests of relative strength in relations to people with smaller body mass and that, although research suggest allometric coefficients for normalization to be lower than theoretical of -0,33., allometric coefficients of at least b_{BM}=*-0,33* should be used when assessing relative strength. That would allow for more reliable comparison of results and tested participants.

If one takes into consideration an *allometric coefficient for fat free mass in tests of relative strength,* then as it is shown in Table 4, AC equals b_{FFMav}=*-0,13* (*SD=0,11*) which is significantly different (*p=0,03*) from theoretically predicted value b_{FFM}=*-0,33*. AC values for each of the relative strength test according to fat free mass were: PUSH2 b_{FFM}=*-0,13* (*95%CI: -0,60 to 0,34*); sit-ups or SIT1 b_{FFM}=*-0,02* (*95%CI: -0,36 to 0,31*); pull-ups or PULL b_{FFM}=*-0,08* (*95%CI: -0,79 to 0,62*); squats or SLSQ1 b_{FFM}=*-0,27* (*95%CI: -0,55 to 0,01*). Crowder & Yunker (1986.) obtained the following results of allometric coefficients for push-ups b_{FFM}=*-0,28* (*95%CI: -0,04 do -0,52*), and for sit-ups b_{FFM}=*-0,21* (*95%CI: -0,09 to -0,33*), while Crowder & Vanderburgh (1995.) obtained b_{FFM}=*-1,88* (*95%CI: 1,53 do -2,23*) for pull-ups. It is evident that those results and results of this research are inconsistent with one another. Although, in this research allometric coefficients for fat free mass in tests of relative strength (Tables 3 and 4) are very close to b_{FFM}=*0*, suggesting that the main confounding factor may might be in fact fatty tissue, also supported by correlation coefficients.

Average allometric coefficient for body height in tests of relative strength was b_{BHav}=*-2,27 (SD=1,11)* (Table 4) which is not significantly different from theoretically predicts value of b_{BH}=*-1*, (*p=0,11*). Results are corroborated by the study of Marković & Jarić (2004.) in which the value of AC was slightly higher b_{BHav}=*-1,51* (*SD=0,54*), but also not significantly different from theoretical one. Very low average allometric coefficient of this study is especially influenced by significantly low results in separate tests such as PUSH2 b_{BH}=*-3,31* (*95%CI: -4,58 to -2,04*) and PULL b_{BH}=*-3,01* (*95%CI: -4,93 do -1,09*) which was also the case in a study by Marković & Jarić (2004.). Results of both studies suggest that body height represents extremely aggravating factor for performance of relative strength test. In other words, tall people perform worse in test involving upper body limbs for managing their own body mass compared to shorter ones.

References

1. Batterham, A. M., & George, K. P. (1997.). Allometric modeling does not determine a dimensionless power function ratio for maximal muscular function. Journal of Applied Physiology, 83 (6), 2158-2166.
2. Crowder, T. A. & Vanderburgh, P. M. (1995.). Scaling of pull-ups by body mass and lean body mass for young, fit men. Medicine and Science in Sports and Exercise, 27 (5), S41.
3. Crowder, T., Yunker, C. (1996.). Scaling of push-up, sit-up and two-mile run performances by body weight and fat-free weight in young, fit men. Medicine and Science in Sports and Exercise, 28 (5) - p 183.
4. Davies, M. J. & G. P. Dalsky (1997.). Normalizing strength for body size differences in older adults. Medicine and Science in Sports and Exercise, 29 (5), 713-717.
5. Jaric, S. (2002.). Muscle Strength Testing. Use of normalisation for body size. Sports Medicine, 32 (10), 615-631.
6. Jarić, S., Mirkov, D., Markovic, G. (2005.). Normalizing Physical Performance Tests for Body Size: A Proposal for Standardization. Journal of Strength and Conditioning Research, 19 (2), 467-474.
7. Markovic, G., Jaric, S. (2004.). Movement performance and body size: the relationship for different groups of tests. European Journal of Applied Physiology, 92, 139-149.
8. Vanderburgh, P. M. (2008.). Occupational relevance and body mass bias in military physical fitness tests. Medicine & Science in Sports and Exercise, 40 (8), 1538-1545.
9. Vanderburgh, P. M., Mickley, N. S., Anloague, P. A., Lucius, K. (2011.). Load-carriage distance run and push-ups tests: no body mass bias and occupationally relevant. Military Medicine, 176 (9), 1032-1036.
10. Vanderburgh, P. M. (2012.). Body Mass Bias in Exercise Physiology, An International Perspective on Topics in Sports Medicine and Sports Injury, Dr. Kenneth R. Zaslav (ur.), ISBN: 978-953-51-0005-8, InTech. Available from:http://www.intechopen.com/books/an-international-perspective-on-topics-in-sports-medicineand-sports-injury/body-mass-bias-in-exercise-physiology

THE EFFECT OF THE IMMEDIATE APPLICATION OF DIFFERENT KINDS OF STRETCHING ON VERTICAL JUMP IN THE ATHLETES – JUMPERS

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Abstract

This paper focuses on identifying the impact of different kinds of stretching exercises on performing explosive-strength exercise. The research evaluated the effects of dynamic stretching with a frequency of motion units of 30 per minute (DS 30), dynamic stretching with a frequency of motion units of 60 per minute (DS 60), static stretching with a duration of 30 seconds (SS 30), static stretching with a duration of 60 seconds (SS 60) and without stretching (NO) on the height of jumps with countermovement (CMJ) and without countermovement (SJ).

Key words: *Dynamic stretching, static stretching, countermovement jump, squat jump, frequency of motion units, stretching with a duration*

Introduction

Stretching is an important part of every training process or a preparation for a competition. It is a preparation of the whole organism for sport and its goal is to improve range of a movement and to stretch muscles, tendons and ligaments. Benefits of a fitness training are well-known, however, not often there is paid proper attention to the importance of the right warm up before a physical activity or to the necessity of stretching after a physical activity.

Opinions on stretching have gone through a dynamic progress during the past years. Neverthless, the following questions are still being asked: What kind of stretching to use before a physical activity as a part of the warm up? What kind of warm up is ideal?

According to A.G.Nelson & J.Kokkonen (2009), we divide stretching into 4 types: static stretching, PNF stretching, ballistic stretching and dynamic stretching.

A studies of authors Behm & Chaouachi (2011), Douglas et al. (1999), Gleim & McHugh (1997), McDaniel & Dykstra (2008), Marek et al. (2005), Power et al., (2004), Robbins & Scheuermann (2008), Young & Behm (2003), point at a negative influence of the static stretching before the performance of explosive-strength character up to 60 minutes. According to these authors, there is an assumption that during the static stretching the following factors have a negative influence on production of the muscle strength: mechanic factors, such as changes of viscoelastic properties of the muscle-tendon apparatus and neurological factors, such as for example reduction of activation of motor units.

Static stretching can change the relation of lenght and tension in the muscle, or a plastic change of the connective tissue in such way, that the maximal ability of the strength production is limited. The authors also claim that the static stretching, which causes decrease of strength production in a muscle, is related to a reduction of stiffness of the muscle, which changes the lenght and tension in muscle fibres. Researches also show that the static stretching can have harmful results on performance requiring maximal speed and expplosive strength and does not neccessarily have to lead to a reduction of the number of injuries.

On the other hand, the dynamic stretching uses controlled movements on the edge of the range of the movement specific for the certain physical activity. After the warm up with the dynamic stretching, there is a faster contraction of the muscle, causes post-activating potentiation in muscles, that is a mechanism that influences the growth of stength in a muscle after a contraction, as a result of a high degree of CNS activation and involvment of a high number of motor units for the time of 5-30 minutes (Lorenz in Behm &Chaouachi, 2011). It stimulates the nervous system and increases the amount of connections or cross-bridge attachments that produce strength. At the same time it improves coordination and balance and decreases the risk of an injury (Douglas & Jones, 1999). It also improves the perception of the body (Faigenbaum in Curry et al., 2009).

Because the effect of the static stretching with a duration 45 - 60 s is not still clear and the negative effect on the performance was documented with a duration of 90 s (Kay & Blazevich, 2012), I have focused in the study on the effect of the static stretching with a duration 60 s. I have also tried to clarify the negative effect of a shorter static stretching with a duration 30 s. Regarding the dynamic stretching, the literature has shown the need of better and more accurate setting of the intensity of the dynamic stretching and to verify its influence on performance of the explosive-strengh character.

The goal of the work

The main goals of the work are:

1) To verify the negative influence of the static stretching on performances of explosive-strength character with a countermovement and without it;
2) To find out the effect of the static stretching with a duration 30 s and 60 s on performances of explosive-strength character with a countermovement and without it;
3) To analyze the effect of the dynamic stretching excercised with the frequency of 30 motion units per minute and 60 motion units per minute on performances of explosive-strength character with a countermovement and without it;
4) To find out differences between the effect of the static stretching, dynamic stretching and without stretching on perfomances of explosive-strength character with a countermovement and without it.

Hypotheses

1) V(11) DS 30, DS 60 CMJ, SJ > V(11) SS 30, SS 60 CMJ, SJ (we expect significantly better performance after application DS 30, DS 60);
2) V(11) DS 60, CMJ, SJ > V(11) DS 30, CMJ, SJ (we expect significantly better performance after application DS 60);
3) V(11) SS 30, CMJ, SJ > V(11) SS 60, CMJ, SJ (we expect significantly better performance after application SS 30);
4) V(11) DS 30, DS 60 CMJ, > V(11) NO, CMJ, SJ (we expect significantly better performance after application DS 30, DS 60);
5) V(11) SS 30, SS 60 CMJ, >V(11) NO, CMJ, SJ (we expect significantly better performance after application NO).

Explanations:
V(11) - tested group
SS 30 - static stretching wih a duration 30 s
SS 60 - staic stretching with a duration 60 s
DS 30 - dynamic stretching with the frequency of 30 motion units per min
DS 60 - dynamic stretching with the frequency of 60 motion units per min
CMJ - Counter movement Jump
SJ - Squat jump
NO - without stretching

Methods

The analyzed tested group for a cooperation of the effect of the static stretching (with a duration) and the dynamic stretching (frequency of the motion units per minute) consisted of 11 people (5 men, 6 women) aged 17-18 years. The analyzed people were sport-active athletes (long jump, triple jump and high jump) of Sport-high school Ludvíka Daňka in Brno. Jumping disciplines require high level of explosive strength and speed – that is the movement abilities that should be influenced by the application of stretching. The analyzed group was chosen according to the availability and voluntariness. Because the chosen group comprises of students of a sports grammar school, it is possible to assume a high level of a right technical performance of by us chosen test.

The research strategy had an interindividual one-group character. The stretching realised in the research was focused mainly on muscle groups activated at jumps: extensors of the knee, plantar flexors, hamstrings, adductors, gluteus, spine errector.

To diagnose the vertical jump with the countermovement and without the countermovement we used the Myotest machine. The factor of explosive strength – the height of the vertical jump (in cm) was evaluated. For the analysis of changes in the chosen parameter of performance of explosive strength we used comparative analysis. The verification of the hypotheses was carried out by the following statistical methods:

1) Tests of normality according to Lillieforse (Kolmogorov-Smirnov´s test), which does not reject the normality of the data resolution;
2) Bartlett´s test – verification of the hypothesis about the same dispersion of the normal resolution, which did not reject the homogenity of dispersions
3) ANOVA
4) The coefficient of of the substantive significance – Cohen’s d

Results

The results of the test of the vertical jump with the countermovement (CMJ) after the application of the static stretching with a duration of 30 s, 60 s (SS 30, SS 60), after the application of the dynamic stretching with the frequency of motion units 30 per minute and 60 per minute (DS 30, DS 60) and without stretching (NO) are stated in the Table 1., 2., Figure 1 and in the Table 3.

Table 1: Achieved average performance after different kinds of stretching, without stretching and statistical characteristics of CMJ (cm)

CMJ (cm)					
	SS 30 CMJ	SS 60 CMJ	DS 30 CMJ	DS 60 CMJ	NO
Average	37,5	38,2	39,4	39,4	38,8
Median	37,1	38,5	39,1	38,8	39
Maximum	48,7	53,0	51,0	52,2	51
Minimum	28,0	27,4	28,8	28,8	30,7
SD	7.4	8.6	7.9	7.9	6.9

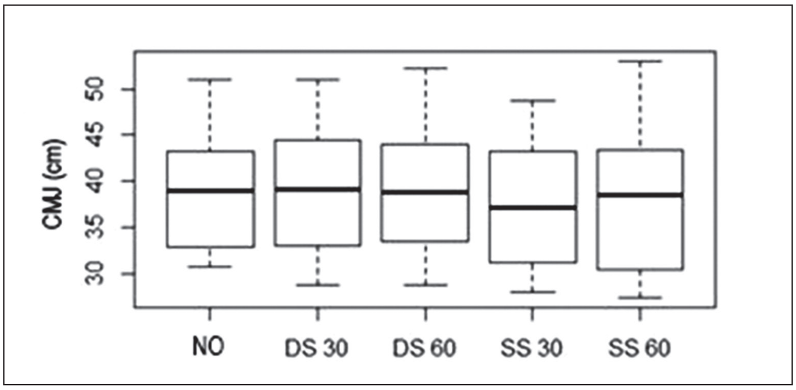

Figure 1: Median, upper quartile, lower quartile, maximum and minimum in performance CMJ

According to the results it is evident that in average in the vertical jump with the countermovement (CMJ) it was achieved a higher performance of the analysed parametre after the application of the dynamic stretching with both higher and lower frequency of motion units per minute (DS 30, DS 60). The lowest performance we can see after the application of the static stretching with a duration of 30 s (SS 30) and then after the application of the static stretching with a duration of 60 s (SS 60).

The results of the ANOVA test do not show any statistical significance (p = 0,973), the value F is 0,124, (Table 2), the coefficient of the substantive significance is 0,02.

Table 2: Results of ANOVA (CMJ)

	Df	Sum Sq	Mean Sq	F	p
ss	4	30,1	7,51	0,124	0,973

The results of the test of the vertical jump without countermovement are stated in the Table 3., 4., Figure 2 and in the Table 5. The best average performance of the tested parametre was achieved after application without stretching (NO), the lower average performance we observed after application static stretching with a duration 60 s (SS 60).

Table 3: Achieved average performance after different kinds of stretching, without stretching and statistical characteristics of SJ (cm)

SJ (cm)					
	SS 30 CMJ	**SS 60 CMJ**	**DS 30 CMJ**	**DS 60 CMJ**	**NO**
Average	33,6	33,2	34,7	35,0	35,1
Median	34	35	34,1	36,8	35,1
Maximum	41,3	40,6	45,3	43,1	44,5
Minimum	27,0	26,8	26,5	27,0	28,0
SD	5,4	5,0	5,9	5,4	5,5

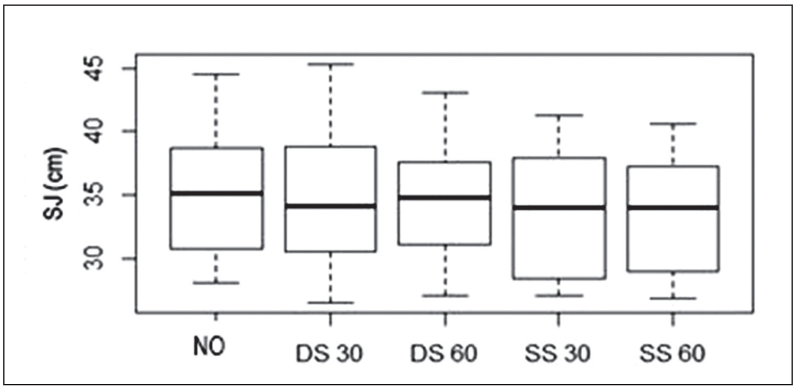

Figure 2: Median, upper quartile, lower quartile, maximum and minimum in performance SJ

The results of the ANOVA test do not show any statistical significance (p = 0,90), the value F is 0, 263, (Table 4), the coefficient of the substantive significance is 0,19.

Table 4: Results of ANOVA (SJ)

	Df	**Sum Sq**	**Mean Sq**	**F**	**p**
ss	4	31,3	7,831	0,263	0,90

Discussion

From the results presented in this work we can say, that we reject the hypotheses about the inequality of performances after the application of each type of stretching. We can say that at the stated design of the research it is possible to confirm, at the defined 5% level of significance, achieving the same performance in the test of the vertical jump with the countermovement and without the countermovement at jumpers of the performance level after the application of each type of stretching and without the stretching. The frequency of the motion units of the dynamic stretching (DS 30, DS 60) has not showed very significantly in the performance in the vertical jump with the countermovement and without the countermovement, as well as the duration of the static stretching (SS 30, SS 60).

However, at the rating of the results it is neccessary to consider the size of the analyzed group, which consisted only of 11 people. It is undestandable that it is difficult to reach statisticly significant differencies in such small group. It is neccessary to consider that the influence of the dynamic stretching on the performance will not be as signifacant at athletes as at untrained people. (small initiative for activation motor units at athletes who have a strength training 3 times a week). As a conclusion, the documented differencies in performances after different type of stretching were relatively small and only exceptionally they reached 4-5 cm in individual cases. Neverthless, the average results after the dynamic stretching always tended to be slightly better (+ 1-2cm) than after the static stretching and the results after the static stretching were the worst of all tested procedures. These tendencies comply with most of the so far undertaken studies.

Conclusion

Although have the results of the study shown no differencies in performances after the application of each type of stretching and without stretching, we recommend to follow the current trends and to apply the dynamic stretching in sports with explosive-strength character.

References

1. Behm D. G. & Chaouachi A. (2011). *A review of the acute effects of static and dynamic stretching on performanc*e. Eur J Appl Physiol.; 111(11):2633-51.
2. Curry, B. S., Chengkalath D., Crouch G. J., Romance M., & Manns P. J. (2009). *Accute effects of dynamic stretching, staic stretching, and light aerobic aktivity on muscular performance in women.* J Strength Cond res 23:1811-1819.
3. Douglas P. M. & Jones T. M. (1999). *Guidelines to the Implementation of a Dynamic Stretching program.* National Strength & Conditioning association. Volume 21, Number 6, pages 53–55.
4. Gleim & McHugh. (1997). *Flexibility and its effects on sports injury and performance.* Sports Medicine, 24 (5), p. 289−299.
5. Kay, A. D., & Blazevich A. J. (2012) *Effect of accute static stretching on maximal muscles performance. Med Sci Sports Excers.* 44(1), 154−64.
6. McDaniel, L. & Dykstra B. (2008). *How does static stretching affect an athletes performance?* [Online] Retrieved from: https://www.brianmac.co.uk/articles/article027.htm
7. Marek S. M., Cramer J. T., Fincher A. L., Massey L. L., Dangelmaier S. M., Purkayastha S, Fitz K. A., & Culbertson J. Y. (2005). *Acute Effects of Static and Proprioceptive Neuromuscular Facilitation Stretching on Muscle Strength and Power Output.* J Athl Train.; 40(2):94-103.
8. Nelson, a. G. & Kokkonen. (2009). *Strečink na anatomických základech*. (1st. Ed.). Praha: Grada Publishing, a. s.
9. Power K., Behm D., Cahill F., Carroll M., & Young W. (2004) *An acute bout of static stretching: effects on force and jumping performance.* Med Sci Sports Exerc.; 36(8):1389-96.
10. Robbins J. W., & Scheuermann B. W. (2008). *Varying amounts of acute static stretching and its effect on vertical jump performance.* J Strength Cond Res.; 22(3):781-6.
11. Young W. B., & Behm D. G. (2003). *Effects of running, static stretching and practice jumps on explosive force production and jumping performance.* J Sports Med Phys Fitness.; 43(1):21-7.

DIFFERENCES BETWEEN TEN GENERATIONS OF FEMALE STUDENTS OF FACULTY OF KINESIOLOGY ON BURPEE30 TEST

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Abstract

Over a ten-year period, longitudinal monitoring of differences and progress in execution of Burpee30 test for evaluation of total body strength, muscular endurance and coordination between initial and final measurement was conducted on a sample of 579 female students on the first year of Faculty of Kinesiology. T – test for dependent samples of two measurements of individual generations ($p<0.05$) has shown expected significant differences in each individual generation. Post Hoc Sheffe test has shown statistically significant differences between generations, in generations which had significant differences in execution of entrance exam.

Key words: *body strength, coordination, muscular endurance, all-in-one exercise*

Introduction

Burpee test or exercise was invented by an American physiologist Royal H. Burpee during the thirties of the last century with a goal to assess the fitness level, quickly review agility, coordination and strength of recruits. This test was used as a fitness test in the military from 1944. (Phillips, 2015). Former researches were dominantly focused on the population of soldiers, police and firemen (Crawley et al., 2015), with the goal of evaluation of effects of high intensity training and specific endurance (Gillen, Gibala, 2013; Gist et al., 2014).

Aside from a relatively high level of adoption of various motor knowledge, high level of motor abilities such as: speed, strength, coordination and endurance, are of great importance in order for students of Faculty of Kinesiology to solve specific demands which are placed before them by the educational plan and program. All-in one exercise or test which involves some degree of agility, balance, coordination, and total body strength, elicits relatively higher acute metabolic demands than traditional resistance exercises (Ratamess et al., 2015). Burpee30 test is a full body, strength exercise that will build and strengthen muscles (arms, shoulders, back, chest, glutes, quads, core and legs), targeting these muscles to improve muscle tone (Phillips, 2015). Therefore, as one of the prerequisites to successfully pass the exam of Basic Kinesiologic Transformations class, variant of Burpee30 test was chosen, in which students had to perform 30 repetitions in 60 seconds.

Methods

This research encompassed ten generations (579) of female students of first year of regular course of study of Faculty of Kinesiology of University of Zagreb; age of 19±1.3 years, average body height ATV = 168.67±2.36 cm; body weight ATT = 60.55±0.8 kg.

Variant of Burpee30 test for evaluation of whole body strength, coordination and endurance was conducted on the beginning of the academic year in month of October, for the purpose of evaluation of different abilities before the execution of the educational plan and program of the study. Students had to perform 30 repetitions of the task: from a squat position with hands on the floor in front, kick feet back and drop into a plank straight position, then return back to the squat position as fast as possible with feet in toward hands and jump up, in the shortest possible amount of time. All students that managed to perform 30 repetitions on the initial measurement were included in the research, regardless of the time needed to execute all of the repetitions. Final measurement was conducted in the month of May at the end of the academic year, after eight months of physically demanding educational process, practical classes in athletics, volleyball, handball, combat sports and Basic Kinesiological Transformations, within which four circuit-based interval trainings were conducted, two weeks before the final testing. A circuit-based whole-body aerobic resistance training program can elicit a greater cardiorespiratory response and similar muscular strength gains with less time (Myers et al., 2015). Training sessions (90 minutes) including warm-up, recovery periods (approximate 60 seconds rest) after 30 seconds intervals of workouts (15 to 22 exercises) and cool down (Gillen and Gibala, 2014) were conducted with the purpose of development of basic motor abilities and dominantly strength of all topological regions of the body, coordination and endurance.

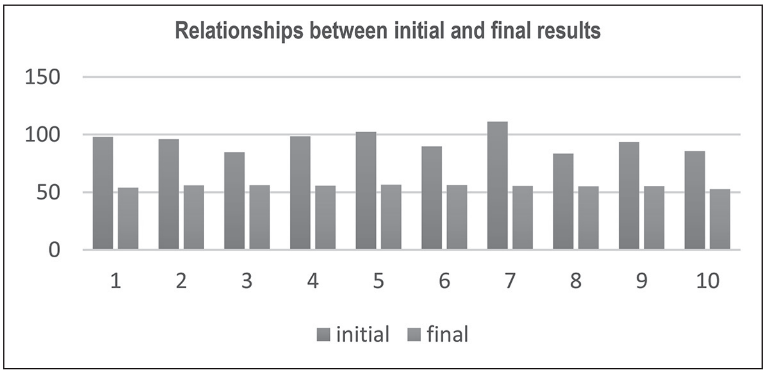
Data was processed by the statistical software package Statistic 13.2. With employment of Kolmogorov-Smirnov test, it was established that the results of the initial and final measurements of individual generations do not significantly deviate from normal distribution, and further processing of the results was done through descriptive analysis (mean, minimum, maximum, standard deviation). With the t-test for dependent samples, it was determined if there were statistically significant differences in the initial and final measurements between individual generations: arithmetic mean (am), standard deviation (sd), number of female students (N), difference (diff), standard deviation of differences (sd.diff), t-value (t), degrees of freedom (df), error (p). The difference between arithmetic mean couples which statistically significantly differ between the generations was tested with Post Hoc Sheffe test.

Results

Table 1: Descriptive parameters of initial (Burpee30 - I)and final(Burpee30 -F) measurement of individual generations

Generation	TEST	N	Mean	MIN	MAX	SD
1.	Burpee30 - I	59	97,88	58,60	180,00	41,32
	Burpee30 - F	59	53,87	46,80	60,00	3,09
2.	Burpee30 - I	56	95,98	55,70	180,00	33,45
	Burpee30 - F	56	55,92	46,46	60,00	3,61
3.	Burpee30 - I	74	84,65	56,00	180,00	20,72
	Burpee30 - F	74	56,07	47,01	60,00	3,20
4.	Burpee30 - I	81	98,49	53,11	180,00	35,25
	Burpee30 - F	81	55,58	44,01	59,99	3,63
5.	Burpee30 - I	53	102,25	66,69	171,34	23,21
	Burpee30 - F	53	56,49	47,19	60,00	3,06
6.	Burpee30 - I	54	89,70	63,59	129,84	15,38
	Burpee30 - F	54	56,19	47,08	60,00	3,62
7.	Burpee30 - I	58	111,17	64,28	190,10	33,21
	Burpee30 - F	58	55,36	48,37	60,00	3,27
8.	Burpee30 - I	43	83,44	58,29	124,61	15,81
	Burpee30 - F	43	55,06	46,22	60,00	3,80
9.	Burpee30 - I	51	93,58	55,68	195,64	29,68
	Burpee30 - F	51	55,21	49,49	59,80	2,68
10.	Burpee30 - I	50	85,64	55,11	145,83	18,52
	Burpee30 - F	50	55,95	46,56	59,96	2,92
all	Burpee30 - I	579	94,55	53,11	195,64	29,56
	Burpee30 - F	579	55,58	44,01	60,00	3,36

Descriptive parameters indicate an expected increase of results from initial to final measurement, which is not exclusively a result of a physically demanding program on the first year of the study, but also because of the requirement that 30 repetitions of the Burpee30 test have to be executed in 1 minute (60 seconds).



Graph 1: Representation of relationships of acquired result through initial and final verification

Table 2: T – test for dependent samples of two measurement of individual generations

Generation	Variable	T-test for Dependent Samples (Burpee30) Marked differences are significant at p < ,05000									
		am	sd	N	diff.	sd.diff.	t	df	p	Confidence -95,000%	Confidence +95,000%
1.	Burpee30-I	97,88	41,32								
	Burpee30-F	53,87	3,09	59	44,01	41,39	8,17	58	0,00	33,22	54,79
2.	Burpee30-I	95,98	33,45								
	Burpee30-F	55,92	3,61	56	40,05	33,22	9,02	55	0,00	31,16	48,95
3.	Burpee30-I	84,65	20,72								
	Burpee30-F	56,07	3,20	74	28,58	20,16	12,19	73	0,00	23,91	33,25
4.	Burpee30-I	98,49	35,25								
	Burpee30-F	55,58	3,63	81	42,91	34,32	11,26	80	0,00	35,33	50,50
5.	Burpee30-I	102,25	23,21								
	Burpee30-F	56,49	3,06	53	45,77	22,64	14,72	52	0,00	39,53	52,01
6.	Burpee30-I	89,70	15,38								
	Burpee30-F	56,19	3,62	54	33,51	15,77	15,62	53	0,00	29,21	37,81
7.	Burpee30-I	111,17	33,21								
	Burpee30-F	55,36	3,27	58	55,80	33,38	12,73	57	0,00	47,03	64,58
8.	Burpee30-I	83,44	15,81								
	Burpee30-F	55,06	3,80	43	28,38	16,04	11,60	42	0,00	23,44	33,31
9.	Burpee30-I	93,58	29,68								
	Burpee30-F	55,21	2,68	51	38,38	29,63	9,25	50	0,00	30,04	46,71
10.	Burpee30-I	85,64	18,52								
	Burpee30-F	55,95	2,92	50	29,69	17,75	11,83	49	0,00	24,64	34,73
all	Burpee30-I	94,55	29,56								
	Burpee30-F	55,58	3,36	579	38,97	29,35	31,95	578	0,00	36,57	41,37

T-test between the initial and final measurements at a significance level $p < 0.05$ has shown expected significant differences in each individual generation.

Table 3: Post Hoc Scheffe test for the initial measurement results

Generation	Scheffe Test; Variable: Burpee30 - I; Marked differences are significant at p < ,05000									
	{1} M=97,875	{2} M=95,975	{3} M=84,648	{4} M=98,495	{5} M=102,25	{6} M=89,697	{7} M=111,17	{8} M=83,436	{9} M=93,581	{10} M=85,640
1 {1}		1,000	0,636	1,000	1,000	0,986	0,708	0,706	1,000	0,838
2 {2}	1,000		0,834	1,000	0,998	0,998	0,532	0,861	1,000	0,943
3 {3}	0,636	0,834		0,434	0,234	1,000	**0,001**	1,000	0,966	1,000
4 {4}	1,000	1,000	0,434		1,000	0,961	0,676	0,557	1,000	0,716
5 {5}	1,000	0,998	0,234	1,000		0,820	0,975	0,332	0,983	0,469
6 {6}	0,986	0,998	1,000	0,961	0,820		0,075	1,000	1,000	1,000
7 {7}	0,708	0,532	**0,001**	0,676	0,975	0,075		**0,006**	0,333	**0,012**
8 {8}	0,706	0,861	1,000	0,557	0,332	1,000	**0,006**		0,967	1,000
9 {9}	1,000	1,000	0,966	1,000	0,983	1,000	0,333	0,967		0,992
10 {10}	0,838	0,943	1,000	0,716	0,469	1,000	**0,012**	1,000	0,992	

Table 4: Post Hoc Scheffe test for the final measurement results

Generation	Scheffe Test; Variable: Burpee30 - F;Marked differences are significant at p < ,05000									
	{1} M=53,870	{2} M=55,924	{3} M=56,073	{4} M=55,581	{5} M=56,487	{6} M=56,186	{7} M=55,364	{8} M=55,060	{9} M=55,205	{10} M=55,952
1 {1}		0,276	0,108	0,430	**0,045**	0,134	0,745	0,955	0,879	0,301
2 {2}	0,276		1,000	1,000	1,000	1,000	1,000	0,996	1,000	1,000
3 {3}	0,108	1,000		1,000	1,000	1,000	0,997	0,980	0,990	1,000
4 {4}	0,430	1,000	1,000		0,983	1,000	1,000	1,000	1,000	1,000
5 {5}	**0,045**	1,000	1,000	0,983		1,000	0,956	0,882	0,918	1,000
6 {6}	0,134	1,000	1,000	1,000	1,000		0,995	0,973	0,986	1,000
7 {7}	0,745	1,000	0,997	1,000	0,956	0,995		1,000	1,000	1,000
8 {8}	0,955	0,996	0,980	1,000	0,882	0,973	1,000		1,000	0,996
9 {9}	0,880	1,000	0,990	1,000	0,918	0,986	1,000	1,000		0,998
10 {10}	0,301	1,000	1,000	1,000	1,000	1,000	1,000	0,996	0,998	

Discussion

Normality of distribution of initial measurement shows negatively asymmetric distribution of results, which is conditioned by the permitted maximal result of 180 seconds for 30 repetitions, but majority of the results is situated in the 60 to 100 second range. Acquired values are not unexpected because Faculty of Kinesiology is enrolled by students of various levels of abilities, capabilities and skill, depending on the extent of their active involvement in sports, which sport they were involved in and on requirements of the entrance exam. Results of final measurement show positively asymmetric distribution with allowed maximal result of 60 seconds, where most of the students achieved results in the last 10 seconds (from 50 to 60 seconds) because of the difficulty of the test itself (30 repetitions).

Most significant differences in descriptive parameters, from initial to final measurement were measured in fifth and seventh generation of students, which had highest average initial results (111,17 seconds, respectively 102,25 seconds) and are also generations of students whose enrollment was not conditioned by a high level of motor abilities, because of a reduction of number of tests used for their evaluation.

Results of Post Hoc Scheffe test for the initial measurement confirmed a statistically significant difference between the third and seventh generation of “old” program and of the “Bologna” program generations and between seventh and eighth generation when the classification procedure for possibility of studying on Faculty of Kinesiology was changed. Statistically significant difference of results of final measurements was obtained between first (with best average result being 53.87 seconds) and fifth generation (with lowest average result being 56.49 seconds), although their progress (diff. = 45,77) was most significant.

Conclusion

Implementation of Burpee30 test in evaluation of initial and final state of level of different motor abilities, as a physically and mentally challenging workout, typical anaerobic exercise (which refers to muscles using glucose in body, rather than oxygen), explosive workouts for maximum results (Phillips, 2015) effect on the body, confirmed that there is a statistically significant difference between measured states between all generations, which confirms the fact that a demanding program of the study causes a positive transformational effect in acquisition of new motor knowledge needed for efficient development of motor abilities. Large number of different factors has a significant impact on the total level of their skills, such as the declining number of female students actively involved in various sporting activities, either in professional sports and/or recreation, etc. (Horvatin-Fučkar et al., 2011). Statistically significant differences were acquired between generations in which the entrance exam for enrollment was significantly changed, either by reducing percentage of importance of motor knowledge and abilities on the overall score (only 20% of points) and/or by reducing the number and selection of tests for evaluation of abilities. Importance of quality of execution of entrance exam in selection of future generations of kinesiologists is ever-increasing.

References

1. Crawley, A.A., Sherman, R.A., Crawley, W.R., Cosio-Lama, L.M. (2015). Physical Fitness of Police academy cadets: Baseline Characteristics and Changes During a 16-Week Academy. Journal of Strength & Conditioning Research, 30(5):1416-1424.
2. Gillen, J.B., Gibala, M.J. (2014). Is high-intensity interval training a time-efficient exercise strategy to improve health and fitness? Appl.Physiol.Nutr.Metab., 39:409-412.
3. Gist, N.H., Freese, E.C., Cureton, K.J. (2014). Comparision of Responses to Two High-Intensity Intermittent Exercise protocols. Journal of Strength & Conditioning Research, 28(11):3033-3040.
4. Horvatin-Fučkar, M., Hečimović, I., Rađenović, O. (2011). Differences in the Explosive Jumping Strength of Different Generations of Female Students at the Faculty of Kinesiology. In: D. Milanović and G. Sporiš (eds.), 6th International Scientific Conference on Kinesiology “Integrative power of Kinesiology” Proceedings Book, (pp. 682-686). Zagreb: Faculty of Kinesiology, University of Zagreb.
5. Myers, T.R., Schneider, M.G., Schmale, M.S. (2015). Whole-Body Aerobic Resistance Trainig Circuit Improves Aerobic Fitness and Muscle Strength in Sedentary Young Females. Journal of Strength & Conditioning Research, 29(6):1592-1600.
6. Phillips, A. (2015). Benefits of the Burpee! Retrieved January 16, 2017 from: http://ameliaphillips.com.au/2015/05/benefits-burpee.html#
7. Rotamess, N.A., Rosenberg, J.G., Klei, S. (2015). Comparison of the Acute Metabolic Responses to Traditional Resistance, Body-Weight, and Battling Rope Exercises. Journal of Strength & Conditioning Research, 29(1):47-57.

DIFFERENCES IN MORPHOLOGICAL CHARACTERISTICS BETWEEN MEMBERS OF INTERVENTION AND SPECIAL POLICE

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Abstract

The purpose of this research was to determine statistically significant differences in arithmetic means for independent samples. The data were processed by application of T-test. The research was carried out on a sample of 70 police officers divided into two groups: 35 intervention police officers and 35 special police officers. Intervention police officers on average are taller than the special police officers; also they are heavier but not statistically significantly heavier. Special police officers have a statistically smaller skin fold thickness measurements of the upper arm (ANAD_X), abdomen (ANTR_X) and the chest (ANPRS_X) as a result of everyday obligatory exhausting and various specialized trainings for special police officers. It was found that special police officers have smaller hip circumference (OPKUK_X), smaller amount of subcutaneous (sub-skin) fat on the hips, which also can be attributed to the impact of intensive specialized training. The obtained results about differences in anthropometric characteristics in favour of special police officers compared to members of the intervention police can be attributed to the high-quality selection process for police officer entrance exam to the special police force. Type of training for special police force is a form of high-intensity training which is more complex and more comprehensive concerning matters arising out of official duties of special police units. The structure of elements of entrance exam for admission to the special police unit has determined the level of anthropometric characteristics of special police which is more homogeneous in their composition. Members of intervention police are more heterogeneous in their composition and with much lower level of carried out both general and specialised training. Members of special police are above average when it comes to conditional preparedness, with high-quality technical and tactical competencies, and optimal health status, which is essence of top level athletes.

Key words: *anthropometric characteristics, t-test, subcutaneous fat, skin folds, specialized training*

Introduction

An important postulate of the scientific approach to members of police populations is that both, conditional abilities and morphological characteristics should be continuously measured and improved using an appropriate physical conditioning program and high-quality scientific diagnosing. Data obtained by measuring reveal only how far our knowledge does reach about biological characteristics which we expressed by the number and possibility of application of the obtained values. Body weight of police officers increases with chronological age, which is related to transversal and circular increases in body dimensions, (Lauš, 2008). Therefore body mass index is increased. The body mass index or Quetlet index (body mass index - BMI) is defined as a BMI - body weight / body height^2, and is used for the quick but approximately assessment of good nutritional status (Mišigoj-Duraković et al., 2008). In every moment police officers of special police force for efficient performance of their tasks have to be physically prepared same as top-level athletes (Šalaj, D., Šalaj, S. 2011), respectively, they have to be trained as athletes with the aim of increasing situational efficiency and reducing negative impact on their psycho-somatic status in general. Measurability of anthropometric characteristics enables physical fitness diagnosis in the intervention police officers at the time of entrance into the intervention police unit and at every stage of the long-term motor improving (Jozić, Zečić, 2008). The dominant form of training in the police force and also in the army should be based on the principle of "you can fight only the way you practice", which means that training has dominantly specific and situational characteristics (Šalaj and Šalaj, 2011). In addition to high-quality core conditional preparedness for realization of such a "dominant" training, it is necessary to monitor and evaluate the morphological characteristics that are correlated with the motor abilities.

The main aim of the research is to determine whether there are differences in morphological characteristics (anthropometric characteristics) between intervention police officers and special police officers. In accordance with a previously defined aim, based on results up to date and the experts' experiences in the research field, the following hypothesis is define: H 1- there are statistically significant differences between members of intervention and special police in some anthropometric characteristics of police officers.

Methods

Sample of entities includes two entities of the police officers, 35 intervention police officers and 35 special police officers. Variables used in this research for the assessment of morphological characteristics were: body height (ATV), body weight (mass) (ATT), skin fold thickness of the upper arm (ANAD), skin fold thickness of the back (ANLE), skin fold thickness of the abdomen (ANTR), abdominal circumference (OPTRBU), hip circumference (OPKUK), body mass index (BMI) (Jukić et al., 2008), the index for assessment of risk type of obesity (WHR), (Lauš, 2017). In processing of data we used standard methods of descriptive statistics. Calculated parameters were:

- Arithmetic mean (A.S), standard deviation (S.D), the maximum result (Max), the minimum result (Min), Skewness-asymmetry measure (a 3), Kurtosis- measure of curvature (a 4)
- Univariate test for determining the differences between the independent groups: t-test as measure of discrimination of arithmetic mean for groups (t), degrees of freedom (df), the error of conclusion (p). Data are analyzed by statistical package "Statistica for Windows 10.0".

Results and discussion

Table 1: Descriptive statistics of the applied variables in a group of intervention police officers

Variable	Valid N	Mean	Min.	Max.	Range	Std. Dev	Skewness	Kurtosis
ATV	35	182,80	172,00	195,00	23,00	5,57	0,20	-0,25
ATT	35	89,83	70,00	115,00	45,00	11,33	0,28	-0,18
ANAD_X	35	12,66	4,33	25,67	21,33	4,69	0,81	0,51
ANLE_X	35	14,48	7,33	34,33	27,00	6,84	1,75	2,80
ANTR_X	35	18,10	6,33	45,00	38,66	9,03	1,41	1,88
ANPRS_X	35	10,83	4,00	22,67	18,67	4,61	0,61	-0,31
OTRBU_X	35	91,64	74,67	120,67	46,00	9,27	0,67	1,47
OPKUK_X	35	103,22	92,33	116,00	23,67	6,33	0,33	-0,66
BMI	35	26,82	21,56	33,60	12,03	2,65	0,17	-0,07
WHR	35	0,89	0,79	1,04	0,25	0,05	0,27	0,99

Descriptive statistics about intervention police officers is presented in Table 1. Based on skin fold thickness measurements of the upper arm (ANAD), we can detect that the skin fold measurements of intervention police officers are similar to average values of skin fold measurements of the upper arm of military pilots (Jukić et al., 2008). Furthermore, the skin fold measurements of the back (ANLE) are smaller than the skin fold measurements of the back of military pilots, significantly smaller than the skin fold measurements of cadets but higher than the skin fold measurements of military specialists (12.9 mm). Skin fold measurements of the chest (ANPR) are lower than the skin fold measurements of the chest of military pilots. Reference measurements for skin fold of the abdomen of intervention police officers (ANTR)), (Table 1), are lower than the skin fold measurements of the abdomen of military pilots of the Croatian Army (Jukić and sur., 2008), but significantly higher than the members of the special police unit of the Ministry of the Interior of the Republic of Croatia (Table 2). Respectively, the skin fold measurements of abdomen of intervention police officers of Croatian Ministry of the Interior are lower than the skin fold measurements of the abdomen of the policemen of Ministry of the Interior of the Republic of Slovenia and from the sample of workers from Slovenia (Zorec, 2009). The skin fold measurements of the chest (ANPRS) (Table 1) are higher than the skin fold measurements of the chest of the special police officers of the Croatian Ministry of the Interior (Table 2), indicating weaker continuity of specialised training because of increased levels of official duties of intervention police officers, as well as the lack of high-intensity and continuous micro-cycle of a specialised training. Body mass index (BMI) of intervention police officers is almost identical to body mass index of members of the regular police unit of Ministry of the Interior (Lauš, Ćurić, 2011). It is on the borderline between the state of normal weight and overweight, a BMI of 25.0 to 29.9., which individually interpreted in some police officers may be the result of larger amount of muscle mass but also the lack of kinesiological activities. According to the results of previous studies, written by Croatian authors, higher BMI at police officers is a burden that hinder their success in coordination tests, tests of strength and power except in manifestations of explosive strength like throwing (Lauš, Ćurić, 2011). In fact, increased fat deposits under the skin indicate that the body store all the extra intake amount of energy as fat. The human body has a special fat storage area, and these depots are fat cells located under the skin. Increased fat layers under the skin are indicators of taking greater amount of energy than needed (Jukić et al., 2008).

Table 2: Descriptive statistics of the applied variables in a group of special police officers

Variable	Valid N	Mean	Minim.	Maxim.	Range	Std.Dev	Skew.	Kurtosis
ATV	35	180,34	174,00	191,00	17,00	3,75	0,52	0,33
ATT	35	88,75	81,00	113,00	32,00	7,23	1,38	2,33
ANAD_X	35	6,27	3,60	9,33	5,73	1,62	0,34	-0,77
ANLE_X	35	12,42	6,73	20,83	14,10	3,85	0,54	-0,78
ANTR_X	35	10,10	5,26	21,06	15,80	3,54	1,68	3,42
ANPRS_X	35	6,19	3,60	14,40	10,80	2,42	1,90	3,47
OTRB_X	35	92,11	85,33	108,86	22,83	5,51	1,16	1,24
OPKUK_X	35	99,21	88,00	111,00	23,00	4,74	0,23	0,41
BMI	35	27,28	24,45	33,01	8,56	1,89	0,86	1,22
WHR	35	0,92	0,86	1,01	0,14	0.03	0,51	-0,30

The index for the assessment of risk type of obesity (waist - hip ratio - WHR), with an average value of 0.88 (Table 1) for intervention police and an average value of 0.92 (Table 2) for special police indicate that these groups of police officers statistically discriminate regarding to WHR index. Intervention police officers have lower values of WHR index which defines obesity regarding to the distribution of subcutaneous (sub-skin) fat (Mišigoj-Duraković, 2008). According to domestic authors (Lauš, 2017), examinees who had higher WHR had a poorer quality of performance of different techniques and elements of self-defence. According to foreign authors (Patel, Singh, 2013), WHR index is a better predictor of diabetes than waist circumference or body mass index, they calculated cut point for WHR = 0.948, which is approximately same average value obtained by members of intervention and special police. The desirable range of results for WHR is from 0.78 to 0.94. Results of t-test (Table 3) for independent samples, in this case between intervention police and special police officers reveal statistically significant differences in the following variables: body height (ATV), where on average the police officers of intervention are taller than the special police officers. They differ in variable for estimating skin fold thickness of upper arm (ANAD_X), the indicator of amount of body fat, which is significantly lower in special police officers, which is a result of the exhausting daily training, typical for the scope of the special police units. Special police officers have statistically significantly smaller skin fold thickness measurements on the abdomen (ANTR_X) and chest (ANPRS_X), which also can be attributed to the daily exhausting specialized drill for police specialist. Likewise, special police officers have a smaller hip circumference (OPKUK_X), which also can be attributed to the impact of more intensive specialised training, (long march with full equipment, searching the terrain by day and by night, training on inaccessible terrain, mastering the terrain in winter and summer conditions, running - interval training, mastering the polygon of infantry obstacles). Special police officers also differ by approximately smaller, but not statistically significant difference in body weight (Table 3). Outstanding level of strength, endurance and power, whose level determines the level of anthropometric characteristics is desirable for the special police, intervention police, and regular police, whose plans and programs for performance improving should pervade in order to increase the situational efficiency of all members of the Ministry of the Interior. The formation of a special police welcomes the best and most complete members of the intervention and regular police. Members of special police are above the average when it comes to conditional preparedness, with high-quality technical and tactical competencies, and optimal health status, which is essence of top level athletes. According to previously defined aim of the research, the H1 hypothesis is confirmed. There are statistically significant differences between intervention police and special police in some anthropometric characteristics of police officers (Table 3).

Table 3: Results of T- test about the differences between intervention police officers and special police officers

Variable	Valid N	mean	mean	t-value	df	p
ATV	35	182,80	180,34	2,16	68	0,03
ATT	35	89,829	88,75	0,47	68	0,64
ANAD_X	35	12,657	6,27	7,61	68	0,00
ANLE_X	35	14,482	12,42	1,55	68	0,13
ANTR_X	35	18,105	10,10	4,88	68	0,00
ANPRS_X	35	10,838	6,19	5,27	68	0,00
OTRB_X	35	91,648	92,11	-0,26	68	0,80
OPKUK_X	35	103,21	99,21	2,99	68	0,00
BMI	35	26,827	27,28	-0,82	68	0,41
WHR	35	0,887	0,92	-3,77	68	0,00

Conclusion

Statistically significant differences in arithmetic means for independent samples are determined by using T-test for independent samples. Statistically significant differences can be seen in Table 3. Intervention police officers in average are taller than special police officers, they are also heavier than members of the special police unit but not statistically significantly heavier (Table 3). By measuring the subcutaneous (sub-skin) fat tissue we directly determine importance and amount of body fat of police officers. Measuring of the subcutaneous fat tissue has markedly significant benefits in comparison with the measuring of height and body weight of police officers. Special police officers have statistically smaller skin fold thickness measurements of the upper arm (ANAD_X), abdomen (ANTR_X) and chest (ANPRS_X), which can be attributed to everyday exhausting specialized training of special forces. Respectively, special police officers have a smaller hip circumference (OPKUK_X), which also can be attributed to the impact of intensive specialised training, (long march with full equipment, searching the terrain by day and by night, training on inaccessible terrain, mastering the terrain in winter and summer conditions, running - interval training, mastering the polygon of infantry obstacles). Persons who train more often, usually on daily and weekly basis lose subcutaneous fat more intensively and increase lean muscle mass along with many other benefits. Previously mentioned results about differences in anthropometric characteristics in favour of the special police unit compared to members of the intervention police can be attributed to the high-quality selection process for entrance into the special police force. Type of training for special police force is a form of high-intensity training which is more complex and more comprehensive concerning matters arising out of the official duties of the special police units. The structure of elements for police officer entrance exam to admission to the special police has determined the level of anthropometric characteristics of special police which is more homogeneous in their composition.

References

1. Jozić, M., Zečić, M. (2008). Efikasnost treninga specijalističke obuke s naglaskom na trening snage za pripadnike interventne policije MUP-a RH. 6. godišnja međunarodna konferencija, *Kondicijska priprema sportaša* 2008. (ur. I. Jukić, D. Milanović i C. Gregov). Zagreb 22. i 23. veljače 2008. (str. 197-201). Zagreb: Kineziološki fakultet, UKTH.
2. Jukić, I. i sur. (2008). *Dijagnostika kondicijske pripremljenosti vojnika*. Zagreb: Kineziološki fakultet, Institut za istraživanje i razvoj obrambenih sustava (MORH).
3. Lauš, D. (2017). Povezanost kvalitete izvođenja zahvata za privođenje i nekih morfoloških čimbenika. 15. godišnja međunarodna konferencija *"Kondicijska priprema sportaša"*, Zagreb, 24-25. veljače 2017, (str. 195-200). Zagreb: Kineziološki fakultet, UKTH.
4. Lauš, D., Ćurić, I. (2011). Utjecaj indeksa tjelesne mase na koordinaciju, snagu i jakost policijskih službenika. 9. godišnja međunarodna konferencija *"Kondicijska priprema sportaša"*, Zagreb, 25. i 26. veljače 2011. (str.512-515). Zagreb: Kineziološki fakultet, UKTH.
5. Lauš, D. (2008). Razlike u morfologiji odraslih muškaraca. Međunarodna znanstveno-stručna konferencija: *"Kineziološka rekreacija i kvaliteta života"*, 23. i 24. veljače 2008., (str. 343-349). Zagreb: Kineziološki fakultet.
6. Mišigoj-Duraković, M., (2008). *Kinantropologija: Biološki aspekti tjelesnog vježbanja*, Zagreb: Kineziloški fakultet.
7. Patel, D.N., Singh, M.P. (2013).Comparison of anthropometric indicator of general obesity (BMI) to anthropometric indicator of central obesity (WC; WHR) in relation to diabetes mellitusin male population. *National Journal of Community Medicine, 4*(3), 377-380.
8. Šalaj, S., Šalaj, D. (2011). Kondicijska priprema specijalne policije Republike Hrvatske – Antiteroristička jedinica Lučko. *Kondicijski trening, 9*(1), 59-70.
9. Zorec, B., (2009). Anthropometric characteristics in police officers. *URL:* https://www.fvv.um.si/varstvoslovje/.../zorec_vs_2008-4_ang.pdf

ANTHROPOMETRIC PARAMETERS AND CARE OF THEIR NUTRITION OF CZECH ARMY AIR FORCE PILOTS AND CZECH CIVIL PILOTS

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Abstract

Purpose: The aim of the study was to evaluate the anthropometric parameters of military and civil pilots and their knowledge of specific nutrition aspects concerning their profession.

Methods: Information concerning pilots' eating habits has been obtained by a questionnaire. Study group consisted of 58 pilots of transport planes (civil pilots) and military pilots from the Czech Army.

Results: A majority of military pilots, however, stated that they were not familiar, or they were aware but did not maintain the specific nutritional recommendations for pilots on flight days. Most civil pilots reported that they knew these specific nutritional recommendations, yet merely 44% of the respondents followed them. On the basis of BMI values, 59.1% of civil and 61.1% of military pilots had excessive body mass. After starting their job, most pilots reported further weight gain.

Conclusions: While military pilots' nutrition is thoroughly planned in every detail, civil pilots have the freedom to decide whether to practice a healthy lifestyle or not. Employers of civil pilots should pay more attention to adequate nutrition in their employees' canteens as well as to support their physical activities.

Key words: *body weight, body height, body mass index (BMI), healthy condition*

Introduction

Being a professional pilot profession might be described as extremely demanding and stressful. Pilots of any craft are forced to excellent in their performance, since any possible mistake or failure might lead to fatal consequences (Melechovský, 2002). Both military and civil pilots are expected to provide extraordinary performance, since the cockpit and air space might unexpectedly become a hostile area (Thurber, 2006). Pilot´s visual memory should be at higher level compared to the general population (Balint et al., 2015). Health requirements pilots are very strict, in comparison with general population expect the pilots are in much better shape (Vespalec et Zvonař, 2016). Nutritional recommendations for pilots are divided into flight days and non-flight days. For non-flight days, pilots are recommended rational nutrition that does not differ from standard recommendations for the general population. The diet should be varied, nutritionally rich and balanced and it should contribute to good health, since even basal disease might cause complications in piloting due to higher altitude.

On flight days, the diet must be adjusted according to the physiological differences caused by changed properties in the pilot's environment during the course of flight. Nutrition must assure that pilot will be in an awakened state and it should also support pilot's vigilance. Therefore pilots should not fly hungry, as this might lead to rapid tiredness and loss of concentration. In order to prevent stomachache and digestive problems, pilots should avoid fat and meals which cause flatulence (Háčik, 2006). The executive pilots and flying service staff of the Czech Army are provided meals free of charge. The Decree orders (Decree no. 266/1999 Coll.) that military flying service staff might be served a cold breakfast and lunch during planned flights, but only if all available possibilities of serving a proper flying hot dish had been previously excluded. Pre-flight meals or hot dishes for breakfast or lunch must be always served before flight.

Methods

Study group consisted of 58 pilots of transport planes (civil pilots) and military pilots from the Czech Army. Information concerning eating habits of pilots were obtained by the questionnaire made up by Department of Kinesiology, Faculty of Sport Studies, Masaryk University in Brno. The questionnaire was anonymous.

Results and discussion

22 civil and 36 military pilots took part in this research. Anthropometric features of civil pilots and period of their flying experience are given in table no. 1, of military pilots in table no. 2.

Table 1: Anthropometric features of civil pilots

	Age [year]	Body height [m]	Body weight [kg]	Flying experience [year]	BMI
Arithmetic mean	35.54545	1.800455	81.45455	13.77273	25.12182
Standard deviation	8.93272	0.062557	6.57632	8.88273	1.53182

Source: Study of authoress

Table 2: Anthropometric features of military pilots

	Age [year]	Height [m]	Weight [kg]	Flying experience [year]	BMI
Arithmetic mean	36.97222	1.801389	83.11111	16.22222	25.6228
Standard deviation	8.27810	0.068684	8.10959	8.73725	2.23084

Source: Study of authoress

Tables show that average BMI in civil pilot is 25.12 ± 1.53, which is slightly lower than military pilots (25.62 ± 2.23). Both values are in normal zone.

Regarding the age: Q = 41,656.613

$\chi^2_{0,95}(3) = 7.8147$

Regarding the age there exist statistically significant differences on the probability level 0.05.

Next table (Tab. 3) shows BMI values according to categories.

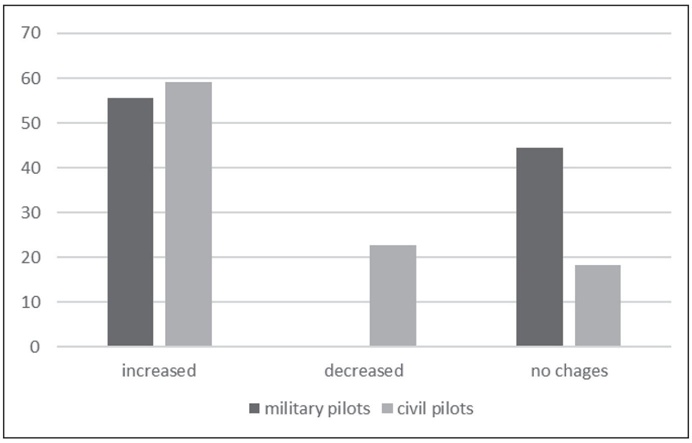
Table 3: Distribution of respondents according to BMI categories

BMI	Number of respondents		Category
	civil pilots	military pilots	
< 18,5	-	-	underweight
18,5 - 24,9	9	13	normal weight
25 - 29,9	13	22	overweight
30 - 34,9	-	1	1st degree of obesity
35 - 39,9	-	-	2nd degree of obesity
> 40	-	-	3rd degree of obesity

Source: Study of authoress

It is obvious that more than half of respondents (59.1% of civil pilots and 61.1% of military pilots) belong to category overweight. This might be caused by two factors. The first one might be the fact, that BMI does not operate with the volume of active body mass and therefore individuals with higher musculature might be assessed as overweight. Secondly, profession of pilot is in fact sedentary job and as such, it might lead to overweight unless the person performs sufficient physical activity in his leisure time – this is probably true for military pilot with number 1 – 50 years old man.

Following question also aims the body weight – respondents were asked whether their body weight has changed since they took up pilot profession. Answers to this question are given in figure 1.

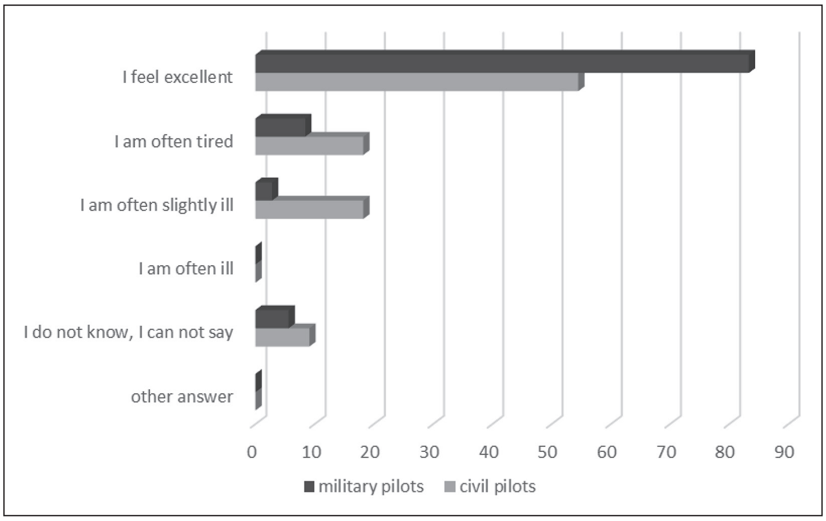


Source: Study of authoress

Figure 1: Changes in respondents' body weight since starting a job

As apparent from this graph 59.1% of civil pilots and 55.6% of military pilots gained their body weight after starting the job. Concerning the fact, that average time of their employment is in civil pilots 13.77 ± 8.88 years and 16.22 ± 8.74 years in military pilots, this result has been predictable with respect to ageing process, when a body weight is naturally increased of about 0.25 kg every year.

Then respondents were asked to provide self-assessment of their own health condition. Answers to this question are shown in figure 2.

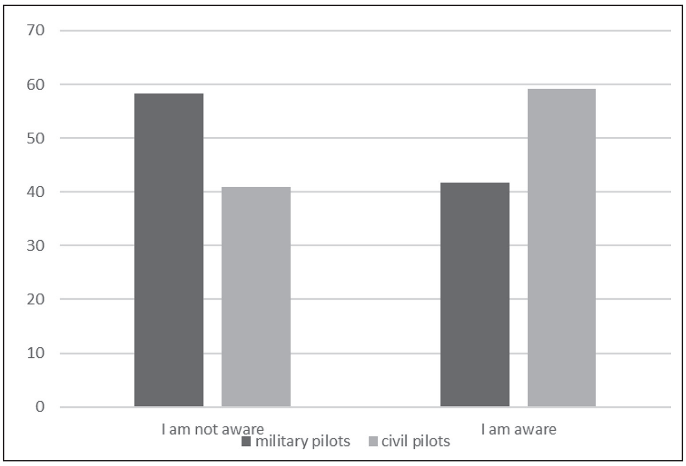


Source: Study of authoress

Figure 2: Self-assessment of current health condition of respondents

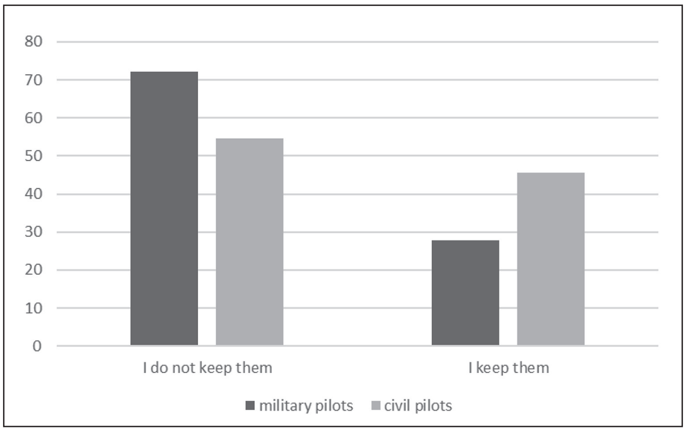
Due to the fact that pilots undergo thorough medical examination regularly, the most frequent answer that they feel excellent (this answer was given by 54.5% of civil and 83.3% of military pilots) was more than desirable. This demanding and responsible profession needs perfectly healthy employees in great condition.

Two following graphs (figure 3 and 4) focus on similar information, yet they particularly concerned pilot profession. Figure 3 shows answers to question whether the respondents are aware of specific nutritional recommendations for pilots on flight days, and figure 4 deals with the question whether the respondents keep these principles.



Source: Study of authoress

Figure 3: Awareness of respondents of specific nutritional recommendations for pilots on flight days



Source: Study of authoress

Figure 4: Keeping the nutritional recommendations for pilots on flight days

Surprisingly, we can see from figure 3 that 59.1% of civil pilots are aware of specific nutritional recommendations for pilots of flight days, while only 41.7% of military pilots gave this answer (Honsová, 2016). Information concerning nutrition issue seem to be rather of general character in the army, military pilots as soldiers encounter the principles of healthy eating in general, but they hardly meet specific principles valid for pilots on flight days and they do not care to maintain them – this answer was given by 72.2% of military pilots (see figure 4). Such finding corresponds to conclusions of questionnaire survey in military pilots in Náměšt nad Oslavou by Špitzerová (2014).

Conclusions

Obtained results show that majority of military pilots (58.3%) surprisingly admitted that they do not know specific nutrition recommendations for pilots during flight days at all, while 72.2% of military pilots do not keep them. Contrary, 59.1% of civil pilots claimed that they know these recommendations, but merely 45.5% of respondents keep them.

According to BMI values similar number of civil (59.1%) and military pilots (61.1%) belong to overweight zone. Moreover, most of civil (59.1%) and military pilots (55.6%) reported that their body weight has increased after they took up the employment. Self-assessment of their own health condition shows that most of military (83.3%) and civil (54.5%) pilots feel excellent.

References

1. Balint, G., Balint, N. T., & Zvonař, M. (2015). Possibilities of assessing the attention and visual memory in primary school children. *Gymnasium, Scientific Journal of Education, Sports and Health,* XVI, 2, 45-51.
2. *Decree no 266/1999 Coll.* (1999). *Vyhláška Ministerstva Obrany č. 266/1999 Sb. o způsobu zabezpečování bezplatného stravování, výstrojních a přepravních náležitostí a o zabezpečování ubytování vojáků z povolání ve znění pozdějších předpisů.* Praha: Ministerstvo Obrany.
3. Háčik, Ľ. (2006). *Lidská výkonnost a omezení.* Brno: Akademicé nakladatelství CERM.
4. Honsová, J. (2016). *Výživové zvyklosti a pohybová aktivita letců*. Brno: MU, FSpS.
5. Melechovský, D., (2002). Kapitoly z letecké medicíny, vyhoření pilota. Downloaded from http://www.leteckylekar.cz/kapitoly-z-letecke-mediciny/51-burn-out-syndrom-pilot.html - 02/14/2016.
6. Špitzerová, L. (2014). *Sledování speciální tělesné přípravy a výživových zvyklostí vojenských pilotů.* [Bachelor´s thesis]. Brno: MU, FSpS.
7. Thurber, M. (2006). *Nine Keys to Hiring Pilots with the Right Stuff.* Business Jet Traveller.
8. Vespalec, T., & Zvonař, M. (2016). Comparison of physical activity and health status in the specified focus group of population to middle-aged and older. In: Zvonař, M., & Sajdlová, Z. *10th International Conference on Kinanthropology „Sport and Quality of Life“.* Brno: MU.

CHANGES IN BIOCHEMICAL BLOOD PARAMETERS IN ONE PRE-SEASON TRAINING UNIT

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Abstract

The body's acid–base balance is tightly regulated by numerous mechanisms keeping the arterial blood pH between 7.35 and 7.45. Diseases as well as physical stress lead to disturbances of acid-base balance, that lead to changes in blood pH and biochemical parameters of blood. The aim of this study was to examine changes in the biochemical parameters before and after single training unit (physical activity). Twenty three male professional soccer players, aged 25.00±4.46 years, participated in this study. Capillary blood samples were collected before and after training to measure concentrations of lactate ([La]), hydrogen ions ([H^+]), bicarbonate ions ([HCO_3^-]), base excess concentrations and the arterial partial pressure of CO_2. Lactate concentration increased from 2.85±0.70 mmol/L before training to 3.58±1.26 mmol/L after training (p=0.031). Comparing the results for blood pH, measured before and after training, we observed no significant changes (p>0.05). Base excess concentration and concentration of HCO_3^- decreased in the body after training, resulting in compensatory metabolic acidosis. Training did not affect the concentration of hemoglobin, and consequently the blood oxygen saturation remained unchanged. The results of the present study show that increased physical activity has resulted in increase of the blood lactate level of the soccer players. At the same time, no significant changes in blood pH were observed because all measurements were performed on athletes who have metabolic and physiological adaptations of muscles.

Key words: *single training unit, lactate, blood pH*

Introduction

Acid-base status in arterial blood (ABS) has a value in the range of 7.35-7.45. Due to this very narrow range of physiological pH it would be expected that the acid-base balance is often distorted. However, several homeostatic responses are activated in order to maintain normal acid–base status (Al-Khadra, 2009; Lindinger, 2003). The buffering systems are involved initially in order to neutralize acid-base disturbances. These reactions are followed by ventilatory adjustments by the lungs and alterations in acid excretion by the kidneys. Despite these numerous mechanisms for regulation of acid-base balance, it is possible to disturb the acid-base balance resulting in acidosis (decrease in pH) or alkalosis (increase in pH). Changes in acid-base status may be due to metabolic and respiratory, can occur due to a disease or due to the increased physical activity (physiological). During intensive muscle load (training), lactic acid formed by anaerobic glycolysis is deposited in the form of lactate. In the last 50 years blood lactate concentration is used as an important diagnostic indicator in different kinds of sports. A number of studies have been conducted testing the biochemical parameters of the soccer players (Anđelković et al., 2014; McMillan et al., 2005; Dunbar, 1999; Bangsbo, 1994; Krustrup, 2006). The main objective of this study was to examine the changes of the concentration of biochemical parameters in the blood of senior soccer players during one training unit in a pre-season training period. Changes in the investigated biochemical parameters are very important for predicting the optimum load and frequency of training for soccer players in order to improve their physical fitness.

Methods

Study design

This study was conducted on the top soccer players (n = 23), aged between 19 and 31 years (25.00 ± 4.46 years), at the end of January, in the first week of the pre-season training period. The subjects were healthy men among whom other psychophysical aberration are not identified, who volunteered to participate in this study. The training consisted of three parts: introductory-preparatory, main and final. Introductory part of the training consisted of a warm-up session (20 min) followed by the mail part of the training with submaximal workload. The final part of training (15 min) consisted of loosening up and stretching. Blood samples were collected at the beginning and at the end of the same training unit within 30 seconds

Blood collection and analysis

Capillary arterialized blood samples were drawn from the earlobe before and after one training unit. All biochemical parameters were obtained from analyzer "Rapid Point 500" (Siemens). Analyzer "Ruby" (Abbott, USA) was used for comparison of the hemoglobin values with values obtained from AU 680 Beckman Coulter analyzer. Glucose concentration was determined using analyzer AU 680 Beckman Coulter (Olympus) and these values were compared to the values obtained with analyzer "Rapid Point 500" (Siemens). Anthropometric characteristics of the soccer players (weight, height)) were determined using Martin anthropometer (GPM model 100) and TANITA TBF 300 model.

Statistical analysis

The results were processed by the software package IBM SPSS 21.0 for Windows. All results were expressed as means ± SD. Differences between the two measurements for biochemical parameters were tested using an un-paired Student t-test.

Results

At the beginning of the pre-season training period for the competitive half-season 2014/15, anthropometric characteristics of the members of the professional soccer team were determined (Table 1).

Table 1: Anthropometric characteristics of the soccer players (N=23)

	Min.	Max.	Mean	SD
Age (years)	19.00	31.00	25.00	4.46
Height (cm)	173.00	198.00	185.50	6.73
Weight (kg)	63.50	87.00	75.25	12.65

Values of the measured biochemical parameters before and after the training are shown in the Table 2.

Table 2: Biochemical parameters of the soccer players before and after the training (N=23)

Parameter	Mean values before training ± SD	Mean values after training ± SD	Value of the T-test	Sig. (2-tailed)
pH	7.41 ± 0.03	7.42 ± 0.02	-1.60	0.13
pCO_2 (kPa)	4.95 ± 0.36	4.42 ± 0.56	3.77	0.00
pO_2 (kPa)	8.71 ± 0.68	8.72 ± 0.84	-0.08	0.94
HCO_3^- (mmol/l)	22.95 ± 1.23	17.65 ± 2.36	3.55	0.00
Base excess	-1.28 ± 1.16	-5.05 ± 1.95	2.82	0.01
tHb (g/l)	156.36 ± 10.59	158.24 ± 20.63	-0.29	0.78
sO_2 (%)	92.65 ± 1.28	92.73 ±1.62	-0.58	0.57
Glucose (mmol/l)	5.07 ± 0.63	5.57 ± 1.17	-2.08	0.05
Lactate (mmol/l)	2.85 ± 0.70	3.57 ± 1.26	-2.20	0.04

The difference was significant at $p<0.05$

Comparing the results for the pH value of the blood measured before and after training, there were no significant differences. pH of the blood increased by 0.011 or 1.001%. Very important parameter of the acid-base status of the blood is the partial pressure of carbon dioxide (pCO_2). We observed significant decrease of the pCO_2 in the blood by 11%. No significant differences were found regarding the partial pressure of oxygen in the blood before and after training ($p> 0.05$). It was found that the average value of HCO_3^- ions in the blood of the soccer players was significantly lower after the training compared to the value before the training ($p = 0.002$). If we compare the value of base excess (BE) before and after the training we can see that there has been a decrease in BE as a result of the accumulation of lactate. Wilcoxon signed-rank test revealed a statistically significant reduction of base excess in the blood of the soccer players after the training ($z = -2.23$, $p = 0.023$). From the results presented we could see that the mean hemoglobin value was slightly higher after the training compared to the value recorded before training, but with no significant difference ($p> 0.05$). The mean blood glucose concentration increased from 5.07 ± 0.63 mmol / L before the training to 5.57 ± 1.17 mmol / L after the training. Statistical analysis of the obtained blood glucose levels before and after the training showed that this difference is not statistically significant ($p> 0.05$). Lactate is produced during the physical load by anaerobic glycolysis. The mean concentration of lactic acid in the blood increased from 2.85 ± 0.70 mmol / L before the training to 3.58 ± 1.26 mmol / L after the training. Since the training is energy demanding process we expected significant increase in the concentration of lactate. This was demonstrated by the value of the T-student test (p = 0.031).

Discussion

Energy used by muscles during basal metabolism or moderate physical activity is produced by aerobic glycolysis. Intense physical activity requires additional energy which is produces by the anaerobic degradation of glucose-G-P. Usually this shift from aerobic to anaerobic metabolism occurs after about 90 seconds or later in trained athletes (Voet and Voet, 2011). During one soccer game players perform between 150 and 250 brief intense actions (Mohr et al., 2003) and this implies high rate of anaerobic metabolism with high muscle lactate production. Lactate is then exported from the muscles to the blood. The resulting buildup of lactate changes the pH, concentration of HCO_3^-, pCO_2, base excess and saturation of the blood (Robergs et al., 2004). Muscle lactate concentration was measured only in one study by Krustrup et al. (2006) where it was demonstrated that the muscle lactate concentration was not correlated with blood lactate. During continuous exercise the blood lactate concentrations are lower but reflect well the muscle lactate concentrations during exercise (Krustrup et al., 2004). This suggests that high blood lactate concentration often seen in soccer probably represent lactate accumulated during a high number of intense actions. We didn't expect drastic changes of these parameters in athletes due to a number of mechanisms developed during the years of training, such as increased lung capacity, increased renal threshold, greater muscle mass, etc. At the same time, it is important to detect any changes in these parameters in order to create optimal exercise intensities in endurance training. Expected changes in the pCO_2 concentration in the direction of its decline confirmed the activation of the respiratory mechanism (Kowalchuk et al., 1988). These results are in accordance with previous findings of Russell and Kingsley (2012) who showed that blood lactate concentration increased during exercise, while the values of other parameters decreased (blood bicarbonate, base excess and pH). Similar results were presented in the study by Ratel et al. (2002) where acid-base balance was investigated during 10 repeated sprints. After 10 sprints, they observed increase in the concentration of lactate while pH, blood bicarbonate, base excess and pCO_2 decreased. In our study, accumulation of lactate was markedly lower than in the study by Russell and Kingsley (2012), which may explain the fact that we did not observe any significant change in the pH although change in the buffering capacity was detected. Also McMillan et al. (2005) suggested that blood lactate concentration between 2 and 4 mmol/l may be used as an indicator of aerobic endurance performance for soccer players. This also implies that participants in our study were not in detrained state after a winter intermission break.

Conclusion

The results of the present study show that training with submaximal workload caused significant increase in the concentration of the lactate in the blood of the professional soccer players. This increase of lactate blood concentration was followed by the decrease of concentration of HCO_3^-, pCO_2 and base excess, while the pH and saturation of the blood remained unchanged. HCO_3^- is the most important factor of acid-base status regulation during exercise. Buffering of produced lactic acid consumes HCO_3^- and causes decrease of the HCO_3^- concentration. We also assume that the main reason for not detected change in the oxygen saturation of the blood is the large lung capacity of the soccer players. The presented work may help to give a rational basis for performance diagnosis and training prescriptions in future research as well as in sports practice.

References

1. Al-Khadra E. (2009). Disorders of the acid-base status. In: Kiessling S.G., Goebel J., Somers M.J.G. (Ed.), *Pediatric Nephrology in the ICU* (20-31). Springer-Verlag: Berlin Heidelberg
2. Anđelković M., Baralić I., Đorđević B., Kotur Stevuljević J., Radivojević N., Dikić N., Radojević Škodrić S., Stojković M. (2014). Hematological and biochemical parametars in elite soccer players during a competitive half season. *J Med Biochem*, 33, 460-466
3. Bangsbo J. (1994). The physiology of soccer – with special reference to intense intermittent exercise. *Acta Physiol Scand,* 619(Suppl), 1-155
4. Dunbar J. (1999). *Longitudinal change in aerobic capacity through the playing year in English professional soccer players*. In: Fourth World Congress of Science and Football, Sydney
5. Kowalchuk J.M., Heigenhauser G.J., Lindinger M.I., Obminski G., Sutton J.R., Jones N.L. (1988). Role of lungs and inactive muscle in acid-base control after maximal exercise. *J Appl Physiol*, 65(5), 2090-6
6. Krustrup P., Mohr M., Steensberg A., Bencke J., Kjær M., Bangsbo J. (2006). Muscle and blood metabolites during a soccer game: Implications for sprint performance. *Medicine and Science in Sports and Exercise*, 38(6), 1-10
7. Krustrup P., Soderlund K., Mohr M., Bangsbo J. (2004). The slow component of oxygen uptake during intense sub-maximal exercise in man is associated with additional fibre recruitment. *Pflugers Archive*, 44, 855-866
8. Lindinger M.I. (2003). Exercise: a paradigm for multi-system control of acid–base state. *J Physiol*, 550, 334

9. McMillan K., Helgerud J., Grant S.J., Newell J., Wilson J., Macdonald R., Hoff J. (2005). Lactate threshold responses to a season of professional British youth soccer. *Br J Sports Med*, 39, 432-436
10. Mohr M., Krustrup P., Bangsbo J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences*, 21, 439 - 449
11. Ratel S., Duche P., Hennegrave A., van Praagh E., Bedu M. (2002). Acid-base balance during repeated cycling sprints in boys and men. *J Appl Physiol*, 92, 479-485
12. Robergs R.A., Ghiasvand F., Parker D. (2004). Biochemistry of exercise-induced metabolic acidosis. *Am J Physiol Regul Integr Comp Physiol*, 287, R502-R516
13. Russell M., Kingsley M.I. (2012). Changes in Acid-base balance during simulated soccer match play. *J Strength Cond Res,* 26(9), 2593-9
14. Voet D. and Voet J.G. (2011), *Biochemistry*, 4th ed. John Wiley & Sons Inc.: Hoboken, NJ.

RELATIONSHIP BETWEEN SPRINT RUNNING PERFORMANCE AND GROUND CONTACT TIME IN JUMPING TEST IN YOUTH SOCCER PLAYERS

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Abstract

The aim of this study was to compare is there any relationship between sprint running performance and ground contact time in jumping test in youth soccer players. The sample included 39 youth soccer players (n=39) of different ages, (U 13=15, 57,09±8,03 kg, 169,04±8,34 cm, U 15=8, U 17=16, 66,91±8,47 kg, 176,6±4,37 cm, 69,85±5,42 kg, 177,61±7,46 cm) middle league. For each participant, the body height (cm), body weight (kg), maximal sprinting speed so as ground contact time in jumping test were measured. Conventional statistical methods were used. Pearson correlation coefficient P <0.05 was taken as the limit of the significance in all statistical tests. ***Jumping test:*** Optimal vertical rebounds (maximal elevation at each jump) were executed from a standing position for 7 jumps. Another measured variable is maximal sprinting speed in 40 m. Passages were recorded with Witty Manager Software, photocells at 10 m, 30 m and 40 m. The time from 30 to 40 meter was used to calculate maximal sprinting speed in 40 meters. The results of the statistical analysis are shown in Table 1. The findings are that there is no significant correlation between these two variables (r = -0,128, P = NS). Most studies have shown that shorter ground contact times are seen in faster subjects compared to slower subjects (Mann, 1986; Weyand et al., 2000; Morin et al., 2012; Lockie et al., 2013) but this is not always the case (Brughelli et al., 2011). Kugler and Janshen (2010) found that prolonging ground contact time led to greater propulsive forces during accelerated sprint running. The sprint component is determined by a number of factors and not just muscle stiffness and ground contact time, so we can assume that this variable is maybe not the main parameter in determining which athlete will be faster in 40 m sprint. Sprinting requires coordination, stability, and muscular power to successfully accomplish the cycle motion of the legs to achieve maximum horizontal speed.

Key words: *youth, maximal sprinting speed, stiffness, sprint, soccer*

Introduction

Applying notation analysis and increasing use of GPS (Global positioning system) in sport games (football, rugby, basketball, hockey) the characteristics of motion structure that occur in these sports have been identified. The largest number of scientific papers have classified the sprint as running speed greater than 25 km/h. Football represents a cyclical and intermittent sport in which short-term highly-intensive activities, like for example, sprints to 20-30 meters, intertwined with the activities of low and medium intensity. Andrejezewski et al., (2013) in their work led to the total distance that players covered in sprint (≥24 km/h), 237 ± 123m. In a review paper authors have (Spencer, Bishop, Dawson, Goodman, 2005) reported that the average distance covered in sprint is 10 to 20 meters and that the average duration of the sprint is 2-3 seconds. By analyzing the match of the Spanish League and European Champions League Di Salvo et al. (2007) determined the average length of the sprint of 19.3 ± 3.2 (sprint ≥22 km/h). Andrejezewski et al., (2013) point out that the 90% of sprints in match are duration less than 5 seconds, while only 10% are sprints over 5 seconds. Analysis of movement in sports games have shown that during the match players preformed relatively large number of sprints and total distance covered in sprint distinguishes superior teams of averrage teams (Mohr et al., 2003), successful from less successful soccer teams (Di Salvo, 2008). So we can assume that sprint component is very important in team sports such as soccer. Female soccer and lacrosse players reach top speed somewhere between 20 and 30 m, by a lack of change in individual 9.1m/s times after 27 m. This is supportive of data that maximal sprint speed occurred at 36 m in a group of college physical education students (Brown et al., 2015). We decided to measure 40 m sprint to achieve maximal sprinting speed of the players. Mero et al., (1981) demonstrated functional links between jumping and sprint performance. The mean power developed during hopping in place can be estimated from the time the foot is in contact with the ground and from the flight time. The stiffness of the legs can be evaluated throughout the spring-mass model (Chelly et al., 2001). Hopping in place has basic mechanical features similar to the spring-mass model used during forward hopping or runnging (Chelly et al., 2001). Most studies have shown that shorter ground contact times are seen in faster subjects compared to slower subjects (Mann, 1986; Weyand et al., 2000; Morin et al., 2012; Lockie et al., 2013) but this is not always the case (Brughelli et al., 2011). The aim of this study was to compare is there any relationship between sprint running performance and ground contact time in jumping test in youth soccer players.

Methods

Participants

The sample included 39 youth soccer players (n=39) of different ages (U 13=15, 57,09±8,03 kg, 169,04±8,34, cm U 15=8, U 17=16, 66,91±8,47 kg, 176,6±4,37 cm, 69,85±5,42 kg, 177,61±7,46 cm) middle league.

Variables

For each participant, the body height (cm), body weight (kg), maximal sprinting speed so as ground contact time in jumping test is measured. Conventional statistical methods were used. Pearson correlation coefficient. $P<0.05$ was taken as the limit of the significance in all statistical tests.

Procedure

Participants were asked not to change their eating habits, sleep and not to do the demanding physical activity for 24 hours before testing besides technical-tactical training day before. Before testing, participants preformed standardized warm up protocol: three minutes of jogging, dynamic flexibility, stability and activation exercises and accelerations at 70-80-90-100% of their speed at 40m lenght. Groups were formed of 9 players in each group, divided by 30 minutes time period between measurements. ***Jumping test:*** Optimal vertical rebounds (maximal elevation at each jump) were executed from a standing position for 7 jumps. The subjects did not use other muscles (arms) by keeping their hands on their hips throughtout the hopping test. All subject performed familirization trials before doing an experimental trial. Opto jump Next equipement have been used for detecting the results. Reaction test in Opto jump Next software detects the time between optical/acoustic impulse and the patients movement. Each participant performed two experimental trials. ***Sprint test:*** Another measured variable is maximal sprinting speed in 40m. Passages were recorded with Witty Manager Software, photocells at 10 m, 30 m and 40 m. The time from 30 to 40 meter was used to calculate maximal sprinting speed in 40 meters.

Results

The findings are that there is no significant correlation between these two variables, ground contant time in vertical jumping test and maximal sprinting speed in 40m test (r = -0,128, P = NS)

Table 1: Correlation between variables

Correlations

		MSS	Tcont
MSS	Pearson Correlation	1	-,128
	Sig. (2-tailed)		,438
	N	39	39
Tcont	Pearson Correlation	-,128	1
	Sig. (2-tailed)	,438	
	N	39	39

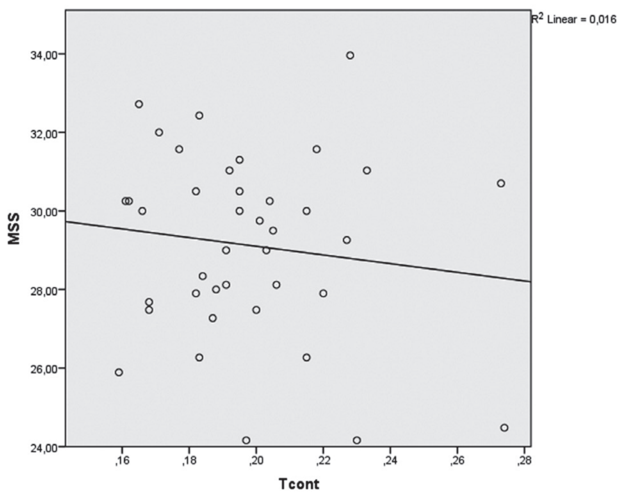

Figure 1: Relationship between ground contact time and maximal sprinting speed (r = -0,128, P = NS)

Discussion and conclusion

It is not strictly possible to draw the inference of cause and effect from correlational studies, some researchers and coaches have interpreted the early findings to imply that deliberately reducing ground contact time might be valuable for improving sprint running speed. However, it seems very likely that longer ground contact times allow athletes who have naturally longer stride lenght to display superior ground reaction forces and impulses with each stride, it seems more probable that shorter ground contact times are a side-effect of faster running speeds, rather than cause of faster sprint running speeds (Beardsley, 2017). Indeed, many researchers have found that greater gorund reaction forces are significantly correlated with faster running speeds (Randell et al., 2010). Weyand et al. (2000) discerned that as running speed increased, ground contact times decreased at a relatively greater rate, which they interpreted as leading to the length of ground contact time being too short to allow the leg extensors to develop maximum force. They therefore suggested that the limiting factor in sprinting speed is governed by the force-velocity relationship and is likely therefore muscle fiber contraction velocity. Essentially, ground contact times reduce with increasing sprint running speed because of the increasing muscle contraction velocity, but at the point where insufficient force can be produced at this muscle contraction speed, sprint running speed stops increasing and maximum velocity is reached. The relationship between the different leg, vertical or joint stiffness measures and sprint running performance is uncertain. Findings regarding vertical stiffness have been particularly conflicting. Chelly and Denis (2001) found that vertical stiffness during repeated jumping was significantly correlated with the maximal sprint running speed over 40m. On the other hand, Bret et al. (2002) found that 100m sprint running performance was not significantly correlated with vertical stiffness. Moreover, Kugler and Janshen (2010) found that prolonging ground contact time led to greater propulsive forces during accelerative sprint running. Taylor and Beneke (2012) compared the 4 fastest runners in in the 100m World Athletics Championship final of 2009, they found that although Usain Bolt displayed the greatest velocity over the 60 – 80 m split, his vertical stiffness was significantly lower than that of the other 2 athletes. Therefore, it is unclear whether vertical stiffness is beneficial for sprint running performance. Also Taylor and Beneke (2012) reported that mean ground contact times fot Usain Bolt, Tyson Gay and Asafa Powell were 0.091 ± 0.001s, 0.070 ± 0.001s, and 0.080 ± 0.001s. In other words, ground contact time ranged between 70 – 90 ms in these athletes in this event. The athlete who displayed the longest ground contact time (Usain Bolt) ran faster than the athlete who displayed the shortest ground contact time (Tyson Gay). This difference in ground contact time between the two athletes occurred because Usain Bolt ran the 100m in a smaller number of total strides (i.e. his stride frequency was lower) because of his greater stature and subsequently greater stride length. Both Beneke and Taylor (2010) and Krzysztof and Mero (2013) have suggested that the superior performances of Usain Bolt could be explained by his exceptional physique that enables him to increase his ground contact time by displaying a longer stride length and a shorter stride frequency than his peers. Indeed, Babić et al. (2007) showed that taller individuals do take longer strides during running. Smaller stride frequency means that Bolt enjoys longer ground contact times and therefore has a longer period of time in which to display ground reaction forces, thereby producing a greater impulse with each stride. On the other hand, field sport athletes sprint shorter distances (eg., 10-30 m) during practice and in competition, so training specifity is drastically different compared with track and field athletes and may alter the abilty of reaching higher speeds more quickly (Brown et al., 2015). The maximal speed from a static start was reached at 36m (Delecluse,1995). It would therefore be logical to conclude that if the same individual was evaluated over the same distance, then he/she would cover that distance in a shorter period through the achievement of a higher speed sooner when beginning the sprint with a flying start. Indeed, data from male rugby players and female soccer players illustrate that top speed are achieved sonner and speeds from consecutive 9.1-m splits over 36.6 m increase by approximately 30% when using a flying start compare with static start. The sprint component is determined by a number of factors and not just muscle stiffness and ground contact time, so we can assume that this variable is maybe not the main parameter in determining which athlete will be faster in 40 m sprint. Sprinting requires coordination, stability, and muscular power to successfully accomplich the cycle motion of the legs to achieve maximum horizontal speed. The muscles responsible for hip, knee, and ankle movement play a specific role during the support phase to efficiently propel the body forward. Unfortunately, the key concepts have been mistakenly reported to be involved with aiding in horizontal propulsion and thus maximal sprint speed. For example, gacrtocnemius-soleus-Achilles complex (GSAC) is considered to be a prime player in horizontal propulsion by storing elastic energy to help project the body forward more quickly while sprinting. It has also often been recomended that athletes actively dorsiflex (i.e. "toe up" position) before ground contact and actively plantarflex later in the support phase to help maximize horizontal propulsion. These statement may lead to erroneus conclusions that the stretch shortening cycle of the ankle joint during the late support phase, contributes considerably to horizontal propulsion during linear sprinting. Several studies provide substantial evidence to the contrary and should help coaches and strength and conditioning professionals understand the contribution of the GSAC during sprinting: which is to help minimize vertical displacement of the center of mass and provide joint stiffness, which assist in power transfer from hip extension into to ground (Brown et al., 2015). Brow et al., (2015) further state reffering to Mann and Spraque (1980) that posterior muscle dominance of the ankle joint was highlighted by eccentric action early and fading concentric action late during the support phase. Corroboration for these findings has been provided by several others groups of researches who reported that as the support phase progresses, the muscle activity of the gastrocnemius begins to subside and may even cease before toe-off. It has also been revealed that hip extensors (gluteus and hamstrings) dominance through initial ground contact and into the mid support phase to minimize breaking but acts primarily to pull the body forwarde-findings that were subsequently supported (Brown et al.,2015). Considering that the push-off during ground support lasts only 0.06 seconds, there is little time for such a small range of muscle (6 degrees out of 33 degrees of motion) activity over such a small range of motion to contribute substantially to horizontal propulsion during linear sprinting. On the other hand, the hamstrings are well suited, because of the favorable lever arm with regard to the hip joint, to generate high levels of force during this phase of sprint cycle (Brown et al., 2015). The large eccentric action during the early support phase is primarly responsible for preventing negative vertical displacement of the center of mass. Concentric activity of the GSAC is balanced, negligible, or nonexistent during the later portion of the support phase, and if the GSAC activity was increased, it would be safe to conclude that greater vertical displacement, not horizontal propulsion, would be elicited. Greater vertical displacement would in turn negatively alter the sinusoidal path of the body or potentially initiate a longer flight phase. The additional elapsed time would appear to be disadvantageous for maximal sprinting speed. Therefore, Mann (1980) concluded that horizontal propulsion from the GSAC does not truly exist, the GSAC provides a way to minimize the vertical displacement rather than contribute substantially to horizontal propulsion (Brown et al., 2015).Experts and trainers are constantly looking for the best method of advancing the capabilities of their athletes. Having these informations in mind, coaches and strenght and conditioning experts must consider that athletes of field sports can achieve maximum sprint speed between 20 and 30 meters, that GSAC provides a way to minimize the vertical displacement rather than contribute substantially to horizontal propulsion, and increased forces generated during the support phase, not quicker swing phase, is the underlying mechanism for faster sprint ability (Brown et al., 2015). As mentioned, the average distance covered in soccer are distances between 10 and 20 m, therefore we suggest comparison between ground contant time in jumping test with shorter distances, because ground contact time decreases as running speed increases.

References

1. Andrzejewski, M., Chmura, J., Pluta, B., Strzelczyk, R., & Kasprzak, A. (2013). Analysis of sprinting activities of professional soccer players. *The Journal of Strength & Conditioning Research*, *27*(8), 2134-2140.
2. Babić, V., Harasin, D., & Dizdar, D. (2007). Relations of the variables of power and morphological characteristics to the kinematic indicators of maximal speed running. *Kineziologija*, *39*(1), 28-39.
3. Beneke, R., & Taylor, M. J. (2010). What gives Bolt the edge–AV Hill knew it already!. *Journal of biomechanics*, *43*(11), 2241-2243.
4. Bret, C., Rahmani, A., Dufour, A. B., Messonnier, L., & Lacour, J. R. (2002). Leg strength and stiffness as ability factors in 100 m sprint running. *Journal of Sports Medicine and Physical Fitness*, *42*(3), 274.
5. Brown, T. D., & Vescovi, J. D. (2012). Maximum speed: Misconceptions of sprinting. *Strength & Conditioning Journal*, *34*(2), 37-41.
6. Chelly, S. M., & Denis, C. (2001). Leg power and hopping stiffness: relationship with sprint running performance. *Medicine and Science in sports and Exercise*, *33*(2), 326-333.
7. Delecluse, C., Van Coppenolle, H. E. R. M. A. N., Willems, E. U. S. T. A. C. H. E., Van Leemputte, M., Diels, R., & Goris, M. A. R. I. N. A. (1995). Influence of high-resistance and high-velocity training on sprint performance. *Medicine and science in sports and exercise*, *27*(8), 1203-1209.
8. Kugler, F., & Janshen, L. (2010). Body position determines propulsive forces in accelerated running. *Journal of biomechanics*, *43*(2), 343-348.
9. Krzysztof, M., & Mero, A. (2013). A kinematics analysis of three best 100 m performances ever. *Journal of human kinetics*, *36*(1), 149-160.
10. Lockie, R. G., Murphy, A. J., Schultz, A. B., Jeffriess, M. D., & Callaghan, S. J. (2013). Influence of sprint acceleration stance kinetics on velocity and step kinematics in field sport athletes. *The Journal of Strength & Conditioning Research*, *27*(9), 2494-2503.
11. Mann, R. V. (1980). A kinetic analysis of sprinting. *Medicine and Science in Sports and Exercise*, *13*(5), 325-328.
12. Mero, A., Luhtanen, P., Viitasalo, J. T., & Komi, P. V. (1981). Relationships between the maximal running velocity, muscle fiber characteristics, force production and force relaxation of sprinters. *Scand J Sports Sci*, *3*(1), 16-22.
13. Morin, J. B., Bourdin, M., Edouard, P., Peyrot, N., Samozino, P., & Lacour, J. R. (2012). Mechanical determinants of 100-m sprint running performance. *European journal of applied physiology*, *112*(11), 3921-3930.
14. Randell, A. D., Cronin, J. B., Keogh, J. W., & Gill, N. D. (2010). Transference of strength and power adaptation to sports performance–Horizontal and vertical force production. *Strength & Conditioning Journal*, *32*(4), 100-106.
15. Spencer, M., Bishop, D., Dawson, B., & Goodman, C. (2005). Physiological and metabolic responses of repeated-sprint activities. *Sports Medicine*, *35*(12), 1025-1044.
16. Weyand, P. G., Sternlight, D. B., Bellizzi, M. J., & Wright, S. (2000). Faster top running speeds are achieved with greater ground forces not more rapid leg movements. *Journal of applied physiology*, *89*(5), 1991-1999.

EFFECT OF THE APPLICATION OF VARIABLE LEARNING CONDITIONS IN BASKETBALL

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Purpose: The accuracy of free throws during the practice session and the match is different: the basketball players are more accurate during the practice sessions. The difference can be explained by different shooting conditions: during the practice sessions the free throws are made in sets (e.g. 10 throws), during a match – two and sometimes three free throws. Constant conditions for practice help to master the movement which will be performed automatically later and variable conditions for practice allow the player to remember the skills better, especially when it is necessary to use it in dynamic conditions of application. For this reason the skills the application situation of which do not change are trained under constant practice conditions, and skill which conditions of application vary are trained under variable practice conditions (Ghodsian et al., 1997; Shoenfelt et al., 2002). The aim of the research was to investigate the effect of the application of variable learning conditions on the accuracy of free throws.

Methods: Research methods applied: experiment, testing free throws. The subjects were second-year Lithuanian Sports university students (64 men and 35 women). Three experimental groups practised shooting under different (constant and variable) conditions.

Results: Due to learning, free throw indices in all three groups during the second testing statistically significantly improved ($p < 0.05$) compared to the first testing: the accuracy of free throws in the constant learning group improved by 22.3 ± 5.6%, in the group of variable learning but when the sequence of movements was familiar – by 19.3 ± 5.8%, and in the group of variable learning with unpredictable sequence of movements – by 17.0 ± 4.6%. After three weeks the subjects took a retention test (the third testing). Skill retention indices of those who learnt under constant conditions statistically significantly decreased ($p < 0.05$) compared to the end of learning. The comparison of retention indices when the skills were acquired under different learning conditions showed that the retention of skills was much better in those groups where the subjects learnt under variable learning conditions compared to constant learning conditions ($p < 0.05$).

Conclusions: A free throw is a constant technical action, and it is performed under constant conditions. Both constant and variable learning conditions affected the accuracy of technical actions while learning free throws. Skill retention was better for those subjects who learnt under variable conditions, but it significantly decreased for those who learnt under constant conditions. The greatest change in learning was achieved during the first five practice sessions.

References

1. Ghodsian, D., Bjork, R. A., Benjamin, A. S. (1997). Evaluating training during training: Obstacles and opportunities. In M. A. Quiñones & A. Ehrenstein (Eds.), *Training for a rapidly changing workplace: Applications of psychological research* (pp. 63-98). Washington, DC: American Psychological Association.
2. Shoenfelt, E. L., Snyder, L. A., Maue, A. E., McDowell, C. P., Woolard, C. D. (2002). Comparison of constant and variable practice conditions on free-throw shooting. *Perceptual and Motor Skills*, 94, 1113-1123.

CHANGES IN THE 30 – 15 INTERMITTENT FITNESS TEST AFTER FOUR WEEK OF HIGH INTENSITY INTERVAL TRAINING

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Abstract

The aim of the present study was to determinate changes in aerobic energetic capacity after 4 weeks of high intensity interval training based on parameters calculated on 30 - 15 intermittent fitness test on youth soccer players – middle league. The sample included 18 youth soccer players (n = 18, 17,4±0,50 year 179,83±6,93 cm, 70,16±6,08 kg). For each subject,the body height (cm), body weight (kg), the maximum heart rate (Fsmax) and inital and final result in 30 – 15 intermittent fitness test has been determined. The average inital and final heart rate has been determined, so as inital and final average VO2max values. Peak heart rate average value (HR peak) on the first test was 199,56±6,84 beats per minute. On the end of the final – second testing HR peak average value was 195, 88±6,33 b/min. Estimated average maximum oxygen uptake (VO2max avg; ml/kg/min), based on algorithm (28.3 – (2.15 x G) – (0.741 x A) – (0.0357 x W) + (0.0586 x 17 x VIFT) + (1.03 x VIFT), was 51,60±2,49 ml/kg/min. The result of final testing session was 53,37±2,61 ml/kg/min. In first testing session, maximum heart rate varied in range of 180-207±6,84 beats per minute. In second testing session, that value was 183- 206±6,33 beats per minute. Maximum oxygen uptake increased for 1,77 ml/kg/min (graph), which is 3,4% higher than in initial testing seassion. The increase of result is 4,35% in second testing session, which represents 0,97±1,26, hence, one level of test. P-value is set on 0,05. From that, the conclusion is that with 95% certainty, there are significant differences between first and second testing session. In preparatory period, beside the training protocol for this ability, other forms and technologies of training were used (strenght trainig, prevention, saq, small sided games, technical and tactical training). Because of that, we can't conclude that this improvement is only result of protocol for maximal oxygen uptake. We can only conclude that there are differences between initial and final testing session. Hence, further research is needed to conclude direct influence of these protocols on result in 30 – 15 intermittent fitness test.

Key words: *youth, maximal oxygen uptake, training protocol, Intermittent fitness test,perfomrance, soccer*

Introduction

High intensity training (HIT) in a variety of forms, is today one of the most effective tools for improving cardiorespiratory and metabolic function and, in turn, the physical performance of athletes. At least nine variables can be manipulated to prescribe different HIT session. The intensity and duration of work and rest intervals are the key influencing factors. Then, the number of intervals, the number of series and between-series recovery duration and intensities determine the total work performed (Buchheit and Laursen, 2013). Therefore, a lot of field based tests have been constructed to provoke similar metabolic reactions in the body as in the game, such as Yo-Yo test (Yo-Yo recovery test level 2), RAST test (6x35m), Beep test or Sintesy test (11x20m + 8 min running). As the number of tests grows, so does the number of training technologies. The test which is often used for valuation and construction of training is 30 – 15 Intermittent fitness test. This test not only assesses the ability of intermittent high-intensity activity of athletes, but also gives a final result achieved on the end of the test which is used for the training construction. The aim of this study was to determine changes in the result in 30-15 intermittent fitness test after four weeks of high-intensity interval training during the preparatory period.

Methods

Participants

The sample included eighteen (18) youth soccer players (n = 18, 17.4 ± 0.50 years 179.83 ± 6.93 cm, 70.16 ± 6.08 kg) – middle league. Initial testing was conducted at the beginning of first half season, at the beginning of the preparatory period, and the second, at the end of the preparatory period. Participants were not familiar with the testing protocol. A short education has been done before testing.

Variables

For each participant, the body height (cm), body weight (kg), the maximum heart rate (Fsmax) and initial and final result in 30-15 intermittent fitness test has been determined. The average heart rate in the initial and final measurements has also been determined so as average VO2max.

Procedure

Intermittent fitness test involves 30 seconds of running alternated with 15 seconds of walking. The initial speed is 8 km/h for the first 30 seconds of running, and is increasing for 0.5 km/h every 30 seconds. Athletes are required to run back and forth between the two lines set 40-metres apart (Figure 1) at a speed governed by an audio "beep". As the individual progresses through the levels, the time between the beeps decreases giving the individual less time to complete each shuttle, thus increasing the speed/intensity of the test. The initial and final testing was carried out at the beginning of the week, on Thuesday at 8:00 pm on the artificial surface on which players normally train and play matches. Participants were asked not to change their eating habits, sleep and not to do the demanding physical activity for 24 hours before testing. The main parameter of this testing was the final result which is interpreted as the maximum aerobic speed (Buchheit, 2000). Before testing, participants preformed standardized warm up protocol: three minutes of jogging, dynamic flexibility, stability and activation exercises and accelerations at 70-80-90-100% of their speed at 40m lenght. Groups were formed of 9 players in each group, divided by 30 minutes time period between measurements. Peak heart rate has been measured (9 RC3 GPS polar monitors). During the preparatory period, eight targeted training session were preformed based on the results achieved in the test, together with all the training technologies that have been implemented during this period (strength training, prevention, small sided games, technical and tactical training). Two training protocol were defined. In the first protocol 95% of the speed reached at the end of the test has been used. Work interval consisted 15 seconds linear movement intervals and 15 seconds intervals of passive recovery. At the first week,6 minutes of work with 2 minutes recovery periods for water and individual preparation has been performed. Each upcoming week duration of the series increased by 1 minute. From the initial 12 minutes of effective work, at the end of the preparatory period that time increased till 18 minutes. This type of training was carried out six times during this period. Training at the maximal oxygen uptake represents the work at the so-called "red zone", or time spend in this zone. For an optimal stimulus (and forthcoming cardiovascular and peripheral adaptations), it is believed that athletes should spend at least several minutes per HIT session in their "red zone" which generally means attaining an intensity greater than 90% of VO2max (Buchheit and Laursen, 2013). During this type of training, 2 sets of 9 minute of work, the athlete spent 16.5 minutes in the red zone, which represents 60% of the total time of 27.6 minutes (85% time of 20 minutes). In the second protocol, 80% of the maximal speed has been used. The work interval consisted 4 minutes intemittent running. The distance for each player has been caltulated based on his final result (0,5km/h between the groups). The second protocol consisted 3 reps of 4 minutes of work and 3 minutes rest periods. Aditional 4 minutes of warm up were preformed. During this type of traning, the athlete spent 16,4 minutes in the "red zone", which is 50% of the total training time of 33.3 minutes. As a basic parameter for monitoring group the 20 second inteval has been taken, which was the time required to cross the distance from the start to the end line.

Table 1: Training protocols

Protocol 1	Protocol 2
15 : 15" straight 95% VIFT 6 min (2 sets)	20 second shuttle 80% VIFT 4 min (3 sets)
2 min passive recovery	3 min rest
15 : 15" straight 95% VIFT 7 min	20 second shuttle 80% VIFT 4 min (3 sets)
2 min passive recovery	3 min rest
15 : 15" straight 95% VIFT 8 min	TOTAL RUNNING TIME: 24 (2x12)
2 min passive recovery	TOTAL TRAINIG TIME: 36
15 : 15" straigth 95% VIFT 9 min	PER TRAINING: 12

Results

Descriptive measures (mean, minimum and maximum values, standard deviation) are taken for the subject group.

Table 2: Descriptive measures for subject group

Varijable	Valid N	Mean	Minimum	Maximum	Std.dev
DOB	18	17.38±0,50	17	18	0,5
ALVT	18	176,60±6,93	170,00	195,00	6,93
ALTT	18	68,00±6,08	61,00	88,00	6,08
VIFTi	18	20,05±1,18	17	21,5	1,18
VIFTf	18	21,02±1,26	18,5	23	1,26
VO2maxi	18	51,60±2,49	45,07	54,69	2,49
VO2maxf	18	53,37±2,61	48,19	57,735	2,61

As seen in *Table 2,* estimated average maximum oxygen uptake (VO2max avg; ml/kg/min), based on algorithm (28.3 – (2.15 x G) – (0.741 x A) – (0.0357 x W) + (0.0586 x 17 x VIFT) + (1.03 x VIFT), was 51,60±2,49 ml/kg/min. The result of final testing session was 53,37±2,61 ml/kg/min. In first testing session, maximum heart rate varied in range of 180-207±6,84 beats per minute. In second testing session, that value was 183- 206±6,33 beats per minute. Average value in first testing session was 199,5±6,84 beats per minute and 195,8±6,33 in the second.

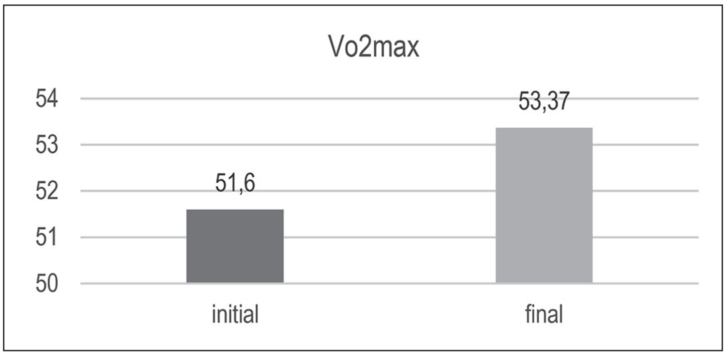

Figure 1: Maximal oxygen uptake results

Maximum oxygen uptake increased for 1,77 ml/kg/min (figure 3), which is 3,4% higher than in initial testing seassion. As mentioned before, in preparatory period, beside training protocol for this ability, other forms and technologies of training were used (strenght training, prevention, saq, small sided games,technical and tactical training).Table of normality of distribution shows that p>0,05, meaning the results in both variables (MAXv 30:15 IFT 2 and MAXv 30:15 IFT) dont't deviate significantly from normal distribution, so we can use Student t-test for dependent samples. In graph 2 the means of first and second testing session are displayed.

Table 3: Mean descriptive parameteres and statistical validation of the initial and final test

Variables	**Mean**	**Standard deviation**	**N**	**t-value**	**Df**	**P value**
VIFTf (km/h)	21,02±1,26570	1,26570	18	4,357106	17	0,00

Table 3 is display of means, standard deviation, number of subjects and t-values. P-value is set on 0,05. From that, the conclusion is that with 95% certainty, there are significant differences between first and second testing session.

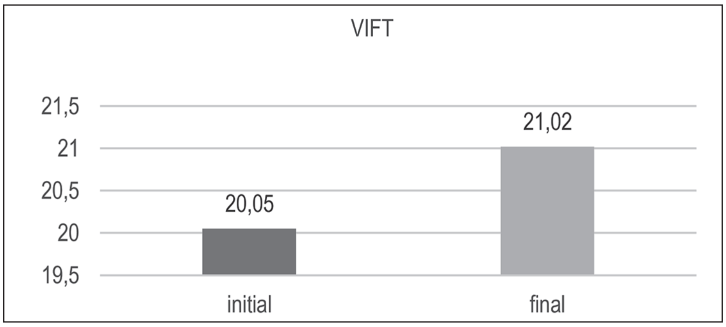

Figure 2: Maximal aerobic speed at the end of the 30 – 15 Intermittent fitness test

The increase of result is 4,35% in second testing session, which represents 0,97±1,26, hence, one level of test.

Discussion and conclusion

Endurance training is important part of conditioning training in football. That is recognized by many experts in the field of strengt and conditioning, hence it is not surprise that there are a lot of technologies and protocols for developing this ability. Dellal et. al (2011) state that small sided games as a method of training closely replicates the physical and technical match-play conditions for proffesionals and constitute a useful training tool for the elite soccer coaches. It also appears that simmilar fitness and preformance gains can be maid with small sided games as is achieved with traditional interval training method (Hill-Haas et.al, 2011). Mallo and Navarro (2008) suggest that small sided games can be used to developt effectively specific endurance capacity of football players. Across the presented studies, Owen, Twist and Ford (2004) conclude that by changing factors such as a number of playes, pitch size, presence/absence of goalkeeper and goals, coach encouragement and the rules, coaches can manipulate the effect of SSG on players. Following early works in the 1970s and 1980s the physiologists V. L. Billat and D. W. Hill popularized the speed (or power) associated with VO2max (so-called v/pVO2max or maximal aerobic speed/power (MAS/MAP)) as a useful reference intesity to programme HIT (Buchheit and Laursen, 2013). Since v/pVO2max is theoretically the lowest speed/power needed to elicit VO2max, it makes intuitive sense for this marker to represent an ideal reference for training. Kelly (2015) in his paper investigated the changes in the 30 – 15 Intermittent fitness test after 2 weeks of high intensity interval training in rugby players. Besides this type of training he used aditional speed work, and tehnical-tactital drills. After two weeks of training they had 3,28% change in high-intensity intermittent running preformance. It is importat to now how quickly preformance on this test will improve if it is to be used for the prescription of training as an improvement of one level is considered a substantial change (Kelly, 2015). Because of that it is a representing parameter that we can use to individualize training procedure. Martin Buccheit (2000) constructed 30 – 15 intermittent fitness test in purpose of creating a training protocol based on the test. The final speed reached at the end of the test is the main parameter in construction of training for maximal oxygen uptake as mentioned in examples. After diagnostic procedure, results showed that, after four weeks of training protocol, there is increase of 3,4% in second testing session in values of maximal oxygen uptake. (51,60±2,49ml/kg/min initial, 53,37±2,61ml/kg/min. final). Speed and distance for each subject were individualized in regarded to score on the test. Two protocols were constructed. Given results showed improvement in the test, namely in maximal speed (VIFT). By analyzing means between initial and final testing session, there is increase of 4,35% which is 0,97±1,26 km / h of one level. Because different training protocols and technologies were used during preparation period, we can't conclude that these improvement is only result of protocol for maximal oxygen uptake. We can only conclude that there are differences between initial and final testing session. Hence, further research is needed to conclude direct influence of these protocols on result in 30 – 15 intermittent fitness test. For higher certanty the control and experimental group should be used. For run-based HIT sessions, VIFT integrates between-effort recovery abilites and change of COD capacities that make VIFT especially relevant for programming short, supramaximal intermittent runs performed with COD, as implemented in the majority of team and racket sports (Buchheit and Laursen, 2013).

References

1. Buchheit, M. (2010). The 30 – 15 Intermitten Fitness test : 10 year review. *Myorobie Journal* 10, 1, 1-9
2. Buchheit, M. (2012). Individualizing high intensity interval training in intermitten sport athletes with the 30 – 15 Intermitten fitness test, NSCA Hot Topics (download from : https://www.nsca.com/Education/Articles/Hot-Topic-Individualizing-HIIT-in-Intermittent-Athletes, september 2015.)
3. Buchheit, M and Laursen B. Paul (2013). High Intesity Interval Training, Solution to the Programming Puzzle: Part I: Cardiopulmonary Emphasis. Sports Medicine, 43, 313-338

4. Dellal, A., Hill-Haas, S., Lago-Penas, C. & Chamari, K. (2011). Small-sided games in soccer: Amateur vs. professional players' physiological responses, physical and technical activities. Journal of Strength and Conditioning Researche, 25, 2371–2381
5. Hill-Haas, S. V., Dawson, B., Impellizzeri, F. M., & Coutts, A. J. (2011). Physiology of small-sided games training in soccer: A systematic review. Sports Medicine, 111-115
6. Kelly, V. (2015). Changes in the 30 – 15 intermittent fitness test after two weeks of high intensity pre – season traning in elite rugby league players. *School of Human Movement & Nutrition Science*
7. Mallo, J., & Navarro, E. (2008). Physical load imposed on soccer players during small-sided training games. The Journal of Sports Medicine and Physical Fitness, 166-171
8. Owen, A., Twist, C., & Ford, P. (2004). Small-sided games: the physiological and technical effect of altering field size and player numbers. Insight, 7(2), 5053.

OCCUPATIONAL KINESIOLOGY - MANUAL HANDLING

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Abstract

In the area of Kinesiology work for occurrence of pain, a particularly interesting area is the one that deals with the mechanic of movement and work, meaning the posture we have while performing different types of work. The correct technique 'manual handling' plays an important role in prevention and preventing the progress of musculoskeletal disorder. The goal was to strengthen some theoretical knowledge about the correct ways of manual handling. The results showed that workers know that it is important to have a good technique while handling loads, no matter what weight it is, but they don't have a good perception about what the correct manual handling is. More than 39% of participants doesn't recognize the correct ways of handling loads, and 86% don't recognize economical technique of lifting and setting loads down which is supposed to be applied in everyday work. It is concluded that workers firstly have to be educated about the basics of correct ways to handle load. After the theoretical basics have been adopted, the workers also have to go through practical education about the correct ways of handling loads.

Key words: *Occupational kinesiology, manual handling, theoretical basics*

Introduction

Occupational kinesiology (OK) is a part of general kinesiology, the science of movement. OK integrates all knowledge from the area of kinesiology and adjusts it to specific work places. The main goal of OK is to give its contribution in preservation and improvement of human health while working, in the frames of multidisciplinary approach. Manual handling, the posture while handling loads (lifting and setting things down) plays a great role in prevention of musculoskeletal disorder. Term musculoskeletal disorder indicates health disorders of the locomotor system, and it can include muscles, tendons, skeleton, cartilage, ligaments and nerves (Radečić, 2011). Musculoskeletal disorder are a global, public health problem because they have high prevalence around the world, which means enormous expenses for health insurance and community in general, and are the most common cause of chronic nonmalignant pain and incompetence (Babić-Naglić, 2012). According to Grazio et al. (2012) we can divide back pain to specific and nonspecific. Nonspecific is the one whose cause we can't find, even though it's presumed that it is usually mechanical back pain.

Lower back and radicular pain, along with cardiovascular diseases, are among the most common health problems (Houra et al., 2013.). Grazio et al. (2012, prema Manek, Mac Gregor, 2005) quotes that the risk factors of occurrence and development of back pain are: individual (age, sex, genetic predisposition, smoking, education, general health, etc.), psychosocial (stress, depression, cognitive functions, etc.), physical exertion (type of work, hardness and the way of exertion).

Statistical data suggests to the fact that during someone's lifetime about eighty or more percent of the population will, at least once, have an isolated lower back pain or spreading pain down one or both legs (Houra et al., 2013. according to Rubin, DI., 2007). Lower back pain affects both males and females (Tešanović et al., 2004). We notice that lower back pain became a contemporary problem of a working population. Decreased work ability, dissatisfaction, sick days, labour turnover etc. are just few of the problems back pain brings.

Prerequisites of the correct way of manual handling, and thus prevention of musculoskeletal disorder, are:

- Certain level of awareness about the importance of right posture while handling load
- theoretical education about right ways of handling loads

In accordance with everything stated above goes the conclusion of Steffens et al. (2016) which claims that the current evidence suggests that exercise alone or in combination with education is effective for preventing LBP.

Objective of the paper

This paper has two goals: First goal of this paper is to establish if physical workers think that the correct way of handling loads that are light is as important as handling the heavy ones. Second goal of this paper is to determine whether the workers can recognize the correct way of handling loads when it's demonstrated to them

Methods

A sample of participants makes a group of 198 workers (148 female and 50 male) which do physical work handling lighter loads with a large number of repetitions. The average age of the participants was 35 years, and average length of service at that job, or a similar one, was 10 years. The participants filled out a questionnaire with a large number of questions. For the needs of this paper we are going to interpret result response of workers to two questions.

Question number 1: When the load is very light, the way the load is lifted is not as important. Loads are supposed to be lifted and set down in a correct posture only when the loads are very heavy. Are these claims correct?

Question number 2: Imagine a situation: We are standing on our feet. From this position we have to lift a piece of paper from the floor. We have to repeat that same action 2000 times a day. Circle only one way of lifting the paper, the one you consider the healthiest, fastest, most efficient, most economic and all in all the best.

The questionnaire was filled out with direct demonstration. With question number 2, the instructore showed the participants five different techniques of lifting the load:

- *Deep squat* – correct
- *Deep squat* - spine flexion – incorrect
- *Romanian deadlift* – correct
- *Romanian deadlift* - spine flexion – incorrect
- *Toe standing deep squat* - spine in neutral position – incorrect

Data was processed with the software package Statistica 13,2 in the Faculty of Kinesiology in Zagreb. Methods of descriptive statistics were used in the analysis.

Results and discussion

193 out of 198 participants successfully answered question number 1. From table number 1 we can see that 193 participants think that the right way of handling loads matters both when the load is light and when it is heavy. That means that 97.5% of participants have a developed conscious about the importance of correct manual handling. The conscious about the importance and use of correct manual handling is the first prerequisite in prevention of musculoskeletal disorders.

Table 1: Frequency of responses to question number 1

Category	Frequency table: Question 1			
	Count	Cumulative Count	Percent	Cumulative Percent
No	193.0	193.0	97.5	97.5
Yes	5.0	198.0	2.5	100.0
Missing	0.0	198.0	0.0	100.0

With developed conscious about importance of correct manual handling, and in prevention of musculoskeletal disorder, theoretical knowledge about correct ways of manual handling has an important role. Theoretical knowledge includes the ability to recognize and differentiate correct from incorrect manual handling.

While the participants were answering question number 2 *"Imagine a situation: We are standing on our feet. From this position we have to lift a piece of paper from the floor. We have to repeat that same action 2000 times a day. Circle only one way of lifting the paper, the one you consider the healthiest, fastest, most efficient, most economic and all in all the best"* the instructor demonstrated 5 different ways of lifting the load from the floor. View table number 2.

Table 2: Frequency and percentage of responses to question number 2

1	2	3	4	5
CORRECT	**INCORRECT**	**CORRECT**	**INCORRECT**	**INCORRECT**
Deep squat	Deep squat – spine flexion	Romanian deadlift	Romanian deadlift –spine flexion	Toe standing deep squat - spine in neutral position
				
N 94	N 17	N 28	N 3	N 56
47.5%	8.6%	14.1%	1.5%	28.3%

Table 2 shows that the participants were offered 5 answers, 3 of them were completely incorrect (2, 4 and 5) and two correct. The correct ways of manual handling are 1 and 3. Even though both techniques are correct, technique number 3 is the only correct answer to this question.

47.5% of participants answered that the most correct technique for picking up a paper 2000 times a day is the technique of correct deep squat. Namely, technique number 1 (deep squat), even though it is correct, it is not the most economical one for performing this move 2000 times a day. Deep squat is not only not an economical technique for many reps of lifting, but it is also a technique that is hard for people who don't exercise regularly.

Only 14% of participants recognized Romanian deadlift technique as the most economical one. The reason behind that is probably the myth that the only correct technique of the right manual handling of loads is the technique of squat in which back has to be as vertical as it can be in relation to the ground. Bogadi-Šare (2002) says that in prevention of painful syndromes, with accent on lumbar spine: *The basic preventive measure is the correct technique which allows **spine load** in vertical position.* The basic preventive measure really is the correct manual handling technique, but **spine load** doesn't have to be only in vertical position. The myth is that the back has to be vertical while lifting and setting loads down. The truth is that the back doesn't have to be vertical but straight. Straight back means that both spine and pelvis are in a neutral **sagittal plane** viewed from the profile.

In support of the foregoing, 56 participants (23,3%) think that the *toe standing deep squat* with the spine in neutral position is the correct technique. From the spine viewpoint that type of squat is correct, but can potentially be very dangerous for the knees because that is the position in which compression of the patella happens, squash of meniscus, unnecessary stretching of ligaments and tendons of knee (Alter, 2004). However, even though deep squat isn't the most economical technique for a large number of reps, it is a positive outcome that more than 61% of workers chose correct techniques. It is concerning that 76 participants (17+3+56), or 39% chose completely incorrect techniques.

Conclusion

In the area of Kinesiology of work for appearance of back pain, especially interesting is the area which deals with posture of workers while handling loads. For Kinesiology of work, the prerequisite to keeping the spine healthy, preventing mechanical changes and spine damages is the correct movement and posture while handling loads.

Along with age and genetic predisposition, the real cause of back pain is the incorrect mechanic of movement and work. We can't affect age and genetic predisposition, but we can affect the mechanic of movement and work. The consequences of several years of incorrect mechanic of movement and work are mechanical changes and damages of the spine and surrounding issues.

First goal of this paper was to determine whether physical workers think that the correct way of handling loads that are light is as important as handling the heavy ones. The result showed that workers know that it is important that the manual handling technique is correct during both lifting heavy objects as well as light objects.

Second goal of this paper was to determine whether the workers can recognize the correct way of handling loads when it's demonstrated to them. The results of this research showed that workers don't have a good perception about what correct movement is. More than 39% of participants don't recognize correct ways of manual handling, and 86% don't recognize the economical technique of lifting and setting the load down, which is supposed to be applied in everyday life.

If we know that the correct ways of manual handling are an important part of prevention of **acute** injuries and cumulative musculoskeletal disorders, then, based on this research, we can conclude that firstly, we have to theoretically educate the workers about the basic characteristics of correct manual handling. After they acquired the theoretical knowledge, workers have to undergo a practical education about manual handling as well.

References

1. Alter, M.: The Science of Flexibility. Champaign. IL: Human Kinetics, 2004.
2. Đ. Babić-Naglić (2012). Kronična mišićnokoštana bol - epidemiologija i faktori rizika. 5. Hrvatski kongres fizikalne i rehabilitacijske medicine, 10-13.5.2012., 8-15.
3. Grazio, S., Ćurković, B., Vlak, T., Bašić Kes, V., Jelić, M., Buljan, D., Gnjidić, Z., Nemčić, T., Grubišić, F., Borić, I., Kauzlarić, N., Mustapić, M., Demarin, V. (2012). Dijagnostika i konzervativno liječenje križobolje: pregled i smjernice Hrvatskog vertebrološkog društva. Acta Med Croatica, 66, 259-294
4. Houra, K., Perović, D., Kvesić, I. (2013). Prve hrvatske smjernice za dijagnostiku i liječenje križobolje i lumboishialgije minimalno invazivnim procedurama. Liječnički Vjesnik, 135:187-195
5. Radečić, M. (2011). Ergonomija na radnom mjestu zdravstvenih djelatnika. Medicinski fakultet, Sveučilište u Zagrebu, diplomski rad.
6. Steffens, D., Maher, C.G., Pereira, L. S. M., Stevens, M.L., Oliveira, V.C., Chapple, M., Teixeira-Salmela, L.F., Hancock, M.J. (2016). Prevention of Low Back Pain. *The Journal of the American Medical Association-Internal medicine,* Feb; 176(2):199-208.
7. Sušić, A., Žokalj, M., Kasović, M. (2015). Nestabilnost slabinske kralježnice kao faktor rizika pri dizanju gabaritnog tereta. Sigurnost: Časopis za sigurnost u radnoj i životnoj okolini, 57(1), 1-9.
8. Šarić, M., Žuškin, E. (2002). Medicina rada i okoliša, Medicinska naklada, Zagreb.
9. Tešanović, G. et al. (2004). Bol u donjem dijelu leđa. Klinički vodič, Ministarstvo zdravlja i socijalne zaštite Republike Srpske.

THE EFFECTS OF PLYOMETRIC TRAINING ON THE MOTOR SKILLS OF BASKETBALL PLAYERS

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Abstract

The aim of this study is to analyze the research in which the effects of plyometric training on motor skills of basketball players were studied. The research included 41 studies that were published in the period from 2001 to 2015. For collection, classification and analysis of the targeted research, the descriptive method and theoretical analysis were used. The results of the analyzed research showed that plyometric training for a minimum of 4 to 12 weeks (2-3x per week) could lead to a significant improvement of explosive power, the height of vertical jump, agility and the situational-motor abilities of basketball players, that plyometric training for at least 6 to 12 weeks (2-3x per week) could lead to significant improvements in the speed of basketball players, that plyometric training for at least 8 to 12 weeks (2-3x per week) could lead to significant improvements in endurance of basketball players. Combination of plyometric training and some other training leads to more significant improvement of motor skills than when plyometric training or other training methods are used separately.

Key words: *plyometrics, basketball players, motor skills, effects*

Introduction

A basketball game consists of short but intense activities, punctuated by longer or shorter periods of passive or active rest (Jakovljević et al. 2011) such as short sprints, fast stops and acceleration, change of direction, different jumps, throws and passing the ball (Erčulj et al., 2004). Jumping skills and explosive strength are crucial for basketball players (Zhang, 2013). Plyometrics is a popular method that is widespread among athletes with the aim to develop the ability to counteract the force of gravity (Jamurtas et al., 2000). Plyometric training is a popular method by which athletes can improve strength and explosiveness (Stemm & Jacobson, 2007), jumps, starting acceleration, sprint (Vrcić, 2009) and the movements in which a change of direction (agility) occurs (Miller et al. 2006; Vrcić, 2009). This is the training that develops explosive power without hypertrophy (Mihajlović et al., 2010). The effects of plyometric training can vary depending on different characteristics of subjects such as: training, gender, age, sports activity as well as knowledge of plyometric training (de Villarreal et al. 2009). Plyometric training combined with regular basketball training leads to a reduction in the risk of injury in young basketball players (Asadi et al.2015).

The **aim** of this study is to analyze the research in which the effects of plyometric training on motor skills of basketball players in the period from 2001 to 2015 were studied.

Method

For collection, classification and analysis of the targeted research, the descriptive method and theoretical analysis were used, and the studies that have been reached were searched on Google, Google Scholar, PubMed and Kobson. The additional literature in the form of textbooks was also used. The search was limited to the studies that were published in the period from 2001 to 2015 and the studies in which the respondents were men. The key words were: **plyometric training** and **basketball**.

Results

Each work is illustrated by the following parameters: sample of respondents (the total number of respondents, age and sex) and the experimental treatment (duration of the experiment, number of groups in the course of the study, parameters that were measured, the program results and the differences between groups at the end of the experiment).

Table 1: Results of the research

References	The sample of respondents			Experimental treatment			
	N	Age	S	duration	Nb.of Gr.	measured parameters	Results and differences between groups
Matavulj, Kukolj, Ugarković, Tihanyi & Jaric (2001)	/	Ju	M	/	K P_{50} P_{100}	VJ, Fmax, RFD	increase in the VJ, Fmax and RFD in both **P** groups / there were no differences between **P** groups
Cheng, Lin & Lin (2003)	16	16-19	M	8 weeks (3x a week)	Pт K	Ma	improvement in VJ and F in **Pt**, no improvement in endurance
Zushi (2006)	10	/	M	7 weeks (3x a week)	P	VJ, footwork and MBT	significant progress of the measured parameters
Santos & Janeira (2008)	25	14-15	M	10 weeks (2x a week)	Pт K	SJ, CMJ, ABA, MBT	progress of **Pt** on tests SJ, ABA and MBT
Boraczyński & Urnia (2008)	14	20,3 ± 1,9	M	8 weeks (3x a week)	P	eP of the lower extremities	increase of the explosive power
Shaji & Isha (2009)	45	18-25	M	4 weeks (2x a week)	Di P DiP	VJ, agility	increase in the VJ with **Di**, **P** and **DiP**, increased agility with **P** and **DiP** / **DiP** the greatest improvement in the VJ compared to **P** and **Di**
Kukrić, Petrović, Dobraš & Guzina (2010)	20	Ju	M	10 weeks (2x a week)	P K	knee extensor muscle strength	**P** increase in the VJ and maximal force in the concentric contraction
Khlifa at al. (2010)	27	/	M	10 weeks (2-3x a week)	P K Po	VJ	**P** and **Po** increase in the VJ / **Po** more progress than **P**
King & Cipriani (2010)	32	14-16	M	6 weeks (2x a week/ 20-30min)	Psr Pfr	VJ	progress in the VJ in **Psr** / Pfr with no progress in the VJ
Shallaby (2010)	20	16	M	12 weeks (3x a week/120min)	P K	VJ, MBT, sprint 5x30m, shuttle running test and SMS	improvement in all measured parameters and motor and SMS in **P** / **P** greater improvement in all measured parameters in relation to **K**
Arazi & Asadi (2011)	18	18-20	M	8 week (3 x a week/ Pv-120min P-90min)	P Pv K	Fmax, sprint and dynamic balance	improvement in sprint, Fmax and dynamic balance for **P** and **Pv** / **Pv** greater progress in sprint and Fmax than **P**, **P** greater progress in a dynamic equilibrium than **Pv**
Bal, Kaur, Singh & Bal (2011)	30	18-24	M	6 week (2x a week/ 25min)	P K	agility (Agility T-Test and Illinois Agility Test)	improvement of agility
Wee, Mudah & Tan (2011)	20	20-23	M	4weeks (2x a week)	P K	VJ	**P** and **K** improvement in the VJ **P** greater improvement in VJ compared to K (11,7% vs. 2,12%)
Santos & Janeira (2011)	24	14-15	M	10 weeks (2x a week)	P K	SJ, CMJ, ABA, DJ, MBT	increasing the level of explosive power in **P**
Draganović & Marković (2011)	23	Ju	M	6 weeks (2x a week)	P K	20m sprint, TJ, VJ	**P** improved the 20m sprint, TJ and VJ / TJ improved for 26cm, VJ for 6cm and 20m sprint for 0,58sec
Adorable Caparino & Abbu (2011)	9	Un	M	10 weeks	P	VJ	increasing the VJ
Kukrić, Karalejić, Jakovljević, Petrović & Mandić (2012)	30	16-17	M	10 weeks (2x a week)	P K Ko	VJ	**P** and **Ko** increased VJ / there is no difference between **P** and **Ko**
Andrejić (2012)	21	12-13	M	6 weeks (2x a week/ 90min)	S Ps	SLJ, VJ, MBT, sprint 20m, running 4x15m and bend in the standing position	**Ps** progress in VJ, SLJ, 20m sprint, running 4x15 and MBT, **S** progress in MBT and bend **Ps** better results than S on the tests: VJ, SLJ, 20m sprint, 4x15m, MBT

Arazi, Coetzee & Asadi (2012)	18	18,81 ± 1,46	M	8 weeks (3x a week/ 40 min)	P Pv K	VJ, agility	progress of **Pv** and **P** in measured parameters there is no difference between **Pv** and **P**
Sağıroğlu, Konar, Önen, Ateş & Alkurt (2012)	18	15-17	M	8 weeks (P_1-1x a week, P_3-3x a week)	P_1 P_3 K	anaerobic capacities (Wingate Anaerobic Test) DJ (4x10 reps / pause 2 min) was used for exercising	progress of $\mathbf{P_1}$ and $\mathbf{P_3}$ in the results of the Wingate Anaerobic Test / $\mathbf{P_3}$ and $\mathbf{P_1}$ better results than **K**, $\mathbf{P_3}$ better results than $\mathbf{P_1}$
Sharma & Multani (2012)	40	/	M	4 weeks	P K	SMS, VJ, balance	**P** advanced in SMS, VJ, balance
Sisodiya & Abhinav (2012)	75	18-25	M	8 weeks (3x a week)	P Kт PKт	SMS (for the estimation of SMS Johnson Basketball Ability Test was used)	all three groups have made progress on all tests of SMS
Bavli (2012)	24	20,7 ± 2,6	M	6 weeks	P K	squat (1RM), VJ, sprint 30m	progress with **P** on all tests
Asadi & Arazi (2012)	16	19-20	M	6 weeks (2x a week/55min)	P K	dynamic balance (Star Excursion Balance Test) agility (T-Test, Illinois Agility Test, 4 × 9 m Shuttle Run), eP (VJ, SLJ, 20m sprint)	**P** progress on all the tests of agility and eP, no progress in dynamic equilibrium / **P** better progress than **K** except in dynamic equilibrium
Asadi (2013)a	20	20.2 ± 1	M	6 weeks (2x a week)	P K	balance and sprint	**P** advanced in 20m sprint, there was no progress in balance
Asadi (2013)b	20	20.1 ± 1.3	M	6 weeks (2x a week)	P K	VJ, SLJ, 4×9m Shuttle Run, Agility T-Test and Illinois Agility Test	progress with **P** on all tests
Zhang (2013)	17	18-24	M	4 weeks (3x a week/ 60min)	P	VJ (left foot), VJ (right foot), anaerobic capabilities of legs, sprint 10 and 40m, VJ (both feet)	improvement of VJ (left foot), VJ (right foot), anaerobic capacity of legs / no improvement in sprint 10 and 40m and VJ (both feet)
Robert & Murugavel (2013)	30	19-25	M	8 weeks (3x a week)	P Sp O	A, tF, VJ	progress in **P**, **Sp** and **O** in all measured parameters / **P** greater improvement in VJ and tF than the other two groups, **Sp** greater progress in A than the other two groups
Bandyopadhyay, Mitra & Gayen (2013)	60	18-23	M	8 weeks (3x a week/ 45min)	P K O	speed	**P** and **O** improvement in speed there is no difference between **P** and **O**
Mitra, Bandyopadhyay & Gayen (2013)	60	18-23	M	8 weeks (3x a week/ 45min)	P K O	agility (Illinois Agility Test)	improvement of agility with **P** / **P** greater progress than **K**, there is no difference between **O** and **K**, and **P** and **O**
Nabizadeh, Bararpour, Chaleh & Najafnia (2013)	30	19,2	M	8 weeks (3x a week/ 20min)	$П_{50}$ $П_{60}$ $П_{70}$	VJ	progress of $\mathbf{P_{50}}$, $\mathbf{P_{60}}$ and $\mathbf{P_{70}}$ in the VJ / there is no difference in progress of the VJ among all three groups
Raj (2013)	80	13-18	M	12 weeks (3x a week)	P K Kт Bp	cardio-resp. endur., flexibility of hip, spine and shoulders, static and dynamic balance	progress of **P**, **Kt** and **Bp** in all measured abilities except flexibility of shoulders **P** better than **Kt** and **Bp** in cardio-resp.endur., there is no difference in other capabilities between **P**, **Kt** and **Bp**
Lehnert, Hůlka, Malý, Fohler & Zahálka (2013)	12	24,36 ± 3,9	M	4 weeks (2x a week) + 2 weeks (4x a week)	P	eP, agility	no significant improvement in eP and agility

Morsal at al. (2014)	30	24-30	M	6 weeks (3x a week)	P K	eP	increase eP
Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel (2014)	19	16.3±0.5	M	8 weeks (2x a week)	P Sp	20m sprint, VJ, Bounding-Power Test, 2×5m Shuttle Run Agility Test and Suicide Run	In **P** progress on test Suicide Run, in **Sp** progress on tests of 20m sprint, Bounding Distance and Suicide Run / there is no difference between **P** and **Sp** at the end of treatment
Zribi at al. (2014)	51	Pu	M	9 weeks	P K	VJ, sprint	progress of measured capacities
Prasad & Subramainiam (2014)	45	13-17	M	12 weeks (3x a week/ 45min)	P K Sк	speed	improvement of speed in **P** and **Sk** / there is no difference between **P** and **Sk**, **P** and **Sk** better results than **K**
Ramateerth & Kannur (2014)	21	12-13	M	6 weeks (2x a week/ 90min)	S Ps	VJ, SLJ, MBT, 20m sprint, running 4x15m and flexibility	**Ps** improvement in all measured parameters / **Ps** greater progress than **S** in all measured parameters
Chidambara (2014)	20	19-25	M	8 weeks (3x a week)	P K	SMS (Johnson Basketball Ability Test)	**P** - progress on all the tests of SMS / **P** greater progress than **K** on all the tests
Nageswaran (2014)	30	18-22	M	10 weeks	P K Pr	eP	**P** and **Pr** improvement in eP **Pr** greater progress than **P**
Abraham (2015)	80	13-18	M	12 weeks (3x a week)	P K Кт Bp	eP og legs, eP of arms and shoulders, endurance, speed and agility	progress of **P**, **Kt** and **Bp** in all measured abilities / **P** and **Bp** greater progress than **Kt** on tests of eP of legs, arms and shoulders

Legend: N - total number; S - sex of respondents; Nb. of gr. - number of groups; P - group that was subjected toplyometric program; K - control group; Pv - group that was subjected to the aquatic plyometric program; Po - group subjected to plyometric training with an external load; Ko - group that was subjected to a complex training; Ps - group that was subjected to combined plyometric training and strength training; S - group subjected to training with strength exercises; Pt - group that was subjected to combined plyometric training and weight training; Psr - group that performed plyometric jumps in the sagittal plane; Pfr - group that performed plyometric jumps in the frontal plane; Di - group that was subjected to dynamic stretching; DiP - group that was subjected to a combination of dynamic stretching and plyometric exercises; Sp - group that was subjected to a specific sprint training; O - group that was subjected to resistance training; Kt - group that was subjected to a circular training; Bp - group that was subjected to circuit breaker program; Pr - group that was subjected to combined plyometric training and resistance training; P_{50}, P_{60}, P_{70} and P_{100} - groups that were subjected to plyometric deep jumps from the bench of 50, 60, 70 and 100cm; Sk - group that was subjected to SAQ training; P_1 - group that had plyometric training once per week; P_3 - group that had three plyometric trainings per week; PKt - group that was subjected to a combination of plyometric and circuit training; Ju - juniors; Un - university basketball players; Pu - puberty; VJ - vertical jump; Fmax - maximum force; RFD - rate of force development; Ma - motor abilities; F - force; MBT - Medicine Ball Throw; SJ - Squat Jump; CMJ - Countermovement Jump; ABA - Abalakov test; eP - explosive power; SMS - situational motor skills: speed of passing the ball test, test of maneuvering around the obstacle, a test of shot on the goal within 30 seconds, the test of depositing the ball into the basket; DJ (Drop Jump); TJ - triple jump; SLJ - Standing Long Jump; 1RM - 1 repetition maximum; tF - time flight; A - acceleration.

Discussion

The analysis of this study shows that in 25 of 27 analyzed studies there was a positive effect of plyometric training on the vertical jump height of basketball players. Matavulj et al. (2001) found that plyometric training leads to an increase of the height of vertical jump in junior basketball players. The presented studies show that an increase in the height of vertical jump of basketball players is due to plyometric training for a period of: 12 weeks (3x per week) (Shallaby, 2010; Abraham, 2015); 10 weeks (2-3x per week) (Khlifa et al., 2010; Kukrić et al. 2010; Santos & Janeira, 2011; Adorable et al. 2011; Kukrić et al. 2012; Nageswaran, 2014); 9 weeks (Zribi et al., 2014); 8 weeks (2-3x per week) (Boraczyñski & Urnia, 2008; Arazi et al 2012; Robert & Murugavel, 2013; Nabizadeh et al. 2013); 7 weeks (3x weekly) (Zushi, 2006); 6 weeks (2-3x per week) (Draganović & Marković, 2011; Bavli, 2012; Asadi & Arazi, 2012; Asadi, 2013b; Morsal et al., 2014); 4 weeks (2-3x per week) (Shaji & Isha, 2009; Wee et al. 2011; Sharma & Multani, 2012). Zhang (2013) found that plyometric training in the mentioned period leads to a significant improvement in the height of vertical jump with the left leg and the height of vertical jump with the right leg, but it does not lead to a significant improvement of high jump with both feet in basketball players.

King & Cipriani (2010) found that plyometric exercises with jumps in the sagittal plane, for a period of six weeks (2x a week), lead to significant improvements in the height of vertical jump, while plyometric exercises with jumps in the frontal plane in the mentioned period do not lead to an increase in the vertical jump height. One of the rare studies in which plyometric training did not lead to a significant increase in the height of vertical jump in basketball players is the research by Lehnert et al. (2013). Gottlieb et al. (2014) in their study also found that plyometric program for a period of 8 weeks (2x a week) does not lead to significant advances of the height of vertical jump in basketball players.

The research shows that to improve the speed of basketball players, plyometric training is needed for a period of: 12 weeks (3x weekly) (Shallaby, 2010; Prasad & Subramainiam, 2014; Abraham, 2015); 9 weeks (Zribi et al., 2014); 8

weeks (3x weekly) (Arazi & Asadi, 2011; Bandyopadhyay et al. 2013); 6 weeks (2x weekly) (Asadi, 2013; Bavli, 2012; Draganović & Marković, 2011).

Gottlieb et al.(2014) found that plyometric training for a period of 8 weeks (2x a week) does not lead to significant speed improvements.The fact that plyometric training for 4 weeks (3x per week) does not improve the speed of basketball players was noted by Zhang (2013). The improvement of speed did not probably happen because four weeks is a short period of time in order to cause positive changes in the above mentioned skills.

The researches show that to improve the agility of basketball players, plyometric training is needed for a period of:12 weeks (3x per week) (Abraham, 2015; Shallaby, 2010); 8 weeks (2-3x per week) (Gottlieb et al. 2014; Mitra et al. 2013; Arazi et al. 2012); 6 weeks (2x weekly) (Asadi, 2013b, Asadi & Arazi, 2012; Bal et al. 2011); 4 weeks (2x weekly) (Shaji & Isha, 2009).

One of the rare studies in which plyometric training did not lead to significant improvements in the agility of basketball players is the research done by Lehnert et al.(2013). In their study, the experimental program lasted for six weeks (2x a week from the first to the fourth week of the program and 4x a week in the fifth and the sixth week of the program).

The analysis of studies in Table 1 showed that plyometric training for a period of 12 weeks (3x weekly) (Raj, 2013), for a period of 8 weeks (3x weekly) (Arazi & Asadi, 2011) and in the duration of 4 weeks (Sharma & Multani, 2012) led to a significant improvement in the balance of basketball players. In contrast to the mentioned studies, Asadi (2013)a and Asadi & Arazi (2012) found that plyometric training for a period of 6 weeks (2x a week) does not lead to a significant improvement in the balance of basketball players. Raj (2013) found that plyometric training in the period of 12 weeks (3 x a week) leads to a significant improvement of the flexibility of hip and spine. Plyometric training for 8 to 12 weeks (1-3x a week) leads to a significant improvement in the endurance of basketball players (Sagiroglu et al. 2012; Raj, 2013; Abraham, 2015).

Shallaby (2010) found that plyometric training for 12 weeks (3x per week) leads to a significant improvement in situational-motor skills (speed of passing the ball, dribbling around obstacles, shot for a goal in 30 seconds, placing the ball into the basket). Chidambara (2014) and Sisodiya & Abhinav (2012) found that plyometric training for a period of 8 weeks (3x per week) leads to a significant improvement in the situational-motor skills of basketball players. In both studies, the authors used Johnson Basketball Ability Test for the assessment of SMS, which includes: *field goal speed test (points / 30 seconds), throw for accuracy (Points / 10 trials)* and *dribble (points / 30 seconds).* Sharma & Multani (2012) found that plyometric training for a period of four weeks led to a significant improvement in the situational-motor abilities of basketball players. Zushi (2006), on a sample of 10 players, found that plyometric training for a period of 7 weeks (3x a week) leads to a significant improvement in the ability of passing the ball with chest. Within plyometric training in the mentioned study *drop jump* exercises and *medicine ball throw* were used.

Nageswaran (2014) found that the combination of plyometric training and resistance training for 10 weeks leads to a significant improvement of the explosive power of basketball players. The author also found that the combination leads to significantly greater progress of explosive power than just plyometric training during the same period. Sisodiya & Abhinav (2012) found that the combination of plyometric and circuit training in the period of 8 weeks (3x per week) leads to a significant improvement in the situational-motor abilities of basketball players. Andrejić (2012) and Ramateerth & Kannur (2014) found that the combination of plyometric training and strength training (*rubber cord exercises* and *body weight exercises*) for 6 weeks (2x a week) leads to a significant improvement in high jump, long jump, medicine ball throw, the 20m sprint and running 4x15m in basketball players. Khlifa at al. (2010) found that plyometric exercises where there is an additional external load in the form of vests (10-11% of total weight) for 10 weeks (2-3x per week) lead to a significant increase in the height of vertical jump of basketball players. Shaji & Isha (2009) found that the combination of dynamic stretching and plyometric exercises in the period for 4 weeks (2x a week) leads to significant improvements in the height of vertical jump and agility of basketball players. Santos & Janeiro (2008) found that the combination of plyometric training and weight training for a period of 10 weeks (2x a week) leads to a significant improvement in test scores of squat jump, Abalakov test, and medicine ball throw, while Cheng, Lin & Lin (2003) found that this combination for a period of 8 weeks (3x a week) leads to significant improvements in the height of vertical jump and the strength of players.

Matavulj et al. 2001 and Nabizadeh et al. 2013 found that there is no significant difference in the effects of plyometric training on the height of vertical jump, depending on whether jumps in depth, in the training, are performed from the bench of 50, 60, 70 or 100cm. Arazi, Coetzee & Asadi (2012) found that there are no significant differences between the effects of aquatic and the effects of terrestrial plyometric training on the height of vertical jump and the agility of basketball players. King & Cipriani (2010) found that plyometric training that uses jumps in the sagittal plane leads to a significant improvement in the height of vertical jump than plyometric training that uses jumps in the frontal plane. For this reason it is important for experts in the field of basketball to choose plyometric exercises that are consistent with the set objectives.

Abraham (2015) found that plyometric training for a period of 12 weeks (3x a week) significantly better affects the improvement of explosive strength of legs, arms and shoulders than circuit training in the same time period. Raj (2013) found that plyometric training for 12 weeks (3x a week) significantly better influences improving the cardio respiratory endurance than circuit training and *circuit breaker* training, while there is no significant difference between the effects of plyometric training and effects of the mentioned training on the flexibility of hip, spine and shoulders, the static and dynamic balance. It is likely that there is no difference because balance and flexibility are motor skills for whose development it is necessary to use more complex forms of movement, which are not represented within plyometric training. Robert & Murugavel (2013) found that plyometric training for a period of 8 weeks (3x weekly) significantly better influences improvement in the height of vertical jump than specific training of sprint and resistance training in the same time period. On the other hand, specific sprint training significantly better influences the improvement of acceleration than plyometric training. Shaji & Isha (2009) found that plyometric training significantly better influences the improvement of agility of basketball players than dynamic stretching training. Prasad & Subramainiam (2014) found that there is no significant difference between the effect of plyometric training and the effect of SAQ training on speed. The difference probably does not occur because SAQ training contains exercises that are similar to exercises within plyometric training. There is no significant difference between the effect of plyometric training and the effect of weight training on agility (*Illinois Agility Test*) (Mitra, Bandyopadhyay & Gayen, 2013) and on speed (Bandyopadhyay, Mitra & Gayen, 2013). Kukrić, Karalejić, Jakovljević, Petrović & Mandić (2012) found no significant difference between the effect of plyometric training and the effect of complex training on the height of vertical jump. A complex training in this study also contained different exercises with jumps, which contributed to avoid differences in the above mentioned capacity.

Conclusion

Plyometric training for at least 4 weeks to 12 weeks (2-3x per week) could lead to a significant improvement of explosive power, the height of vertical jump, agility and situational-motor abilities of basketball players; that plyometric training for at least 6 weeks to 12 weeks (2-3x per week) can lead to significant improvements in the speed of basketball players (only one study was found in which the experimental treatment lasted less than six weeks (four weeks) and no positive effect was found); that plyometric training for at least 8 weeks to 12 weeks (2-3x per week) can lead to significant improvements in the endurance of basketball players (studies which studied the effect of plyometric training on the endurance of basketball players but which lasted less than eight weeks were not found). There are not many studies that have dealt with the effects of plyometric training on the development of balance and flexibility. The researches show that different ways of plyometric training can have different effects on motor skills of basketball players. For this reason it is necessary that experts in the field of basketball select exercises, within plyometric training, which are in accordance with the set target.

References

1. Abraham, B. (2015). Comparative effects of selected motor components of school level basketball players on plyometric, circuit training and circuit breaker programmes. International Online Multidisciplinary Journal Review Of Research 3 (7), 1-4.
2. Adorable, L., Caparino, C. A., & Abbu, C. C. (2011). The effect of plyometric training on the vertical leap of university varsity basketball players. In. A. Wicker (ed), 7th EFSMA - European Congress of Sports Medicine, 3rd Central European Congress of Physical Medicine and Rehabilitation (pp. 44-45). Salzburg: Austrian Society of Physical Medicine and Rehabilitation.
3. Andrejić, O. (2012). The effects of a plyometric and strength training program on the fitness performance in young basketball players. Facta universitatis-series: Physical Education and Sport, 10 (3), 221-229.
4. Arazi, H., & Asadi, A. (2011). The effect of aquatic and land plyometric training on strength, sprint, and balance in young basketball players. Journal of Human Sports & Exercise, 6 (1), 101-111.
5. Arazi, H., Coetzee, B., & Asadi, A. (2012). Comparative effect of land-and aquatic-based plyometric training on jumping ability and agility of young basketball players. South African Journal for Research in Sport, Physical Education and Recreation, 34 (2), 1-14.
6. Asadi, A. (2013a). Effects of in-season plyometric training on sprint and balance performance in basketball players. Sport Science, 6 (1), 24-27.
7. Asadi, A. (2013b). Effects of in-season short-term plyometric training on jumping and agility performance of basketball players. Sport Sciences for Health, 9 (3), 133-137.
8. Asadi, A., & Arazi, H. (2012). Effects of high-intensity plyometric training on dynamic balance, agility, vertical jump and sprint performance in young male basketball players. Journal of Sport and Health Research, 4 (1), 35-44.
9. Asadi, A., de Villarreal, E. S., & Arazi, H. (2015). The effects of plyometric type neuromuscular training on postural control performance of male team basketball players. Journal of strength and conditioning research, 29 (7), 1870-1875.
10. Bal, B. S., Kaur, P. J., Singh, D., & Bal, B. S. (2011). Effects of a short term plyometric training program of agility in young basketball players. Brazilian Journal of Biomotricity, 5 (4), 271-278.
11. Bandyopadhyay, S., Mitra, S., & Gayen, A. (2013). Effects of plyometric training and resistance trainng on specific speed of basketball players. Paripex - Indian Journal of Research, 2 (7), 249-251.
12. Bavli, Ö. (2012). Investigation the effects of combined plyometrics with basketball training on some biomotorical performance. Pamukkale Journal of Sport Sciences, 3 (2), 90-100.
13. Berić, D., i Kocić, M. (2010). *Košarka-tehnika i metodika*. Niš: Fakultet sporta i fizičkog vaspitanja.

14. Boraczyñski, T., & Urnia, J. (2008). The effect of plyometric training on strength-speed abilities of basketball players. Research Yearbook, 14 (1), 14-19.
15. Cheng, C. F., Lin, L. C., & Lin, J. C. (2003). Effects of Plyometric Training on Power and Power-Endurance in High School Basketball Players. Annual Journal of Physical Education and Sports Science, (3), 41-52.
16. Chidambara, R.S. (2014). Effect of plyometric training on performance variables of basketball players. International Journal of Behavioral Social and Movement Sciences, 3 (4), 1-4.
17. de Villarreal, E. S. S., Kellis, E., Kraemer, W. J., & Izquierdo, M. (2009). Determining variables of plyometric training for improving vertical jump height performance: a meta-analysis. The Journal of Strength & Conditioning Research, 23 (2), 495-506.
18. Draganović, A., & Marković, S. (2011). Influence of plyometric training on the development of leg explosive strength. *Proceedings*, 3, 183-188.
19. Erčulj, F., Dežman, B., & Vučković, G. (2004). Differences between three basic types of young basketball players in terms of jump height and ground contact time. *Kinesiologia Slovenica*, 10 (1), 5-15.
20. Gottlieb, R., Eliakim, A., Shalom, A., Dello-Iacono, A., & Meckel, Y. (2014). Improving Anaerobic Fitness in Young Basketball Players: Plyometric vs. Specific Sprint Training. Journal of Athletic Enhancement, 3 (3), 1-6.
21. Ivanović, J., Dopsaj, M., Ćopić, N., & Nešić, G. (2011). Is there a relation between maximal and explosive leg extensors isometric force?. Facta universitatis-series: Physical Education and Sport, 9 (3), 239-254.
22. Jakovljević, S., Karalejić, M., Pajić, Z., i Mandić, R. (2011). Ubrzanje i brzina promene smera i načina kretanja kvalitetnih košarkaša. Fizička kultura, 65 (1), 16-23.
23. Jamurtas, A. Z., Fatouros, I. G., Buckenmeyer, P., Kokkinidis, E., Taxildaris, K., Kambas, A., & Kyriazis, G. (2000). Effects of plyometric exercise on muscle soreness and plasma creatine kinase levels and its comparison with eccentric and concentric exercise. The Journal of Strength & Conditioning Research, 14 (1), 68-74.
24. Jovanović, I. (1999). Košarka-Teorija i metodika. Niš: Filozofski fakultet
25. Khlifa, R., Aouadi, R., Hermassi, S., Chelly, M. S., Jlid, M. C., Hbacha, H., & Castagna, C. (2010). Effects of a plyometric training program with and without added load on jumping ability in basketball players. The Journal of Strength & Conditioning Research, 24 (11), 2955-2961.
26. King, J. A., & Cipriani, D. J. (2010). Comparing preseason frontal and sagittal plane plyometric programs on vertical jump height in high-school basketball players. The Journal of Strength & Conditioning Research, 24 (8), 2109-2114.
27. Kukrić, A., Petrović, B., Dobraš, R., & Guzina, B. (2010). Uticaj pliometrijskog treninga na eksplozivnu snagu opružača nogu. SportLogia, 6 (1), 14-20.
28. Kukrić, A., Karalejić, M., Jakovljević, S., Petrović, B., & Mandić, R. (2012). Uticaj različitih metoda treninga na maksimalnu visinu vertikalnog skoka kod košarkaša juniora. Fizička kultura, 66 (1), 25-31.
29. Lehnert, M., Hůlka, K., Malý, T., Fohler, J., & Zahálka, F. (2013). The effects of a 6 week plyometric training programme on explosive strength and agility in professional basketball players. Acta Gymnica, 43 (4), 7-15.
30. Matavulj, D., Kukolj, M., Ugarkovic, D., Tihanyi, J., & Jaric, S. (2001). Effects of plyometric training on jumping performance in junior basketball players. The Journal of sports medicine and physical fitness, 41 (2), 159-164.
31. Miller, M. G., Herniman, J. J., Ricard, M. D., Cheatham, C. C., & Michael, T. J. (2006). The effects of a 6-week plyometric training program on agility. Journal of sports science & medicine, 5 (3), 459-465.
32. Mitra, S., Bandyopadhyay, S., & Gayen, A. (2013). Effects of plyometric training and resistance trainng on agility of basketball players. International Online Physical Education and Sports Research Journal "Academic Sports Scholar", 1 (12), 1-5.
33. Morsal, B., Shahnavazi, A., Ahmadi, A., Zamani, N., Tayebisani, M., & Rohani, A. (2014). Effects of polymeric training on explosive power in young male basketball. European Journal of Experimental Biology, 4 (3), 437-439.
34. Nabizadeh, M., Bararpour, E., Chaleh, M. C., & Najafnia, Y. (2013). Comparison of three deep jump plyometric trainings on vertical jump in basketball players. International Research Journal of Applied and Basic Science, 4 (12), 3798-3801.
35. Nageswaran, A.S. (2014). An impact of plyometric training packages with and without resistance training on leg explosive power of arts college men basketball players. Indian journal of applied research, 4 (2), 28-29.
36. Prasad, R., & Subramainiam, P. K. (2014). Effect of SAQ training and plyometric training on selected motor fitness and physiological variables among junior basketball players. Paripex - Indian Journal of Research, 3 (11), 156-157.
37. Raj, X. M. (2013). Comparative effects of plyometric, circuit training and circuit breaker programmes on selected motor components of school level Basketball Players. Indian Journal of Movement Education and Exercises Sciences, 3 (1), 1-5.
38. Ramateerth, P. R., & Kannur, N. G. (2014). Effects of a plyometric and strength training program on the fitness performance in basketball players. International Online Physical Education and Sports Research Journal "Academic Sports Scholar", 3 (7), 1-7.
39. Robert, A., & Murugavel, K. (2013). Effect of plyometric resistance and sprint training on acceleration speed flight time and jump height of male basketball players. International Journal for Life Sciences and Educational Research, 1 (3), 105 - 109.
40. Santos, E. J., & Janeira, M. A. (2008). Effects of complex training on explosive strength in adolescent male basketball players. The Journal of Strength & Conditioning Research, 22 (3), 903-909.
41. Sağıroğlu, I., Konar, N., Önen, M. E., Ateş, O., & Alkurt, Z. (2012). Effect of pliometric training on anaerobic performance in young basketball players. Nigde University Journal of Physical Education And Sport Sciences, 6 (3), 258-264.

42. Santos, E. J., & Janeira, M. A. (2011). The effects of plyometric training followed by detraining and reduced training periods on explosive strength in adolescent male basketball players. The Journal of Strength & Conditioning Research, 25 (2), 441-452.
43. Shaji, J., & Isha, S. (2009). Comparative analysis of plyometric training program and dynamic stretching on vertical jump and agility in male collegiate basketball player. Al Ameen Journal of Medical Sciences, 2 (1), 36-46.
44. Shallaby, H. K. (2010). The effect of plyometric exercises use on the physical and skillful performance of basketball players. World Journal of Sport Sciences, 3 (4), 316-324.
45. Sharma, D., & Multani, N. K. (2012). Effectiveness of Plyometric Training in the Improvement of Sports Specific Skills of Basketball Players. Indian Journal of Physiotherapy and Occupational Therapy-An International Journal, 6 (1), 77-82.
46. Sisodiya, A. S., & Abhinav (2012). Effect of plyometric exercise, circuit training and their combined effect on the basketball playing ability. International Journal of Health, Sports and Physical Education, 1 (1), 28-33.
47. Stemm, J. D., & Jacobson, B. H. (2007). Comparison of land-and aquatic-based plyometric training on vertical jump performance. The Journal of Strength & Conditioning Research, 21 (2), 568-571.
48. Vrcić, M. (2009). Modeliranje jednogodišnjeg ciklusa pliometrijskog treninga bacača kugle. Sportekspert, 2 (1), 12-14.
49. Wee, E. H., Mudah, F., & Tan, C. H. (2011). Effects of a 4-Week Plyometric Training on the Jumping Performance of Basketball Players. Malaysian Journal of Sport Science and Recreation, 7 (1), 64-82.
50. Zhang, X. (2013). Research of Jumping Ability and Explosive Power Based on Plyometric Training. *Lecture Notes in Electrical Engineering*, 206, 427-433.
51. Zribi, A., Zouch, M., Chaari, H., Bouajina, E., Ben, N. H., Zaouali, M., & Tabka, Z. (2014). Short-Term Lower-Body Plyometric Training Improves Whole Body BMC, Bone Metabolic Markers, and Physical Fitness in Early Pubertal Male Basketball Players. Pediatric exercise science, 26 (1), 22-32.
52. Zushi, K. (2006). Effects of plyometrics on the abilities of the jump, footwork and the chest pass in competitive basketball players. Japanese Journal of physical fitness and sports medicine, 55 (2), 237-245.

AGE – GROUP DIFFERENCES OF YOUNG SERBIAN GYMNASTS IN CERTAIN TESTS OF STRENGTH

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Abstract

The aim of this research was to investigate differences in certain tests of strength in young gymnasts belonging to different age groups who are competing in the "A" and "B" program of the Gymnastics Association of Serbia. The sample of gymnasts was divided into two groups: the first group (n=12, born in 2004-2006), and the second group of gymnasts (n=18, born in 2007-2009). To assess certain aspects of strength, six tests were used according to the Age Group Development and Competition Program for Women's Artistic Gymnastics (FIG AP, 2015, 89): the *Standing long jump*, *20 meter sprint*, *Hanging leg lifts*, *Rope climb*, *Dips* and *Hold Handstand on a low Balance Beam*. The data were analyzed using the One-way Anova and Manova analysis. The results show that the *Standing long jump* variable (SDAL) and *20 meter sprint* variable (SPRI) show a statistically significant difference in gymnasts of various age groups, with a 100% explanation (.00). The *Hold Handstand on a low BB* variable (STOJ) shows a statistically significant difference with a 95% explanation (.05). These tree tests have been determined as ones that contribute to the significant differentiation (.00) in gymnasts of different age groups. The variables *Hanging leg lifts, Rope climb* and *Dips* represent the repetitive strength of the body and no statistically significant difference was determined for them.

Key words: *gymnast, strength, differences, program, age group*

Introduction

Artistic gymnastics has made outstanding improvements in accordance with the tendencies of high-performance sport, but it also has its specific features, such as: increase of sports mastery, development and rivalry of competitive program complexity, processing of new routines, etc. (Vieru, 1997; Arkaev & Suchilin, 2004). The selection process in competitive sport such as Artistic Gymnastics is highly important. Children who are selected in certain disciplines have genetic, motor and intellectual predispositions which should lead to the achievement of high competitive results. Every sport has its own model for selection which is based on the model characteristics of a champion. The process of selection in gymnastics is based on the assessment of a model's characteristics, which are dominant and have a significant influence on the gymnast's performance (Marinšek & Veličković, 2010). According to Marinšek &Veličković (2010) the development of motor abilities is one of the most important issues in gaining motor efficiency. Only physically well-prepared gymnasts will be able to perform gymnastic skills and routines in a technically correct manner and without any unnecessary injuries. The technology of sports preparation of elite gymnasts assumes that sports and technical results as well as normative indexes should be obtained at all stages of the long-term preparation (Arkaev & Suchilin, 1997). Versatile exercise contents like gymnastics are highly suitable for the development of motor abilities (Pajek, Cuk, Kovac & Jakse, 2010; Werner, Williams & Hall, 2012). From the perspective of child development, gymnastics is one of the key sports that plays an important role in the successful performance of floor exercises or use of gymnastics apparatus, and offers a great range of locomotive, stability and body control movements which are highly important (Pajek, Cuk, Kovac & Jakse, 2010). As a basic sport, artistic gymnastics affects the development of motor skills: strength, coordination, flexibility, power, endurance and balance (Albuquerque & Farinatti, 2007; Carrick, Oggero, Pagnacco, Brock & Arikan, 2007; Tonić, Petković, Mekić & Radenković, 2010).

The aim of this research was to investigate differences in certain tests of strength in young gymnasts of different age groups.

Methods

The sample of participants

The research sample consists of 30 Serbian female gymnasts that are members of three gymnastic clubs competing in the "A" and "B" program of the Gymnastics Association of Serbia (2012 - 2016). The sample of gymnasts was divided into two groups: the first group (n=12, born in 2004-2006, mean age: 11± 6 months; body height: 129±0.5cm; body mass: 30±0.5kg), and the second group of gymnasts (n=18, born in 2007-2009, mean age: 9± 6 months; body height: 13o±0.5cm;

body mass: 27±0.5kg). All of the female gymnasts had taken part in the gymnastics training process for at least two to four years, and all the participants in this study were competing in national competitions in the 2015/16 competitive season. They trained five times a week, with the training sessions lasting for 2 hours. All of the participants in this study underwent certified medical examinations, which is registered in their official competition identity card, issued by the Gymnastics Association of Serbia.

The procedures

To determine the level of strength, power and special power endurance of the gymnasts six tests were used (Table 1), according to Age Group Development and Competition Program for Women's Artistic Gymnastics (FIG AP, 2015, 90): the *Standing long jump* (SDAL), *20 meter sprint* (SPRI), *Hanging leg lifts* (RIPS), *Rope climb* (KONO), *Dips* (PROP) and *Hold Handstand on a low Balance Beam* (STOJ). All of the procedures were approved by the Ethics Committee of the Faculty of Sport and Physical Education, University of Niš, according to the Helsinki Declaration (World Medical Association, 2002). The statistical analyses were performed using the Statistics for Windows program, version 10.0. The data were analyzed using the One-way Anova and Manova analysis. A significance criterion was defined at the level of $p \leq .05$. All of the testing procedures were conducted by the same trainers. The gymnasts were measured indoors, each time before training, after a standard gymnastics warm up (5 minutes of running and 10 minutes of a warm-up protocol).

Table 1: Variables with abbreviations

Name of the variable	The abbrev	Measurement unit	Strength
1. Standing long jump	SDAL	cm	explosive leg power
2. 20 meter sprint	SPRI	seconds	velocity
3. Hanging leg lifts	RIPS	number of repetition	repetitive strength of the abdomen
4. Rope climb	KONO	seconds	repetitive arm strength
5. Dips	PROP	number of repetition	the power of the arms and shoulders
6. Hold Handstand on low Balance Beam (BB)	STOJ	seconds	special power endurance

The FIG Age Group Development and Competition Program (AGDCP) is connected with the educational efforts of the FIG Academy Program. The FIG Academy Program has focused on the safe and healthy preparation and development of young gymnasts towards high performance excellence (FIG AP, 2015, 10). A systematic long-term preparation of gymnasts is required, which takes into consideration growth and maturation principles. According to Hofmann (FIG AP, 2015, 14) common effort in the performance development of gymnasts preparation should be concentrated on the essential aspects: a systematic increase of the load for the purpose of creating a long-lasting load ability of the support and motor system, and a high development of the prerequisites (flexibility, power, basic structures). The purpose of the Physical Ability Testing Program (PAT) shows demands for the development of flexibility and power skills. The selection of test exercises is based on experiences compiled over many years, and is extracted from training programs for the development of physical ability prerequisites for performance. The test exercises for power skills are based on the determination of the level of development of explosive power, special power endurance, and the level of static and dynamic components of exercises (FIG AP, 2015, 87). *Strength* can be defined as the ability to produce force (Siff, 2001; Stone, 1993), or strength is the ability of one person to overcome the resistance of the external work of the muscles (Željaskov, 2004). Thus, the measurement of strength is, in effect, a measure of an ability or skill. Therefore, the ability to generate force (*strength*), which is an integral part of power production, may be a key component in determining athletic success (Stone, Moir, Glaister & Sanders, 2002; Stone, Plisk, & Collins, 2002). By definition, according to Zatsiorsky & Kraemer (2006, 28) *Explosive strength* is the ability to exert maximal forces in minimal time. In gymnastics, *special power endurance* refers to specific motor abilities that develop specialized gymnastic training. *Endurance* is defined as the ability to bear fatigue (Zatsiorsky & Kraemer, 2006, 162). S*trength endurance* is a muscle's ability to perform a maximum contraction time after time (https://www.brianmac.co.uk/conditon.htm). Power is the ability to exert maximum muscular contraction instantly in an explosive burst of movements (https://www.brianmac.co.uk/conditon.htm).

Results and discussion

Table 2. shows the descriptive statistics, including mean values for the variables of strength of the older age group of gymnasts (born in 2004-2006).

Table 2: Descriptive statistics for the first group of gymnasts (2004-2006)

Variable	N	Mean	Min	Max	Range	St. Dev.	Error	Skewness	Kurtosis
SDAL	12	181.75	156.00	206.00	50.00	13.92	4.01	-0.14	0.00
SPRI	12	3.72	3.20	4.22	1.02	0.29	0.08	0.07	-0.61
RIPS	12	19.75	7.00	44.00	37.00	12.03	3.47	1.07	0.31
KONO	12	9.71	4.73	28.00	23.27	6.41	1.85	2.42	6.52
PROP	12	8.25	5.00	11.00	6.00	2.22	0.64	-0.25	-1.46
STOJ	12	4.77	1.06	22.41	21.35	6.04	1.74	2.66	7.51

Legend: N-number of participants; **Mean**- arithmetic mean; **Min**-minimum and **Max**-maximum value; **R**-range; **St. Dev**-standard deviation; **Skew**- skewness; **Kurt**-kurtosis; **SDAL -** *Standing long jump;* **SPRI -** *20 meter sprint;* **RIPS -** *Hanging leg lifts;* **KONO -** *Rope climb;* **PROP-** *Dips;* **STOJ -** *Hold Handstand on a low Balance Beam*

Table 3. shows the same results for the gymnasts of the younger age group (born in 2007-2009). All of the data had normal distribution according to the Skewness and Kurtosis values.

Table 3: Descriptive statistics for the second group of gymnasts (2007-2009)

Variable	N	Mean	Min	Max	Range	St. Dev.	Error	Skewness	Kurtosis
SDAL	18	155.50	117.00	182.00	65.00	17.13	4.03	-0.41	-0.06
SPRI	18	4.14	3.20	4.66	1.46	0.38	0.09	-0.99	0.46
RIPS	18	17.56	3.00	35.00	32.00	9.82	2.31	0.13	-1.14
KONO	18	11.93	5.54	26.00	20.46	4.76	1.12	1.33	3.57
PROP	18	6.50	1.00	14.00	13.00	4.23	0.99	0.56	-0.70
STOJ	18	1.90	1.00	4.40	3.40	1.10	0.26	0.97	-0.13

Legend: N-number of participants; **Mean**- arithmetic mean; **Min**-minimum and **Max**-maximum value; **R**-range; **St. Dev** -standard deviation; **Skew**-skewness; **Kurt**-kurtosis; **SDAL -** *Standing long jump;* **SPRI -** *20 meter sprint;* **RIPS -** *Hanging leg lifts;* **KONO -** *Rope climb;* **PROP-** *Dips;* **STOJ -** *Hold Handstand on a low Balance Beam*

The values of the variables in Table 2. and Table 3. indicate that the older age group of gymnasts is generally better. The *Standing long jump* (SDAL) measures explosive leg power in *cm,* giving a better test score a higher value. The Mean values in this variable indicate that the first group of gymnasts (born in 2004-2006) achieved better results than the second group of gymnasts (born in 2007-2009). The *20 meter sprint* (SPRI) measures running velocity. The results are better if the values of the running velocity are lower. The results achieved in the Mean values by the older age group of gymnasts are better than those achieved by the younger age group of gymnasts (n=12, 3.72; n=18, 4.14). *Hanging leg lifts* (RIPS) indicate slightly better results for the older age group of gymnasts. This variable measures repetitive strength of the abdomen, which is expressed in the maximum number of repetitions. The *Rope climb* (KONO) shows better results for the older age group of gymnasts, as lower values represent better scores. The *Dips* (PROP) represents the number of repetitions reached in 20 seconds on the Parallel Bars. The Mean values are slightly better in the older age group of gymnasts (n=12, 8.25; n=18, 6.50). *Hold Handstand on a low Balance Beam* (STOJ) represents the gymnasts' special power endurance. The *Hold Handstand* is a gymnastics routine that reflects the static strength of the trunk and shoulders and the strength of the fist flexors. This routine, which includes a standing position in the *Handstand* and maintains a balanced position, also requires strength for proper performance.

The data in Table 4. and Table 5. were analyzed using the One-way Anova and Manova analysis. A significance criterion was defined at the level of $p \leq .05$. Table 4. has shown the results of the One-way Anova for repeated measures.

Table 4: Results of the One-way Anova

Variable	Group	N	Mean	SD	F	p
SDAL	I group	12	181.75	13.92	19.49	**0.00**
	II group	18	155.50	17.13		
SPRI	I group	12	3.72	0.29	9.77	**0.00**
	II group	18	4.14	0.38		
RIPS	I group	12	19.75	12.03	0.30	0.58
	II group	18	17.56	9.82		
KONO	I group	12	9.71	6.41	1.18	0.28
	II group	18	11.93	4.76		
PROP	I group	12	8.25	2.22	1.72	0.20
	II group	18	6.50	4.23		
STOJ	I group	12	4.77	6.04	3.91	**0.05**
	II group	18	1.90	1.10		

Legend: N-number of subjects; **Mean**- arithmetic mean; **SD**-standard deviation; **F**- F test; **p**-significance of differences, **SDAL -** *Standing long jump;* **SPRI** *-20 meter sprint;* **RIPS -** *Hanging leg lifts;* **KONO -** *Rope climb;* **PROP-** *Dips;* **STOJ -** *Hold Handstand on a low Balance Beam*

Based on the results of the Anova analysis, it can be concluded that significant differences between the different age groups of gymnasts were found in three tests of strength. The *Standing long jump* (SDAL) and *20 meter sprint* (SPRI) show a statistically significant difference in gymnasts of various age groups with a 100% explanation (.00). The *Hold Handstand on a low BB (*STOJ) shows a statistically significant difference with a 95% explanation (.05). The remaining tests *Hanging leg lifts, Rope climb* and *Dips* did not show a statistically significant differences. These three tests represent the repetitive strength of the body. The variables that represent explosive leg power, velocity and special power endurance indicate statistically significant differences between gymnasts of various age group categories. This research shows that gymnasts who are competing in the Serbian competition “A” and “B” program and have been training five times a week for 2 hours show no statistically significant differences in the variables of repetitive strength. The lack of significant differences indicates their good physical preparation. A statistically significant difference between gymnasts of various age groups was determined for the variables of explosive power, velocity and special power endurance. The existence of significant differences indicates their different age categories.

Table 5. presents the results of the difference in strength, power and endurance of the different age groups of gymnasts.

Table 5: Results of the Manova analysis

Wilks Value	F	df 1	df 2	p
0.47	4.20	6	23	**0.00**

Legend: F- F-test; **df 1, df 2** - degrees of freedom; **p** - sig. of differences, **Wilks Value -** test the differences between group means

The results of the Manova analysis showed that the statistically significant difference in certain tests of strength in gymnasts of various age groups was explained with a 100% (.00). The following three tests *Standing long jump* (SDAL), *20 meter sprint* (SPRI) and *Hold Handstand on a low BB* (STOJ) have been determined to contribute to the significant differentiation (.00) in the strength of gymnasts of different age groups.

Conclusion

The goal of this study was to compare certain tests of strength between two age groups of young gymnasts. This study confirmed that strength ability is related to the competition level and age group. In this research the older age group of gymnasts achieved better results than the younger age group. The FIG presented a battery of tests that showed a space of strength which was not completely covered, considering that other types of strength are not necessary for success in Artistic Gymnastics. Gymnastics compositions in different age groups do not differ much in terms of difficulty requirements, but the results in some strength tests showed a statistically significant difference between the age groups (.00).

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References

1. Age Group Development and Competition Program for Women's Artistic Gymnastics according to Fédération Internationale de Gymnastique –FIG Academy Program, taken from http://www.fig-gymnastics.com/site/page/view?id=772, Accessed 20.10.2016.
2. Albuquerque, P. A., & Farinatti, P. T. V. (2007).Development and validation of a new system for talent selection in female artistic gymnastics: the PDGO Battery. *Revista Brasiliera de Medicina de Esporte*, 13 (3), 139-145.
3. Arkaev, L. I., & Suchilin, N. G. (1997). Metabiological foundations of the modern system of training top - class athletes. *Theory and methods of physical culture, 11,* 17-25.
4. Arkaev, L.I., & Suchilin, N.G. (2004). *Gymnastics: How to create Champions. The Theory and methodology of training top class gymnasts*. Fizkultura i Sport, Moscow.
5. Carrick, F. R., Oggero, E., Pagnacco, G., Brock, J. B., & Arikan, T. (2007). Posturographic testing and motor learning predictability in gymnasts. *Disability* & *Rehabilitation*, 29 (24), 1881-1889.
6. Marinšek, M., & Veličković, S. (2010). Analysis of motor abilities between male gymnasts of two different countries. *International Quarterly of Sport Science,* 1, 9-16.
7. Pajek, M. B., Cuk, I., Kovac, M., & Jakse, B. (2010). İmplementation of the gymnastics curriculum in the third cycle of basic school in Slovenia. *Sci. Gym. J.* 2 (3): 15-27.
8. 8. Siff, M. C. Biomechanical foundations of strength and power training. In: *Biomechanics in Sport*. Zatsiorsky, V. ed. London: Blackwell Scientific Ltd., 2001. pp. 103-139.5
9. Stone, M. H. (1993). Explosive exercise. *NSCAJ*.15: 7-15.
10. Stone, M.H., Moir, G., Glaister, M., & Sanders, R. (2002). How much strength is necessary? *Phys. Ther. Sport*. 3:88-96.
11. Stone, M. H., Plisk, S., & Collins, D. (2002). Training principle: Evaluation of modes and methods of resistance training—A coaching perspective. *Sport Biomech*. 1:79-104.
12. Tonić, M., Petković, E., Mekić, H., & Radenković, O. (2010).Differences in coordination, strength and speed at gymnasts of different categories. *In: Stanković, R. (Ed.): Proceedings of the FIS Communications, 2010 (pp. 434-437).* Niš: Faculty of Sport and Physical Education
13. Vieru, N. (1997). *Manual of Sports Gymnastics*. Bucharest: Driada Publishing House, 65- 67.
14. World Medical Association (2002). World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. Available at http://www.fda.gov/ohrms/dockets/dockets/06d0331/06D-0331-EC20-Attach-1.pdf; accessed on 11.01.2017.
15. Zatsiorsky, M. V. & Kraemer, J. W. (2006). *Science and Practice of Strength Training. 2nd ed*. Human Kinetics Pub., pp 28, 162
16. Željaskov, C. (2004). *Conditional Preparation of Elite Athletes*. Belgrade: Sports Academy
17. Werner, P. H., Williams, L. H., & Hall, T. J. (2012). *Teaching Children Gymnastics. 3rd ed.* Human Kinetics Pub., pp. 23-38.

Sources: https://www.brianmac.co.uk/conditon.htm accessed on 11.01.2017.

THE RELATIONSHIP BETWEEN FOOT ARCH AND PHYSICALL FITNESS AMONG YOUNG TRIATHLETES

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Abstract

Purpose: Different foot arches could influence ground reaction force or motor skills in children generally, so the purpose of our research was to determine the relation among foot arches and physical fitness in young triathletes'.

Methods: In order to evaluate young athletes' fitness it was used ARISTO protocol. According the protocol athletes' maturity was assessed by Tanner scale. We evaluated athletes training experience, anthropometrical data, athletes' general physical fitness: long jump, 4x10 m shuttle run, 20 m shuttle run test, and specific tests for triathlon physical fitness: 200 m and 400 m running and 100 m, 400 m and 800 m swimming tests. The medial longitudinal foot arch was evaluated according to arch angle by Clarke.

Results: Correlation analysis shows that normal foot arch has relation among athletes' maturation stage (r = - 0.578, p = 0.008), height (r = - 0.496, p = 0.026) and lean body mass%, (r = - 0.472, p = 0.036). We found no relation between high and low foot arch and anthropometrical tests. Analyzing relationship among general and specific fitness tests results and different feet arches groups we established no relations among all the foot arch groups and physical fitness tests.

Conclusion: We found no relation among all the foot arch and physical fitness tests results in young triathletes.

Key words: *foot arch, tanner, fitness tests*

Introduction

The human foot is individual static-dynamic part of the movement apparatus. The foot plays an important role in the mechanics of walking, as an element of posture that maintains a direct connection with the floor in a stationery position and in locomotive movement. It also accounts for amortization, protecting the spine and skull against tiny shocks while in motion (Lichota et al., 2013).

Individual sporting disciplines have different levels of impact on the morphological structure and active efficiency of the foot. The state of the feet of sportsmen depends significantly on the type of effort and the weight of the load carried, which differs in different disciplines, and depends on the type of surface on which training and competition are conducted. The athletes'' ability to move depends to a significant degree on the efficacy of the feet. The morphology of the feet and its relation to risk factors in sport, as well as trauma, are the subject of interest of numerous researchers (Andrzejewska J., 2010)

There is a wide range of variability in foot arch flexibility within the human population. It has been discussed whether the foot arch height (FAH) is responsible for motor skills and physical performance in children (Lin et al., 2001) or not (Aydog et al., 2005; Lizis et al., 2010; Tudor et al., 2009). The medial longitudinal arch is given more attention because it seems to play an important role in supporting the body weight during static and dynamic movements.

Researches shows that different foot arches could influence ground reaction force or motor skills in children generally, so the purpose of our research was to determine the relation among foot arches and physical fitness in young triathletes'.

Methods

Participants

The study involved 22 boys triathletes. They were 13.12 ± 1.98 years old, height – 1.64 ± 0.12 m; weight – 50.30 ± 11.77 kg on average. The researches were performed in Lithuanian University of Educational Sciences.

All subjects didn't have lower-extremity abnormalities or injuries at the time of measurement. Subjects were informed about the course of the research. Parental consent for children to participate in the study were obtained. The National Bioethics Committee reviewed and approved the study protocol.

Measures and procedures

In order to evaluate young athletes' functional capacity, we used the ARISTO protocol (Sakalauskaite et al., 2014). According the protocol athletes' maturity was assessed by Tanner scale. We evaluated athletes training experience, anthropometrical data, athletes' general physical fitness: performed long jump, 4x10 m shuttle run, 20 m Shuttle run test, and specific tests for triathlon physical fitness: 200 m and 400 m running and 100 m, 400 m and 800 m swimming tests.

The medial longitudinal foot arch (MLA) was evaluated according to arch angle by Clarke (1933). Static footprints were taken from a standing position on a paper with colored sole in a weight-bearing position.

For the analysis of the MLA, necessary lines were drawn with a pencil and rulers on the footprints following the authors' instruction. For calculation of the Clarke's angle (CLA) the line "AC" was drawn between point A and the apex of the concavity of the arch of the footprint point C (Figure 1).

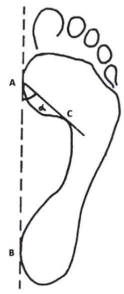


Figure 1: The Clarke's angle

The CLA is the angle between lines "AB" and "AC". The medial longitudinal arch (MLA) is classified as follows: 55° is overarched; 42-54° normal MLA; 31-41° flattened; 30° and below is flatfoot. Subjects were divided to groups according foot arch: low (LFA), normal (NFA), high (HFA) foot arch. Flattened feet were designated to flatfoot group.

Statistical analysis

The average and the standard deviation of foot arch angle and all physical fitness tests were calculated. Nonparametric Mann-Whitney U test was used to identify the difference between data of different foot arch. The significance level was $p<0.05$. Spearman's correlation coefficient was calculated in order to determine the link between foot arch type and all physical fitness tests. The significance level was $p<0.05$. The data were calculated using SPSS 20 package.

Results

The study involved 22 athletes (44 feet). 20 feet had normal arch NFA (average arch angle was 48.75±3.97 degree). 17 feet were assessed as some low arch feet LFA (average arch angle was 30.6±9.81 degree) and 7 feet were evaluated as a high arch HFA (average arch angle was 56.67±0.58 degree). The differences between the foot arch type groups were statistically significant ($p<0.05$).

Studies following the Aristo protocol shows that our subjects' training experience was – 2.53±1.51 years and they trained 8.85±4.62 hours per week on average. BMI of young triathlonists was 18.51±2.67, lean body mass – 80.91±5.23% and fat mass – 19.09± 5.23% on average.

Assessment result of athletes' maturity according the Tanner scale was 2.37±1.18.

Athletes general physical fitness and foot arches data presented in Table 1. The results show that athletes with the low foot arch performed the long jump test 5 cm longer tan athletes with the normal arch of the foot and 14 cm better then athletes with high foot arches. However, these differences were not statistically significant.

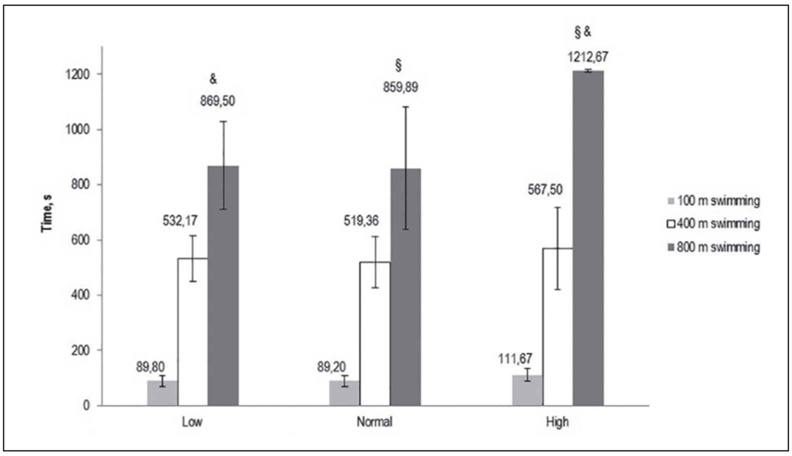
Analyzing shuttle run (4x10 m) test data we found the best results were in NFA group. The difference between the LFA and HFA were 0.03 s and 12.08 s, respectively, but these differences were not statistically significant.

Table 1: Athletes general physical fitness and foot arches data

Tests	Foot arch		
	Low	Normal	High
Long jump, m	1.84±0.25	1.79±0.32	1.70±0.41
4x10 m shuttle run, s	11.28±0.96	11.25±0.73	11.33±1.69
20 m Shuttle run, min.	7.04±3.12	7.39±2.12	6.01±3.15

Evaluating athletes 'endurance ability in 20 m shuttle run test we determine that NFA athletes showed the best results. Comparing NFA to LFA and HFA athletes, NFA ran 0.35 min. and 1.38 min. more, respectively. These differences were not statistically significant.

Analyzing specific triathlon 100, 400 and 800 m swimming tests results it was established that NFA athletes showed the best results (figure 2). Athletes with LFA performed 100 m swimming test 0.6 s, 400 m – 12.81 s, and 800 m – 9.61 s slower, comparing to NFA. HFA group results were worse than LFA. Significant difference in 800 m swimming test was established between LFA and HFA groups, NFA, and HFA athletes.



Note. & - significant difference p<0,05 between HFA and LFA; § - p<0,05 between HFA and NFA.

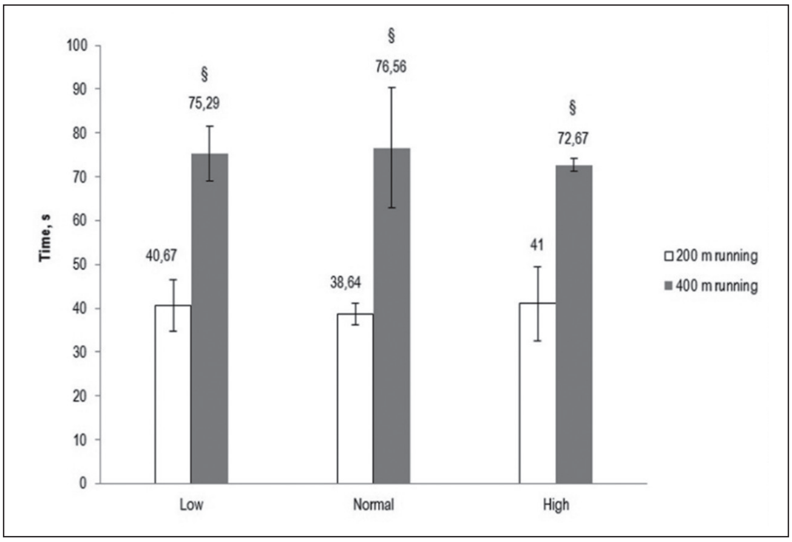
Figure 2: Swimming tests and foot arches data

Performing 200 m running test results show a tendency that NFA athletes were the fastest, but these differences between groups were not significant.

HFA group in 400 m running tests were 2.62 s faster than LFA ($p < 0,05$) and 3,89 s ($p < 0,05$) faster than NFA athletes.

Correlation analysis showed that NFA has relation among athletes' maturation stage ($r = - 0.578$, $p = 0.008$), height ($r = - 0.496$, $p = 0.026$) and lean body mass%, ($r= - 0.472$, $p = 0.036$). However, we found no relation among these parameters in HFA and LFA groups.

Analyzing relationship among general and specific fitness tests results and different feet arches groups we established no relations among all the foot arch groups and physical fitness tests.



Note.§ - significant difference (p<0,05) between HFA and NFA, HFA and LFA

Figure 3: Running tests and foot arches data

Discussion and conclusions

Foot arch height may be related to a weakness of the extensor muscles including the tibialis anterior, extensor digitorum longus, and extensor halluces longus which has been termed extensor deficiency (Kulig et al., 2005; Takao et al., 2007; Villarroya et al., 2008). Thus, individuals may present with a reduction in ability to generate explosive muscle strength and anaerobic power, as measured by long jump and vertical jump tests for example. In our case athletes with low foot arch performed long jump tests better than other foot arch types, though there were no significant differences between all groups. Agility and endurance tests results in our study did not differ significantly among foot arch types and this results support Aydog et al., 2005; Lizis et al., 2010; Tudor et al., 2009 data that foot arch height is not responsible for motor skills and physical performance in children.

Analyzing specific tests results in our study we found that subjects with normal foot arch performed the 200 running test better than other foot arch types. The foot arch might help enhance some physical performance. The foot arch may have an important role in storing and releasing elastic strain energy during repetitive dynamic movements of the foot and leg (Morita et al., 2015).

Specific triathlon 400 m tests result for endurance showed that high foot arch plays an important role in endurance tests (though the results did not differ significantly) and it support the theory of Wiliams et al., 2001 that the high-arched runners had higher vertical loading rates, it means that foot support time decrease and running economy increase.

Our study found no correlation among young triathletes foot arches and physical fitness tests. Lin et al. (2001) have shown that flatfoot is related to poor motor skills and physical performance in children. On the other hand, Tudor et al. (2009) have found no correlation between foot arch height and motor skills in children. In addition, it has been reported that foot arch height is not significantly related to the explosive power of the lower limb muscles (Lizis et al., 2010). Our research supports these data.

Williams, et al. (2001) study suggest there is a relationship between arch structure and lower extremity kinematics and kinetics during running. Low-arched runners seem to experience greater rearfoot eversion excursion, velocity, and higher eversion to tibial internal rotation ratios. High-arched runners also had greater vertical loading rates in the lower extremity when compared to low-arched runners.

The relation between foot arch height and physical performance in children remains a subject of discussion and controversy.

References

1. Lin, C.J., Lai, K.A., Kuan, T.S., Chou, Y.L. (2001). Correlating factors and clinical significance of flexible flatfoot in preschool children. *Juornal of Pediatric Orthopaedics*, 21(3), 378-382.
2. Aydog, S.T., Ozcakar, L., Tetik, O., Demirel, H.A., Hascelik, Z., Doral, M.N. (2005). Relation between foot arch index and ankle strength in elite gymnasts: a preliminary study. *British Journal of Sports Medicine,* 39(3):e13.
3. Lizis, P., Posadzki, P., Smith, T. (2010). Relationship between explosive muscle strength and medial longitudinal arch of the foot. *Foot & Ankle International*, 31(9), 815-822.
4. Tudor, A., Ruzic, L., Sestan, B., Sirola, L., Prpic, T. (2009). Flat-footedness is not a disadvantage for athletic performance in children aged 11 to 15 years. *Pediatrics* 123(3), e386-392.
5. Lichota, M., Plandowska, M., Mil, P. (2013). The arches of the feet of competitors in selected sporting disciplines. *Polish Journal of Sport and Tourism*, 20(2), 135-140.
6. Sakalauskaitė, R, Kemerytė-Riaubienė, E, Jaščaninienė, N, Gocentas, A. (2014). Overwiev of the “Aristo: a european monitoring protocol of young athletes‘ health and training conditions” project. *Sporto mokslas/ Sport Science*, 3 (77), 58-62
7. Clarke, H.H. (1933). An objective method of measuring the height of the longitudinal arch in foot examinations. *Research Quarterly. American Physical Education Association*, 4(3), 99-107.
8. Villaroya, M.A., Esquivel, J.M., Toma’s, C., Buenafe, A., Moreno, L. (2008). Foot structure in overweight and obese children. *International Journal of Pediatric Obesity*, 3(1), 39-45.
9. Andrzejewska, J., Burdukiewicz, A., Chromik, K., Pietraszewska, J., Stachon, A. (2010). Morphological structure and characteristics of judo contestants’ feet. *Acta Bio-Optica et Informatica Medica*, 1(16), 21-24.
10. Kulig, K., Burnfield, J.M., Reischl, S., Requejo, S.M., Blanco, C.E., Thordarson, D.B. (2005). Effect of foot orthoses on tibialis posterior activation in persons with pes planus. *Medicine & Science in Sports & Exercise,* 37(1), 24-29.
11. Queen, R.M., Mall, N.A., Hardaker, W.M., Nunley, J.A. (2007). Describing the medial longitudinal arch using footprint indices and a clinical grading system. *Foot & Ankle international*. 28(4), 456-462.
12. Takao, M., Komatsu, F., Oae, K., Miyamoto, W., Uchio, Y., Ochi, M., Matsushita, T. (2007). Proximal oblique-domed osteotomy of the first metatarsal for the treatment of hallux valgus associate with flat foot: effect to the correction of the longitudinal arch of the foot. *Archives of Orthopaedic and Trauma Surgery*, 127(8), 685-690.
13. Morita, N., Yamauchi, J., Kurihara, T., Fukuoka, R., Otsuka, M., Okuda, T., Ishizawa, N., Nakajima, T., Nakamichi, R., Matsuno, S., Kamiie, S., Shide, N., Kambayashi, I., Shinkaiya, H. (2015). Toe flexor strength and foot arch height in children. *Medicine & Science in Sports & Exercise*, 47(2), 350-356.
14. Williams, D.S., McClay, I.S., Hamill, J. (2001). Arch structure and injury patterns in runners. *Clinical Biomechanics*, 16(4), 341-347.

VARIATION IN PRESSURE APPLIED BY COMPRESSION CALF SLEEVES DOES NOT INFLUENCE IMMEDIATE POST EXERCISE RECOVERY

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Abstract

The purpose of this study was to assess the effect of different pressure levels of compression calf sleeves (two types of graduated and one type of inversely graduated compression) on running performance, pressure pain threshold and lactate removal immediate after the experimental running test. The data was collected from 10 moderately trained runners (age 24.8 ± 3.45 years; body mass 74.11 ± 8.63 kg; maximum oxygen uptake 62.89 ± 7.68 mL kg^{-1} min^{-1}). Significant differences were not found for any type compression calf sleeves but a positive trend in better performance time and lactate clearance were recoded for medium compression calf sleeves (25 mmHg at the ankle and 21 mmHg at the widest part of calf muscle).

Key words: *algometry, endurance athletes, ergogenic aid, lactate concentration*

Introduction

Adequate recovery is essential part of training loads. Today´s recovery techniques utilised by athletes include cold water immersion, hot/cold contrast water immersion, deep water running active recovery, stretching, massage and other techniques which are highly discussed (Kapounková & Bernacikova, 2013). The procedures which can facilitate recovery should start immediately after training. Over the past decade, the compression garments (CGs) started to be used by athletes across various sport disciplines. Commercially CGs are becoming popular not only in the group of competitive athletes (Struhár, 2016). Especially, athletes in various endurance sports disciplines wear CGs with the anecdotal assumption that CGs improve performance and/or facilitate recovery. In practice, however, the usage of CGs by athletes is mainly empirical, without evidence-based selection according to optimal patterns of pressures delivered. A previous meta-analysis had observed that the use of CGs reduced perception of muscle soreness (Hill, Howatson, van Someren, Leeder, & Pedlar, 2014). Blood concentrations of various muscle metabolites have been used to investigate CGs effects on post-exercise recovery (MacRae, Cotter, & Laing, 2011). Lactate is the most frequent marker due to quick and easy cause-effect translation in the training practise. In literature sources, authors often describe the effect of CGs on running performance (expressed in minutes). Studies show that compression clothing has no significant impact on performance (Ali, Creasy, & Edge, 2011), not even in runners with venous insufficiency (Moehrle et al., 2007). Furthermore, most studies failed to demonstrate an effect of CGs on immediate post exercise recovery (Beliard et al., 2015). An ideal compression pressure required for performance and recovery benefits has not been defined yet. Among athletes, the most prevalent pattern of compression calf sleeves is a graduated compression (progressive) where the applied pressures are highest distally, and decrease proximally. Little is known about the effect of reverse graduation. The purpose of this study was to analyze the effect of different pressure levels of compression calf sleeves on running performance, pressure pain threshold and lactate removal.

Methods

Participants in the study

Ten moderately trained runners participated in the study (mean ± SD; age 24.8 ± 3.45 years; body mass 74.11 ± 8.63 kg; maximum oxygen uptake 62.89 ± 7.68 mL kg^{-1} min^{-1}; 10 km best time 38.0 ± 1.5 min). All participants gave written consent before participating in the study and the study was approved by the university ethics committee. Inclusion criteria were defined as: (a) men, 18-30 years (b) $VO_{2max} \geq 50$ mL kg^{-1} min^{-1} (c) no history of cardiovascular, metabolic or respiratory disease and no tobacco use (d) personal best time for 10 km running less than 40 minutes (e) providing written informed consent before participation in the study (f) no history of leg injuries within the last six months (g) no experience with any type of compression garments.

Study design

The study was designed as a double blind study. A three compression sleeves (CS) with different compression pressures was used in this study (two types of graduated compression calf sleeves with a higher pressure at the ankle and gradually lower toward the widest part of calf: LOW-CG, 18 mmHg ankle – 15 mmHg calf; MED-CG; 25 mmHg ankle, 21 mmHg calf and the third one was designed as inversely graduated compression calf sleeves HIGH-RCG 18 mmHg ankle, 24 mmHg calf). To determine the correct size of CS, the calf circumference at the widest part was measured. CS were coded with three randomly chosen letters in order to prevent of researcher bias. On the day of experimental test, participant randomly chose one pair of sleeves. Participants were required to perform each running experimental test with one of three grades of compression calf sleeves. Before the running experimental protocol, Maximal Oxygen Consumption Test (VO_{2max}) was conducted on a treadmill ergometer (Lode Katana). Gas exchange was continuously measured by system with a breath by breath technology (METALYZER®3B, CORTEX). Each participant visited the laboratory 3 times (each measurement including pre-test measurements, the experimental running test with different compression pressure distribution and post-test measurements; a 7-days wash-out period was set up between each measurement). Before the experimental test protocol, all participants were instructed to refrain from exhausting physical activity, not to drink any beverages with caffeine the day before the test.

Experimental day procedures

After arrival to the laboratory, each participant sat for fifteen minutes before taking capillary blood sample. Subsequently, the participant put on CS to each calf. Then, lactate concentration was determined through a portable lactate analyzer. Subsequently, pressure pain threshold was recorded with the algometer. Then, the participant performed a warm-up on treadmill for 5 minutes (running speed depended on participant´s decision). Immediately after warm-up phase, the running experimental protocol started (8 km running on a treadmill, 6% elevation rate at 75% personal VO_{2max}). Finally, blood sample for lactate concentration analyses was collected and pressure pain threshold was recorded in 5 minutes after finishing running.

Measurement of pressure pain threshold (PPT)

The findings of PPT were conducted with Computerized Pressure Algometer (The AlgoMed from Medoc Company). It was tested for the dominant leg of each participant (participant was in prone position with support of tibia). Circle was marked on the dominant leg with a pen for consistency (circle contained four different points for algometry measurement). The circle was 14 cm under popliteal fossa on lateral head of gastrocnemius muscle. Pressure was applied manually by the researcher until the point when the pressure changed to the sensation of pain. In that point, the participant was instructed to push a button of algometer which locks the algometer display. PPT was measured before the test and 5 minutes after the experimental running test.

Blood lactate (LA) concentration measurement

LA concentration was determined through a portable lactate analyzer (Lactate Plus manufactured by Nova Biomedical), which analyzed a small blood sample obtained by pricking the tip of a finger with a lancet. LA concentration was measured before the test and 5 minutes after the experimental running test.

Statistical analyses

Data was calculated with conventional procedures and presented as mean values and standard deviation. Paired t-test for dependent samples was used to data analyses.

Results

Running test performance

Table 1: Mean performance time for experimental running trials

Compression profile of sleeves	Mean performance time (min:sec)
LOW-CG	46:50
MED-CG	46:14
HIGH-RCG	47:32

Notes: Distribution of pressure: LOW-CG: 18 mmHg ankle, 15 mmHg calf; MED-CG: 25 mmHg ankle, 21 mmHg calf; HIGH-RCG: 18 mmHg ankle, 24 mmHg calf

Values of pressure pain threshold are presented in Table 2. It was not proved any statistical significance difference for any profile of sleeves.

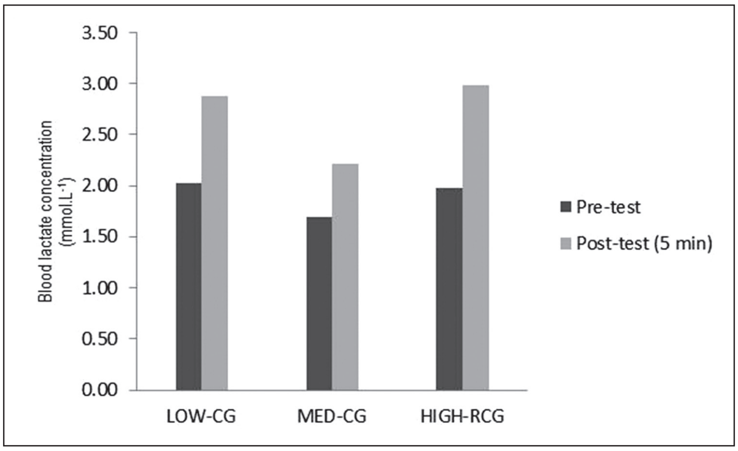
Table 2: Pressure pain thresholds (kPa) assessed by pressure algometry in the calf muscle

	LOW-CG	MED-CG	HIGH-RCG
Pre-test	667.77±234.21	587.83±233.03	555.67±237.23
Post- test (5min)	606.72±203.97	510.48±234.467	452.85±216.90

Notes: Distribution of pressure: LOW-CG: 18 mmHg ankle, 15 mmHg calf; MED-CG: 25 mmHg ankle, 21 mmHg calf; HIGH-RCG: 18 mmHg ankle, 24 mmHg calf

The running with CS lead to changing of PPT (ΔT_{5}- difference between the PPT 5 min after and before the running test; ΔT_5 LOW-CG: -61.05 kPa, ΔT_5 MED-CG: -77.35 kPa, ΔT_5 HIGH-RCG: -102.82 kPa). Paired t-test for dependent samples was used to analyze data (pre-test vs. 5 min post-test LOW-CG: p= 0.0119, MED-CG: p= 0.1608, HIGH-RCG: p= 0.0959).

Figure 1 shows the blood lactate concentration of participants from pre-test to post-test.



Notes: Distribution of pressure: LOW-CG: 18 mmHg ankle, 15 mmHg calf; MED-CG: 25 mmHg ankle, 21 mmHg calf; HIGH-RCG: 18 mmHg ankle, 24 mmHg calf

Figure 1: Blood lactate concentration between pre and post-test

The running with CS lead to changing of lactate concentration (ΔLA_{5}- difference between the lactate concentration 5 min after and before the running test; ΔLA_5 LOW-CG: +0.85 mmol L^{-1}, ΔLA_5 MED-CG: +0.52 mmol L^{-1}, ΔLA_5 HIGH-RCG: +1.01 mmol L^{-1}).

Discussion

Over the last decade, the influence of CGs in relation to enhance performance and exercise recovery have been discussed topic (Ali, Caine, & Snow, 2007; Ali, Creasy, & Edge, 2010). The purpose of this study was to analyze the effect of different pressure levels of compression calf sleeves on running performance, pressure pain threshold and lactate removal. This is one of the first studies which focused on different compression pressure profile. It was compared LOW-CG (pressure at the ankle 18 mmHg, pressure at the widest part of calf muscle 15 mmHg), MED-CG (pressure at the ankle 25 mmHg, pressure at the widest part of calf muscle 21 mmHg), HIGH-RCG (pressure at the ankle 18 mmHg, pressure at the widest part of calf muscle 24 mmHg). LOW-CG and MED-CG are types of graduated compression calf sleeves which provide higher pressure at the ankle and continuously lower to the calf muscle. This is different with HIGH-RCG which exerts the highest pressure at the widest part of calf muscle. Previous studies had investigated an enormous difference between applied pressure ranging from 1.1 to 46 mmHg at the ankle, and from 8 to 39 mmHg at the calf muscle (Beliard et al., 2015). In the study of Lawrence & Kakkar (1980), authors claimed increasing compression to 30 mm Hg at the ankle led to decrease subcutaneous blood flow. On the other hand, the study (Mosti & Partsch, 2014) proved that even values of pressure higher than 40 mm Hg do not disturb ejection fraction of the venous calf pump. According to this fact, higher pressure distribution at the calf muscle could lead to greater muscle efficiency. Then, it should be seen for example in $\Delta La_{5.}$ Contrary to this assumption, the opposite result was recorded for HIGH-RCG: +1.01 mmol L^{-1}. We are strongly convinced that this can be connected with our running test protocol which was designed as a continual running

(8 km running on a treadmill, 6% elevation rate at 75% personal VO_{2max}). If the running test was set up with changing speed or inclination, it would be opposite results especially for HIGH-RCG. Our study did not prove significantly effects of different pressure levels of compression calf sleeves on 8-km uphill running performance (6% incline, 75% VO_{2max}). This finding is generally consistent with other running studies (Areces et al., 2015; Vercruyssen et al., 2014). The mean performance time was lowest with using MED-CG (46:14) and highest with using HIGH-RCG (47:32). However, the time difference of 81 seconds may be of practical or physiological importance in the real sport events. The speed of exercise recovery and subjective evaluation of the level of pain are one of the crucial components after strenuous exercise. This is important especially when the athlete must perform repeated short bouts of high intensity exercise interspersed with short recovery periods. For this reason, we decided to record PPT before and 5 min after the experimental running test. The data showed ΔPPT_5 LOW-CG: -61.05 kPa, ΔPPT_5 MED-CG: -77.35 kPa, ΔPPT_5 HIGH-RCG: -102.82 kPa). Results showed better effect of graduated compression calf profiles of sleeves than inversely graduated compression stockings.

Conclusions

Running with compression calf sleeves did not lead to statistical significant effect for immediate post exercise recovery and time performance (8 km on a treadmill, 6% elevation rate at 75% personal VO_{2max}). However, the time difference between MED-CG and HIGH-RCG was 81 seconds which definitely can have a practical importance during competition. Following this finding, difference between the LA concentration 5 min after and before the running test was also the best for MED-CG (+0.52 mmol L^{-1}). Similar positive trend of MED-CG is seen for PPT.

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References

1. Ali, A., Caine, M. P., & Snow, B. G. (2007). Graduated compression stockings: physiological and perceptual responses during and after exercise. *Journal of Sports Sciences*, *25*(4), 413-419.
2. Ali, A., Creasy, R. H., & Edge, J. A. (2010). Physiological effects of wearing graduated compression stockings during running. *European Journal of Applied Physiology*, *109*(6), 1017-1025.
3. Ali, A., Creasy, R. H., & Edge, J. A. (2011). The effect of graduated compression stockings on running performance. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, *25*(5), 1385-1392.
4. Areces F, Salinero JJ, Abian-Vicen J, et al. The use of compression stockings during a marathon competition to reduce exercise-induced muscle damage: are they really useful? J Orthop Sports Phys Ther, 2015; 45(6): 462-470
5. Beliard, S., Chauveau, M., Moscatiello, T., Cros, F., Ecarnot, F., & Becker, F. (2015). Compression garments and exercise: no influence of pressure applied. *Journal of Sports Science & Medicine*, *14*(1), 75-83.
6. Hill, J., Howatson, G., van Someren, K., Leeder, J., & Pedlar, C. (2014). Compression garments and recovery from exercise-induced muscle damage: a meta-analysis. *British Journal of Sports Medicine*, *48*(18), 1340-1346.
7. Kapounková, K., & Bernacikova, M. (2013). Regenerace sil. In Bernacikova, M., Cacek, J., Dovrtělová, L., Hrnčiříková I., Kapounková, K., Kopřivová, J., … Ulbrich, T. (2013). Regenerace a výživa ve sportu. (1. ed.). Brno. Masarykova univerzita. 978-80-210-6253-5.
8. Lawrence, D., & Kakkar, V. V. (1980). Graduated, static, external compression of the lower limb: a physiological assessment. The British Journal of Surgery, 67(2), 119-121.
9. MacRae, B. A., Cotter, J. D., & Laing, R. M. (2011). Compression garments and exercise: garment considerations, physiology and performance. *Sports Medicine (Auckland, N.Z.)*, *41*(10), 815-843.
10. Moehrle, M., Kemmler, J., Rauschenbach, M., Venter, C., Niess, A., Häfner, H.-M., Stroelin, A., et al. (2007). Acute and long term effect of compression stockings in athletes with venous insufficiency. *Phlebologie*, *36*(6), 313-319.
11. Mosti, G., & Partsch, H. (2014). Improvement of venous pumping function by double progressive compression stockings: higher pressure over the calf is more important than a graduated pressure profile. *European Journal of Vascular and Endovascular Surgery: The Official Journal of the European Society for Vascular Surgery*, *47*(5), 545–549.
12. Struhár, I. (2016). Použitie kompresného oblečenia u bežcov: áno, nie? *Studia Sportiva, 11*(2), 78-88.
13. Vercruyssen F, Easthope C, Bernard T, et al. The influence of wearing compression stockings on performance indicators and physiological responses following a prolonged trail running exercise. Eur J Sport Sci, 2014; 14(2): 144-150

CAN AN INCREMENTAL KETTLEBELL SWINGING TEST BE USED TO ASSESS AEROBIC CAPACITY?

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Abstract

The aim of this study was to determine the effectiveness of a novel incremental kettlebell test (IKT) by comparing the cardiorespiratory and metabolic response to those of a standard incremental running treadmill test (ITT). Eleven subjects (9 men and 2 women) volunteered to perform both tests. The kettlebell test was performed with the swing technique increasing the load every 30 seconds to exhaustion, without rest between stages. It starts with a 4 kg kettlebell load and with each successive stage the kettlebell weight is increased for 2 kg. A week later the subjects performed an ITT test, with speed increments of 0.5 km/h every 30 seconds (at a constant 1% incline) up to volitional exhaustion. Blood lactate concentration (BL), heart rate (HR) and gas exchange variables were monitored in both tests. There was a strong correlation between tests for peak oxygen uptake (r=0.92), and low to moderate for the other variables. However, the mean peak values differed significantly for VO_2, HR, BL and ventilation, with lower values recorded in IKT than in ITT. The values of the remaining parameters were also lower in IKT, but the differences were not significant ($p > 0.05$). The mean values of all IKT variables were in the range of 82% - 103% of ITT values (88% on average). In most subjects, muscle fatigue rather than cardio-respiratory factors caused exhaustion in the IKT test. In conclusion, the kettlebell test may be considered for athletes who train with external loads, as well as in subjects that are poor runners. However, several methodological issues need to be addressed in future research to obtain a valid and reliable kettlebell swinging test protocol.

Key words: *kettlebell test, treadmill test, heart rate, oxygen uptake, blood lactate*

Introduction

In modern sport, it is of great value to implement valid diagnostic methods within the training schedule of athletes. Diagnostic procedures comprise numerous methods to evaluate both, the aerobic and the anaerobic capacity. In activities in which performance depends on the aerobic capacity, incremental maximal tests are used to gather parameters such as maximal oxygen uptake (VO_{2max}), relative maximal oxygen uptake (RVO_{2max}), ventilation threshold (VT) etc. As there is no unified, standard test for direct measurement of aerobic and anaerobic capacity, experts use specific tests depending on specific requirements for a given discipline. Over the last 20 years, numerous studies focused on the effects and precision of test protocols that estimate peak ventilatory and metabolic parameters (Myers et al., 2000).

In recent years kettlebell has become a tool used by many athletes and coaches. Ease of use, availability and benefits of using kettlebells are the main reasons for its popularity. Recent studies show that kettlebell swinging may have an impact on cardiorespiratory fitness. Farrar et al. (2010.) in their research state that continuous kettlebell swing can impart a metabolic challenge of sufficient intensity to increase VO_{2max}. Also, William and Kraemer (2015.) have developed new high-intensity interval training (KB-HIIT) with kettlebell and compared it with standard cycling training (SIC), showing that KB-HIIT may be more attractive and sustainable than SIC and can be effective in stimulating cardiorespiratory and metabolic responses that could improve health and aerobic performance. Kettlebell high-intensity training has the effect on enhancing VO_{2max} (Fallatic et al., 2015.)

In view of those studies indicating a possible effect of training with kettlebell, we constructed a new incremental kettlebell test. To establish the extent of aerobic capacity activation, we compared the IKT with a standard incremental treadmill test (ITT).

Methods

Subjects

The study group consisted of 11 healthy subjects (2 females, 9 males, 25.9±4.0 yrs., body height 175.8 ±13.3 cm and weight 73.1±21.1 kg). Measurements were carried out at the Sports Diagnostic center, Faculty of Kinesiology, University of Zagreb. All the tests were conducted in accordance with ethical principles. Each subject had the procedures explained before the experiments, and was familiarized with the hardstyle swing technique as well as with treadmill running, before undertaking the tests.

Testing procedure

The study was carried out within two weeks, with each subject completing both tests. Both protocols consisted of four phases: rest, warm - up, the main part of the protocol testing and lactate measurements after the test completion. The IKT protocol starts with one minute resting followed by warm – up consisting of 30 imitations of swing. After 30 seconds begins the main part of the protocol testing. Each stage lasts for 30 seconds, without rest, with a starting load of 4 kg kettlebell and increasing the load (kettlebell weight) for 2 kg (4, 6, 8, 10, etc.) with each successive stage. The task was to swing at maximal speed, to do as many swings as possible in every stage. The test ended when the subject could not perform further swings for any reason. In the ITT test, a standard protocol for assessing aerobic and anaerobic fitness was carried out. A warm-up consisted of walking at a speed of 3 km/h at 1% incline for 2 minutes. After warm-up the subject accelerates every 30 seconds for 0.5 km/h continuously until exhaustion. During recovery, subjects walked at 5 km/h and blood lactate (BL) measurements were performed 1, 3 and 5 minutes after test completion.

Ventilation and gas exchange parameters were monitored and collected with CORTEX METAMAX 3B (CM3B). Heart rate was recorded continuously with a heart rate monitor (H7 Polar). Both, CM3B and H7 data were imported to MetaSoft Studio software for data storage and analysis. Blood samples were taken from the middle finger tip of the left hand. BL was measured with LACTATE SCOUT+ lactate analyzer. The highest BL measured was considered as the maximum BL concentration.

Statisical analisys

Statistica for Windows 10.0 and Microsoft Office Excel 2016 were used for storage and statistical analysis of the results. Descriptive statistic and Student t-test for dependent samples were used to analyze the differences between test means, while the relationship between variables of the two tests were analysed with the Pearson product moment correlation.

Results

Table 1: Results in gas exchange and heart rate

	ITT MD±SD	IKT MD±SD	p-value	r
HR_{peak} (bmp)	194,91±8.25	185.27±8.39	**<0.05**	**0,86**
VO_{2peak} (LO_2/min)	3.99±0.71	3.27±0.67	**<0.05**	**0.92**
RVO_{2peak} (LO_2/min)	50.06±6.10	41.71±5.27	**<0.05**	**0.92**
VE_{peak} (L/min)	146.15 ±25.43	124.93±28.73	**<0.05**	**0,81**
RF_{peak} (B/min)	63.72 ±11.73	58.94±14.75	0.14	**0,74**
VT_{peak} (L)	2.44±0.45	2.51±0.48	0.46	**0,83**
v_{peak}-ITT (km/h)	16.32±1.25			
KM_{peak}-IKT (kg)	24.55±5.15			

$p<0.05$ = significant differences were found between ITT and IKT
$p>0.05$= no significant differences were found between ITT and IKT

Table 2: Results in blood lactate concentration

	ITT MD±SD	IKT MD±SD	p-value	r
BL_{1peak} (mmol/L)	11,32±2,46	9,25±1,66	<0.05	**0,57**
BL_{3peak} (mmol/L)	12,04±2,65	10,73±2,05	0.24	-0,10
BL_{5peak} (mmol/L)	11,42±2,95	9,71±1,15	0.08	0,24
BL_{peak} (mmol/l)	12,38±2,72	11,04±2,03	0.19	0.14

$p<0.05$ = significant differences were found between ITT and IKT
$p>0.05$= no significant differences were found between ITT and IKT

Discussion and conclusions

The main finding of the study is the high correlation of VO_{2peak} values between IKT and ITT. Moreover, relatively high values of HR_{peak}, VO_{2peak} and other parameters were achieved in the kettlebell test. Although the values are significantly lower than the values obtained in the standard ITT test, the mean difference was only 10-20%, very similar to the differences reported between treadmill and cycle ergometer tests. Moreover, the IKT test was short, lasting less than 6 minutes on average. Regarding sports disciplines and subjects where running is not the preferred modality of physical activity and training, IKT may be a useful, more specific test (combat sports, throwing disciplines in athletics, CrossFit, weightlifting etc.). Also, running on a treadmill at higher speeds presents a risk for certain subjects and populations, where a sense of fear and instability with treadmill acceleration can cause premature end of the test, or even injury. Therefore, the IKT may be considered as an appropriate test for athletes who train with external loads, as well as in subjects that are poor runners.

Although cardio-respiratory factors do not reach peak values in IKT, subjects were forced to discontinue with the test due to muscle fatigue. Further research should investigate whether changes in the IKT test protocol could influence the outcome (longer test duration, smaller load increase per stage, continuous swing speed, etc.) so that peak values can be reached.

Moreover, it would be interesting to detect equivalent values between IKT and ITT, i.e. energy consumption at a running speed of 9 km/h corresponding to work with 12 kg kettlebell. It might also be useful to detect the intensity in IKT at which the subject crosses the anaerobic threshold and enters the predominantly anaerobic zone (the kettlebell weight at the anaerobic threshold for a certain swinging speed). Having those information would allow to plan a training program with kettlebells for developing aerobic and/or anaerobic fitness.

Based on the obtained results it can be concluded that IKT has benefits and practical application, but for more accurate conclusions it is necessary to address several methodological issues in future research with incremental kettlebell swinging protocols to validate the method and compare it with standard incremental treadmill tests.

References

1. Astrand, P.O., Saltin, B. (1961). Maximal oxygen uptake and heart rate in various types of muscular activity. *Journal of Applied Physiology, 16, 977-981.*
2. Barstow, T.J., Jones, A.M., Nguyen, P.H., Casaburi, R. (2000). Influence of muscle fibre type and fitness on the oxygen uptake/power output slope during incremental exercise in humans. *Exerimental Physiology, 85(1), 10-116.*
3. Farrar RE, Mayhew JL, Koch AJ. (2010). Oxygen cost of kettlebell swings. *The Journal of Strength and Conditioning Research, 24(4), 1034-6.*
4. Flatic JA, Plato PA, Holder C, Finch D, Hank K, Cisar CJ. (2015). Effects of kettlebell training on aerobic capacity. *The Journal of Strength and Conditioning Research,* 29(7), 1943-7.
5. Hoffman, P., Bunc, V., Leitner, H., Pokan, R., & Gaisl, G. (1994). Heart rate threshold related to lactate turn point and steady-state exercise on a cycle ergometer. *European Journal of Applied Physiology, 69(2), 132-9.*
6. Myers J, Bellin D. (2000). Ramp exercise protocols for clinical and cardiopulmonary exercise testing. *Sports Medicine, 30(1), 23-29.*
7. Rocha FP, Louro H, Matias R, Brito J, Costa AM. (2016.) Determination of aerobic power through a specific test for taekwondo – A predictive equation model. *Journal of Human Kinetic, Dec 1; 53: 117–126.*
8. Thomas JF, Larson KL, Hollander DB, Kraemer PR. (2014.) Comparison of two-hand kettlebell exercise and graded treadmill walking: effectiveness as a stimulus for cardiorespiratory fitness. *The Journal of Strength and Conditioning Research, 28(4), 998-1006.*
9. Vučetić, V. (2007). Razlike u pokazateljima energetskih kapaciteta trkača dobivenih različitim protokolima opterećenja *(Doktorska disertacija, Sveučilište u Zagrebu). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.*
10. Vučetić V, Šentija D, Sporiš G, Trajković N, Milanović D. (2014.) Comparison ventilation threshold and heart rate deflection point in fast and standard treadmill test protocol. *Acta Clinica Croatica, 53(2):190-203.*
11. Wasserman, K., Hansen, J.E., Sue, D.Y., Casaburi, R., Whipp, B.J. (1999). Principles of exercise testing and interpretation (III Ed). *Baltimore: Lippincott Williams & Wilkins.*
12. Williams BM, Kraemer RR. (2015.) Comparison of cardiorespiratory and metabolic responses in kettlebell high-intensity interval training versus sprint interval cycling. *The Journal of Strength and Conditioning Research, 29(12), 3317-25.*
13. Zubčić D, Reinholz K, Vučetić V. (2015.) Mogu li se vršne fiziološke vrijednosti izmjeriti progresivnim testom hodanja? *13. Godišnja međunarodna konferencija KONDICIJSKA PRIPREMA SPORTAŠA - Zbornik radova međunarodno znanstveno – stručnog skupa, Zagreb*

FACTORIAL VALIDITY OF UPPER BODY POWER TESTS

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Abstract

The purpose of this study is to evaluate the validity of tests for assessment of one's upper extremities power and to establish correlation between open-chain and close-chain tests. All 102 participants were physical education students (age: 18 – 27) with at least one year of weight training experience. Seated medicine ball (1kg and 3kg) chest throw (concentric and countermovement), plyometric push up, concentric push up, and one repetition maximum (1RM) bench press were used as upper body power test. Based on the results of this study, there are two factors, or latent dimensions in these tests and there is low correlation between throwing tests, push up tests and bench press 1RM.

Introduction

Numerous studies have analysed and done factorial analyses to estimate power of lower extremities (Marković et al., 2004); however, there is a lack of studies which estimate the validity of tests for the power of upper extremities. One of the most common tests for estimation of the power of upper extremities is throwing a medicine ball which is usually done in two ways: a seated position chest throw and an overhead standing throw (Van den Tillar, R. and Marques, 2013). Most similar researches use tests with open-chain exercises like a medicine ball throw (Stockbrugger, B.A., and Haennel R.G. 2001; Haris, C et al., 2011; Clemons, M.J., Campbell, B., and Jeansonne, C. 2010) or ballistic exercises such as a bench press throw (Garcia-Ramos et al., 2015) to assess one's upper extremities power. On the other hand, there is a lack of research that use close-chain exercises to test one's upper extremities power. Koch et al. (2012), Moore et al. (2012) and Garcia-Mosso et al. (2011) measured ground reaction force (GRF), using a contact mat, and electromyography activation while performing different variants of plyometric push-ups. The aim of this study is to evaluate the validity of tests for assessment of one's upper extremities power and to establish correlation between open-chain and close-chain tests.

Methods

Subjects

A group of 102 healthy men between the ages of 18 and 27 volunteered to participate in this study. They were all physical education students who had at least one year of experience in weight training. Prior to giving written consent, all participants were fully informed about the measurement procedures and potential risks through verbal expression. All of which was in accordance with the University of Zagreb Guidelines for the use of Human Subjects.

Testing procedure

The research included the following tests: concentric medicine ball chest throw 1kg (CONT1kg), concentric medicine ball chest throw 3kg (CONT3kg), countermovement medicine ball chest throw 1kg (CMT1kg), countermovement medicine ball chest throw 3 kg (CMT3kg), plyometric push up (PP), concentric push up (CP), and bench press 1RM (BP1rm). Protocol will be explained in the following text.

Before warm up, participants were measured in the proceeding anthropometric characteristics: body height (BH), body mass (BM), arm span (RR), length of right arm (ALr), length of the left arm (ALl) and sitting height (SH).The measures were taken by anthropometer and digital scale.

After the anthropometric measurement, the testing procedure was preceded by a 10 minute warm up session during which the subjects ran in an indoor facility for 4 minutes followed by specific preparation exercises: shoulder, arm and fist circulation (both directions), trunk twists (10 times each sides), jumping jacks (20x), chest medicine ball throw (3x5 reps), medicine ball slam (3x5 reps) and plyometric push-ups with arms on elevated surface (3x5 reps). Afterwards, examinees performed the tests in this order: CONT1kg, CONT3kg, CMT1kg, CMT3kg, PP, CP and BP1rm.

CONT1kg and CONT3kg

Test was performed from sitting position with medicine ball touching the chest. From that position, examinees extend their arms and throw a medicine ball without moving their trunk. First, they do three repetitions of throwing a medicine ball that weighs 1 kg with recovery time of 1 minute. Next, they do the same thing only with a medicine ball that weighs 3 kg. Power was estimated by measuring the throw distance from the starting point to the landing point at ball contact.

CMT1kg and CMT3kg

This test was performed from sitting position with medicine ball held in outstretched arms. From that position, examinees flex and extend arms (countermovement) and throw a medicine ball without moving their trunk. First, they do three repetitions of throwing a medicine ball that weighs 1 kg with a recovery time of 1 minute. Next, they do the same thing only with a medicine ball that weighs 3 kg. Power was estimated by measuring the throw distance from the starting point to the landing point at ball contact.

PP

This test was performed starting from the push-up position with hands in optimal width and feet in hip width apart. From that position examinees performed fast eccentric and concentric movements (countermovement). The subjects were instructed to explode off the ground as high as possible from a push-up position without moving their hips or lifting their feet from the ground. Take-off height was assessed with the *Opto Jump* system based on the measurement of the flight time. Three attempts were measured with rest time of one minute between each repetition.

CP

This test was performed starting from the push-up position with hands in optimal width and feet in hip width apart. From this position, examinees lower their body in bottom position and hold it for 2 seconds, after that they performed maximal concentric movement. The subjects were instructed to explode off the ground as high as possible without moving their hips or lifting their feet from the ground. Take-off height was assessed with the *Opto Jump* system based on the measurement of the flight time. Three attempts were measured with rest time of one minute between each repetition.

BP1rm

This test was performed on a flat bench using an Olympic bar. Examinees were warming up with low weight performing 5 repetitions and progressively adding more weight and lowering number of repetitions. Rest between attempts was 3 – 4 minutes.

Data Analyses

All data were entered into *Statistica* for statistical analysis. Descriptive analysis, including experience in weight training (EWT), age (AGE), body height (BH), body mass (BM), arm span (AS), arm length-right (ALr), arm length-left (ALl), sitting height (SH), body mass index (BMI), mean (e.g. CONT1kgav) and maximum scores (e.g. CONT1kgmax) for each of the six tests, 1 RM in Bench Press and ratio of BP1rm and BM (BPindex).

Correlation analysis was performed to determine if relationship exists between the seven tests. Factorial analysis was used to determine one or more factors which are dominant in each test.

Results

All 102 subjects successfully completed all the testing procedures. Descriptive variables are presented in Table 1. Correlation between all variables is shown in Table 2. Factorial analysis results are presented in Table 3.

Table 1: Descriptive statistic for entire group n=102

	Valid N	Mean	Minimum	Maximum	St. Dev.
EWT	102	3,1373	1,0000	10,0000	2,12034
AGE	102	22,0196	18,0000	27,0000	1,78542
BH	102	182,8255	170,4000	198,7000	5,60415
BM	102	83,9843	64,6000	106,7000	8,58407
AS	102	186,7647	172,7000	204,4000	6,50506
ALr	102	79,6157	72,8000	87,7000	2,92401

ALI	102	79,4657	72,3000	87,1000	3,00371
SH	102	96,3912	88,7000	102,1000	2,76649
BMI	102	25,1087	19,6613	32,7136	2,12598
CONT1kgav	102	9,7554	6,9567	12,4100	1,01971
CONT1kgmax	102	10,1741	7,6400	12,7600	1,04353
CONT3kgav	102	6,3051	3,9000	8,2333	0,67133
CONT3kgmax	102	6,5252	5,1000	8,7500	0,67301
CMT1kgav	102	10,1384	7,7567	13,0667	1,06446
CMT1kgmax	102	10,5775	8,0400	13,6200	1,10057
CMT3kgav	102	6,2110	4,6700	8,3967	0,67367
CMT3kgmax	102	6,4192	4,8000	8,4800	0,68562
PPav	102	14,3887	4,9667	27,8667	5,05293
PPmax	102	16,1725	5,8000	28,8000	5,56124
CPav	102	13,3386	5,1000	25,2667	4,94675
CPmax	102	14,7784	5,3000	29,0000	5,31299
BP1rm	102	87,9657	50,0000	140,0000	19,36406
BPindex	102	1,0448	0,6619	1,5837	0,19069

Table 2: Correlational Matrix for entire group n=102

	CONT1kgmax	CONT3kgmax	CMT1kgmax	CMT3kgmax	PPmax	CPmax	BP1rm
CONT1kgmax	1,00	0,75	0,86	0,79	0,28	0,25	0,36
CONT3kgmax	0,75	1,00	0,77	0,85	0,33	0,26	0,49
CMT1kgmax	0,86	0,77	1,00	0,84	0,30	0,26	0,44
CMT3kgmax	0,79	0,85	0,84	1,00	0,40	0,37	0,59
PPmax	0,28	0,33	0,30	0,40	1,00	0,91	0,38
CPmax	0,25	0,26	0,26	0,37	0,91	1,00	0,37
BP1rm	0,36	0,49	0,44	0,59	0,38	0,37	1,00

In the correlation matrix the correlation between each variable is shown. From this table it is visible that there is no statistically significant correlation between medicine ball throw tests and jump push-up tests but there is much higher correlation between PPmax tests and CMT3kgmax than with other medicine ball tests. BP1rm highly correlates with CMT3kgmax and there is very low correlation between the push-up tests.

Table 3: Factorial analysis

	Factor 1	Factor 2
CONT1kgmax	-0,840852*	0,335913
CONT3kgmax	-0,864976*	0,276575
CMT1kgmax	-0,874155*	0,319441
CMT3kgmax	-0,932171*	0,189497
PPmax	-0,600459	-0,75613*
CPmax	-0,560781	-0,788961*
BP1rm	-0,655661	-0,123706

Factorial analysis showed two factors or two latent dimensions which indicate that two different abilities impact the result in medicine ball throw tests and push-up tests. These results indicate that trainers, in sports where upper body power for throwing is important, should train and test power abilities with specific throwing tests and not with push-up tests.

Discussion and Conclusion

The main objective of this research was to determine whether these two types of tests (throwing medicine ball tests and push-up tests) were determined by one or more factors. Based on the results obtained, it is possible to arrive at a conclusion about the relatively same test for assessing explosive power of upper-body extremities. Both variants of push-up tests that we compared have same determinant factor. It is known that results in upper body strength can predict throwing distance (Negrete, R.J. et al., 2011), and also strength training protocol can increase throwing velocity (Hermassi, S. et al., 2015). But, from the results based on this research there is small correlation between BP1rm, throwing tests, and push-up tests. Furthermore, some examinees had very good results in BP1rm, but very low results in throwing, maybe because they lack in ballistic training, and vice versa. That can indicate that some athletes need more ballistic training, while some of them need more strength training, which tells that coaches should test both ballistic power and strength.

References

1. Marković, G., Dizdar, D., Jukić, I., and Cardinale, M. (2004). Reliability and factorial validity of squat and countermovement jump tests. *Journal of Strength and Conditioning Research.* 18(3), 551-555.
2. Van den Tillaar R, and Marques C M. (2013). Reliability of seated and standing throwing velocity using differently weighted medicine balls. *Journal of Strength and Conditioning Research.* 27(5), 1234-1238.
3. Clemons, M.J., Campbell, B., and Jeansonne, C. (2010). Validity and reliability of a new test of upper body power. *Journal of Strength and Conditioning Research.* 24(6), 1559-1565.
4. Garcia-Masso, X., Colado, J.C., Gonzalez, L.M., Salva, P., Alaves, J., Tella, V., and Triplett, N.T. (2011). Myoelectric activation and kinetics of different plyometric push-up exercises. *Journal of strength and conditioning research.* 25(7), 2040-2047.
5. Moore, L.H., Tankovich, M.J., Riemann, B.L., and Davies, G.J. (2012). Kinematic analysis of four plyometric push-up variations. *International Journal of Exercise Science.*5 (4), 334-343.
6. Koch, J., Riemann B.L., and Davies G.J. (2012). Ground reaction force patterns in plyometric push-ups. *Journal of Strength and Conditioning Research.* 26(8), 2220-2227.
7. Haris, C., Wattles, A.P., DeBeliso, M., Sevene-Adams, P.G., Berning, J.M., and Adams, K.J. (2011). The seated medicine ball throw as a test of upper body power in older adults. *Journal of Strength and Conditioning Research.* 25(8), 2344-2348.
8. Stockbrugger, B.A., and Haennel R.G. (2001). Validity and reliability of a medicine ball explosive power test. *Journal of Strength and Conditioning Research.* 15(4), 431-438.
9. Garcia-Ramos, A., Padial, P., Garcia-Ramos, M., Conde-Pipo, J., Arguelles-Cienfuegos, J., Štirn, I., Feriche, B. (2015) Reliability analysis of traditional and ballistic bench press exercises at different loads. *Journal of Human Kinetics.* 47, 51-59.
10. Hermassi, S., van den Tillaar, R., Khlifa, R., Chelly, M.S., and Chamari, K. (2015). Comparison of in – season – specific resistance vs. a regular throwing training program on throwing velocity, anthropometry, and power performance in elite handball players. *Journal of Strength and Conditioning Research.* 29(8), 2105-2114.
11. Negrete, R.J., Hanney, W.J., Kolber, M.J., Davies, G.J., Riemann, B. (2011). Can upper extremity functional tests predict the softball throw for distance: a predictive validity investigation. *The International Journal of Sports Physical Therapy.* 6(2), 104-111.

THE EFFECT OF UNILATERAL OR BILATERAL STRENGTH TRAINING ON THE BILATERAL LIMB RATIO IN COLLEGE STUDENTS

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Purpose: Bilateral deficit (BLD) describes the phenomenon of a reduction in force during synchronous bilateral movements when compared to the sum of identical unilateral movements, the opposite is called bilateral facilitation(BLF). BLD or BLF were usually evaluated by bilateral limb ratio (BLR). The purpose of this study was to figure out the effects of unilateral or bilateral strength training on BLR of lower limb.

Methods: 28 male college students were randomized to bilateral (n=9)training, unilateral (n=9) training and non-training control (n=10) groups. Double leg squat (75%1RM, 5 set, 2 days/week, 8weeks)and single leg squat were performed by bilateral training and unilateral training group,respectively. BLR derived from bilateral and unilateral maximal isometric strength of keen extension (in 60 degrees) was evaluated before and after training intervention.

Results: (1) After training,both training groups had a greater increase in bilateral and unilateral isometric knee extension strength compared to the control group ($P<0.05$); however, no difference between unilateral and bilateral training groups was identified. (2) No significant differences in BLR were observed before and after training; bilateral training group showed BLF after training. (3) In two training groups, the changes of BLR after training was negatively correlated to the BLR before training (bilateral: $r=-0.929$, $P<0.001$; unbliateral: $r=-0.934$, $P<0.001$).

Conclusions: The changes of BLR after 8 weeks moderate intensity unilateral or bilateral strength training was correlate with BLR values before training.

THE EFFECTS OF PLYOMETRIC TRAINING FOLLOWED BY TRAINING CESSATION ON MOTOR PERFORMANCE

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Abstract

In sports, there is constant need for evaluation of different training regimes and recovery process in order to discover what can improve athlete's performance. Plyometric training regime can result with positive physiological changes in motor performance, but also can cause great muscle damage. To avoid any injuries, monitoring of recovery periods in training, between training and after plyometric training program is necessity. Training cessation is one of the possibilities for providing recovery after plyometric or some other training program. The question is, will training cessation cause increase, maintaining or decrease of motor performance levels. In this research, ten healthy students underwent 8-week long plyometric program with two weeks of training cessation. Results showed no significant differences between motor performance levels after the completion of plyometric program and after extra two weeks of training cessation. Authors concluded that for speed, jumping abilities and agility, complete training cessation will not cause detraining status of athletes, but with great caution in practical application of results in sports, due to activity level of participants in this study.

Key words: *eccentric training, adaptations, athletic performance*

Introduction

Motor performance presents one of the major aspect in sports and physical conditioning for discriminating levels of athletes. To be more exact, physical capacities of strength, power and speed are the most important qualities for many sports, especially sport games. To develop those capacities, resistance training is the basis of conditioning preparation, but to produce higher power outputs and to be able to include fast movements, athletes need to incorporate explosive component into training. Plyometric training, as an intensive form of power training, can create physiological changes in motor performance, and overall athletic performance (Saravanan, 2011). During plyometric motor patterns, such as jumping, running, hopping etc., the stretch-shortening cycle (SSC) plays an important role in improving strength, power, speed, joint function and stability, balance and neuromuscular control during landing (Donoghue et al., 2011; Marković and Mikulić, 2010). Eccentric contraction during plyometric exercises can generate high tensions per myofibril that leads to alterations in motor unit recruitment and results in muscle fiber damage. Regarding that fact, there is always constant need for tracking the athlete's physiological status during the plyometric training program and need for adequate volume, load and recovery as recommended (Potach and Chu, 2000). Plyometrics should not be considered as program by itself, but as part of an overall conditioning process. While strength training produces nervous and muscular adaptations necessary for power development, plyometrics focuses on the speed component of power and transforms it into motor performance. Due to competition period and tapering process, reduction of training and training cessation is often phenomenon. Not only then, but due to some injuries complete training cessation is usually required. To better explain terminology, Mujika (2000) defines that training reduction and cessation can lead to maintenance of the physiological adaptations achieved during previous training period while detraining defines partial or complete loss of many physiological adaptations as a result of training reduction or cessation. It is important to differ detraining and training cessation while some authors consider it the same. So not every training cessation results with detraining. In this research, the main objective is to find whether training cessation in length of 2 weeks results in improved, maintained or decreased motor performance in physically active men. Most of the research on this topic was done to evaluate endurance performance and cardiorespiratory parameters (Fleck, 1994; Mujika, 2000a; Mujika, 2000b) and also with providing taper strategies, lower number of training, lower duration and higher intensity, and not complete training cessation. It is known that training adaptation occurs when the training load is above habitual level and when overload is applied. Some say that those adaptation are lost in few days if athlete stops with training stimulus. This research will try to explain effects of plyometric training after training cessation of 2 weeks.

Methods

Data collection

With the aim of monitoring the influence of a plyometric training program and training cessation on motor performance indicators, ten healthy and physically active male second year students from the Faculty of Kinesiology participated in the study (age: 22,33 ± 2,06 years, BW: 79,10 ± 9,24 kg, BH: 180,27 ± 7,31cm, BF: 12,34 ± 4,75%) and underwent the measurement of basic anthropometric parameters and motor performance test at the Sports Diagnostic Centre of the Faculty of Kinesiology. The 8-week long plyometric program consisted of unilateral and bilateral plyometric exercises (standing jumps, multiple hops and jumps, bounds, depth jumps) with progressive load from 150 to 200 contacts with the ground, as recommended by Potach and Chu (2000). They were all instructed not to include any other activity during the plyometric training program except the teaching process at the faculty with accent on minimal physiological loads. Each participant was informed on the aim of the study and gave a written consent for the participation in the study. The protocol of the study was approved by the Ethical Committee of the Faculty of Kinesiology, University of Zagreb, in accordance with the Declaration of Helsinki.

Six motor performance tests were measured three times. Before (PRE) the start of plyometric program, two days after the completion of 8-week long plyometric program (POST 1) and the third time at the end of two weeks of training cessation after the completion of plyometric program (POST 2). Speed was assessed using the time for a 5 meter sprint running (v5), 10 meter sprint running (v10) and 20 meter sprint running (v20). Agility, also referred as change of direction speed was assessed using the time for running 20 yards (20y) with direction change for two times. Explosive power was assessed using height for a standing vertical jump (VJ) and length for a standing horizontal (long) jump (SLJ). All statistical analysis were performed using the STATISTICA 10.0 (StatSoft, USA). The results were expressed as the mean and standard deviation (X±SD). Due to normal distribution of results, T-test for independent samples was used to determine whether the change in variables from first to second (Δpre and post 1) and from first to third (Δpre and post 2) measurement exists. The level of significance (p) was set at 0.05 for all analyses.

Results

In Figure 1, 2 and 3 all the results of test were shown in order from PRE test to POST 1 and POST 2. Those figures present actual results which shows that speed performance and also explosive and agility performance improved from first to last testing. While there are small improvements, statistical results of this research indicate no significant differences in all tested changes of variables (Table 1). Although it is noticeable that after two weeks of training cessation none of motor performance decreased, improvement was not significant due to large standard deviations (Figure 4, 5 and 6) that were even bigger in change of variables from POST2 to PRE test directing to conclusion that on individual level not every heathy and active subject reacts in maintaining and improving motor performance after training cessation. Effect size (ES) presented a quantitative measure of the strength of a phenomenon and it was calculated using Cohen's d-index which size determines weak (< 0,2), medium (0,2 - 0,5), medium large (0,5 - 0,8) and large influence (> 0,8). Differences in changes of variables indicate mostly medium strength (Table 1).

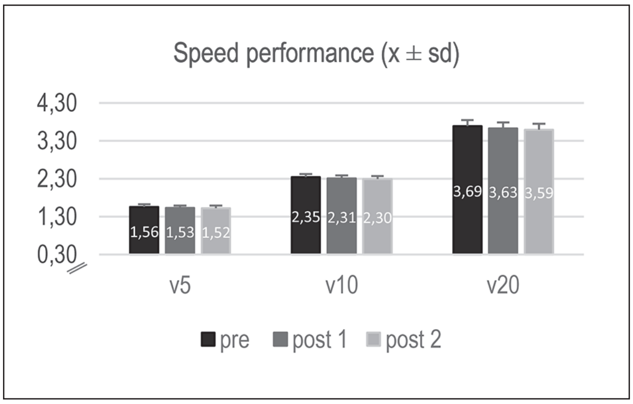

Figure 1: Graphic display of speed performance in three different points of research (PRE, POST 1 and POST 2).

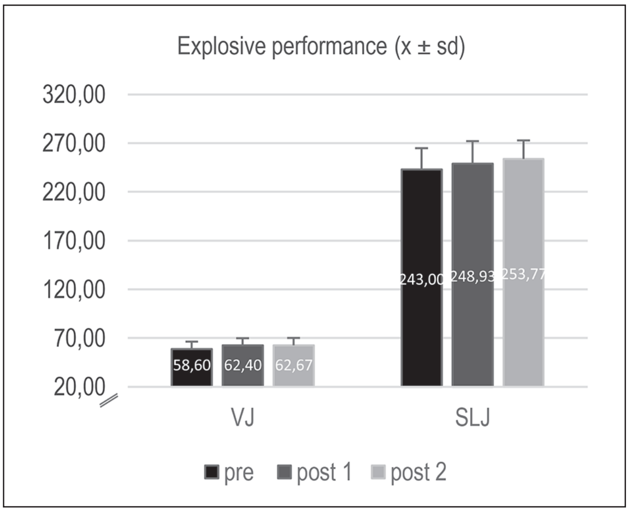

Figure 2. Graphic display of explosive performance in three different points of research (PRE, POST 1 and POST 2).

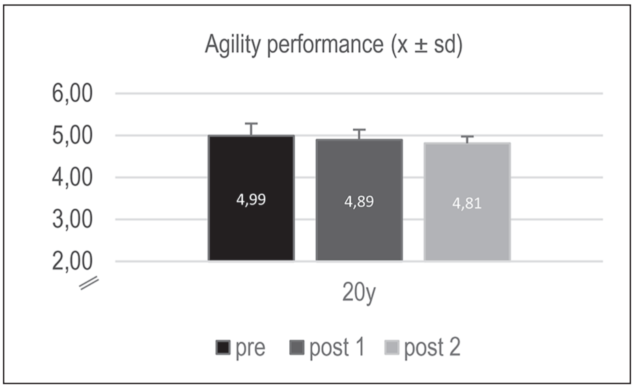

Figure 3. Graphic display of agility performance in three different points of research (PRE, POST 1 and POST 2).

Table 1: T-test for independent variables with Cohen's d (ES). Differences between two changes of variables for six performance test. Level of significance: p < 0.05.

		t-value	df	p	ES
Δ (pre-post 1) vs Δ (pre-post 2)	**v5**	0.55	18	0.59	0.22
	v10	0.85	18	0.41	0.26
	v20	0.89	18	0.39	0.34
	VJ	-0.14	18	0.89	0.07
	ALJ	-1.02	18	0.32	0.45
	20y	1.12	18	0.28	0.51

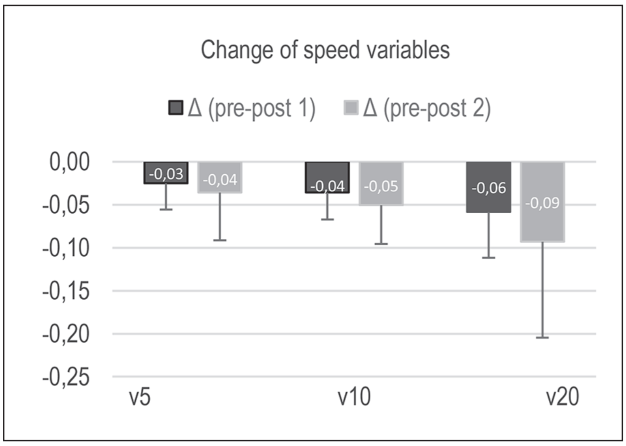

Figure 4: Graphic display of changes in speed variables from POST 1 to PRE testing and from POST 2 to PRE test.

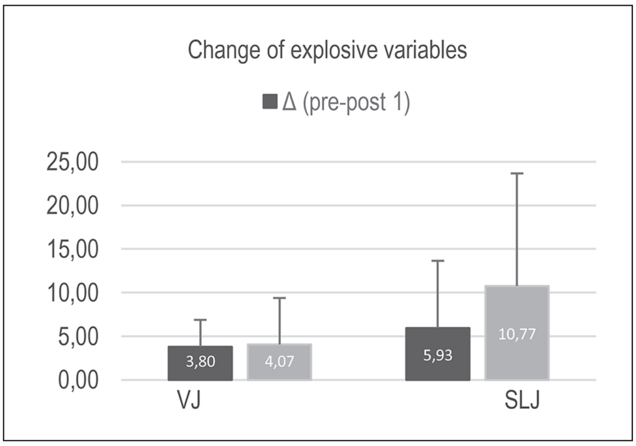

Figure 5: Graphic display of changes in explosive variables from POST 1 to PRE testing and from POST 2 to PRE testing.

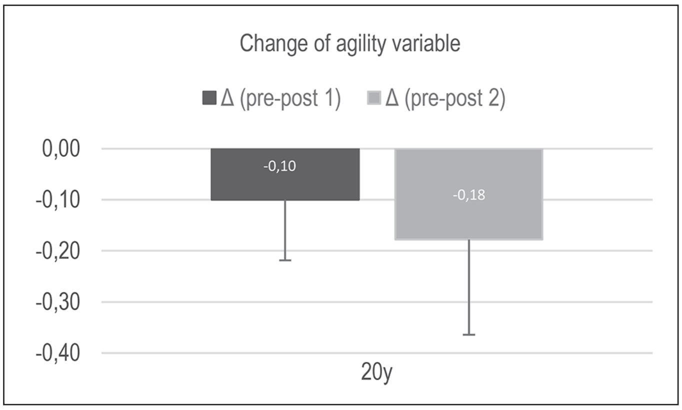

Figure 6: Graphic display of changes in agility variable from POST 1 to PRE testing and from POST 2 to PRE testing.

Discussion

There are several observations emerging from this analyses. First, although it was not primary goal of the analysis, it is visible that plyometric training can improve motor performance. Those improvements were not statistically tested but this research supports previous done research on the topic about effects of plyometric training (Rimmer and Sleivert, 2000; Miller et al., 2006; Marković, 2007; Thomas et al., 2009; Marković and Mikulić, 2010). The main observation and finding refers to the effects of plyometric training after two weeks of training cessation which points that there's no statistical differences in motor performance at two points, two days after and two weeks after finishing plyometric training program, so we can conclude that participant maintained their level of motor performance after plyometric training cessation. In two similar research done by Santos and Janeira (2009, 2011) young basketball players maintained their strength and power levels during the period of reduced training that lasted for 4, 8, 12, 16 weeks. It is important to mention that there was implemented specific basketball training that stimulated motor and nervous system, while this research did not include any training during those two weeks. Luebers et al. (2003) tested two plyometric training programs and effects after 4 weeks of training cessation. They observed no statistical difference in vertical jump and vertical jump power between groups and there was no significant differences after training cessation. Diallo et al. (2001) concluded that young football players improved their speed, agility and explosive strength after 10 weeks of plyometric training and observed no statistical difference after 2 weeks of no training, but on the other hand decreased levels of motor performance after 3 and 4 weeks of plyometric training cessation. Saravanan (2011) supports that results with his own research on physically active population where there was no significant reduction in performance variables after first and second week of training cessation after 12-week long plyometric program, while reduction was observed on third and fourth week of training cessation. In a review article, Pritchard et al. (2005) concluded that from 2 to 7 days there is no negative influence of training cessation, but any longer period cannot have positive effects referring to mainly muscle strength.

Conclusion

There is no doubt of beneficial effects of plyometric training program, but eccentric exercises which are part of plyometric training can cause great muscle damage and overall fatigue which can lead to overtraining due to the duration and intensity of the exercise itself and plyometric program. With this research, authors wanted to support earlier findings that complete training cessation in duration from one to two weeks does not decrease motor performance. Main conclusion is that effects of 8 week long plyometric program on motor performance are not impaired after two weeks of training cessation and can result with small improvements which were not statistically significant for six motor performance tests performed in this study. Future research should be implemented with the same elements of this research but with female participants and professional athletes in sports games.

Literature

1. Diallo, O., Dore, E., Duche, P., Van Praagh, E. (2001). Effects of plyometric training followed by a reduced training programme on physical performance in prepubescent soccer players. *Journal of Sports Medicine and Physical Fitness, 41*(3), 342-348.
2. Donoghue, O., Shimojo, H. & Takagi, H. (2011). Impact forces of plyometric exercises performed on land and in water. *Sports health, 3*(3), 303-309.
3. Fleck, S.J. (1994). Detraining: It's effect on endurance and strength. *Journal of Strength and Conditioning Research,* 22-28.
4. Luebbers, P., Potteiger, J., Hulver, M., Thyfault, J., Carper, M., Lockwood, R. (2003).Effects of Plyometric Training and Recovery on Vertical Jump Performance and Anaerobic Power. *Journal of Strength and Conditioning Research, 17*(4).
5. Markovic, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical review. *British journal of sports medicine*, *41*(6), 349-355.
6. Marković, G., & Mikulić, P. (2010). Neuro-muskuloskeletal and performance adaptations to lower-extremity plyometric training. Sports Med. 40:10, 859-895.
7. Miller, M. G., Herniman, J. J., Ricard, M. D., Cheatham, C. C. and Michael, T. J. (2006). The effects of a 6-week plyometric training program on agility. *Journal of Sports Science and Medicine*, *5*(3), 459-465.
8. Mujika, I. & Padilla, S. (2000a). Detraining: Loss of training-induced physiological and performance adaptations. Part 1: Short term insufficient training stimulus. *Sports Medicine, 30*(2), 79-87.
9. Mujika, I. & Padilla, S. (2000b). Detraining: Loss of training-induced physiological and performance adaptations. Part 2: Long term insufficient training stimulus. *Sports Medicine, 30*(3), 145-154.
10. Pritchard, H., Keogh, J., Barnes, M, McGuigan, M. (2015). Effects and Mechanisms of tapering in maximizing muscular strength. *Strength and Conditioning Journal, 37*(2): 72-83.
11. Potach, D.H., and Chu, D.A. (2000) Plyometric training. In: Essentials of Strength Training and Conditioning (2nd ed.). Baechle TR, Earle RW. eds. Human Kinetics.
12. Rimmer, E. & Sleivert, G. (2000). Effects of a plyometrics intervention program on sprint performance. *Journal of Strength and Conditioning Research, 14*(3), 295-301.

13. Santos, E. and Janeira, M. (2009). Effects of reduced training and detraining on upper and lower body explosive strength in adolescent male basketball players. The Journal of Strength and Conditioning Research, 23(6): 1737-1744.
14. Santos, E. and Janeira, M. (2011). The effects of plyometric training followed by detraining and reduced training periods on explosive strength in adolescent male basketball players. *Journal of Strength and Conditioning Research*, 25(2), 441-452.
15. Saravanan, B. (2011). Effect of maximum strength and plyometric training followed by cessation on selected physiological and performance variables among college men basketball players. Doctoral thesis. Ganesar College of Arts and Science, India.
16. Thomas, K., French, D. & Hayes, Pr. (2009). The effect of two plyometric training techniques on muscular power and agility in youth soccer players. *Journal of Strength and Conditioning Research*, *23*(1), 332-335.

EFFECTS OF STRENGTH TRAINING ON VERTICAL JUMP PERFORMANCE IN VERY OLD PEOPLE

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Abstract

The aim of this study was to examine the effects of 12-week strength training program on jump height and leg power development in very old people. Forty very old men and women were randomly assigned to either a training group (n = 20; 86.33 ± 1.59 years), or a control group (n = 20; 86.36 ± 1.91 years). The 12-week strength training program included strength exercises with their own body weight. The control group did not participate in any training. Each subject was tested prior to commencement of training (pre-training), and one week after the completion of the 12-week training period (post-training). The jump height and peak power output were assessed using the countermovement jump and squat jump performed on a force plate. There were no significant differences in the pre-training jump heights (p = 0.793 and p = 0.795 for SJh and CMJh, respectively) and peak power (p = 0.499 and p = 0.244 for P_{peak}SJ and P_{peak}CMJ, respectively) between the training group and control group. There was a significant post-training effect for the jump heights (11.81% and 8.73% for SJh and CMJh, respectively; p < 0.01), but not for peak powers (p = 0.159 and p = 0.130 for P_{peak}SJ and P_{peak}CMJ, respectively) in the training group. The study results showed that the 12-week resistance training is a safe, suitable, and efficient strength-training method for very old people. It may be helpful in preserving leg muscle power with advancing age and suitable for increasing strength and jump height in the very old people, which may be an important way to increase functional independence and decrease the prevalence of many age-associated chronic diseases.

Key words: *elderly, physical activity, quality of life, power, jump height*

Introduction

Between 30 and 80 years of age, the skeletal muscles of men and women undergo atrophy and a decrease in force development of ~30% (Janssen et al., 2000; Doherty, 2003). The age-associated decline in peak muscular power generation has important clinical and functional implications for independent living among the elderly (Evans, 1995). These reductions impair the performance in the activities of daily living and, consequently, impair the quality of life (Doherty, 2003). The ability to perform many activities of daily living may be compromised by low muscular strength and power even in healthy elderly persons (Rogers & Evans, 1993), and higher levels of anaerobic muscular power can contribute to high levels of physical function (Slade et al., 2002). In frail men and women, muscle strength is an important determinant of functional capacity, i.e. highly related to habitual working speed. Bassey and co-workers (Bassey et al., 1992) found that leg extensor power is closely related to the speed of walking upstairs, to standing up from a chair, and to gait speed. Leg power, which represents a more dynamic measurement of muscle function, may be a useful predictor of functional capacity in the very old (Rogers & Evans, 1993) and is needed for many basic activities in daily life, such as walking or rising from a seated position (Hyatt et al. 1990). The ability to do these things easily is taken for granted by healthy young people, but it is threatened in old age by various impairments that probably include lack of muscle power (Bassey et al., 1992). Therefore, the elderly are encouraged to perform strength training regimes to maintain bone mass and strengthen muscles (LaStayo et al., 2003; Hubal et al., 2005), to maintain muscle power and reduce the risk of falls (Beck & Snow, 2003).

In light of the aforementioned considerations, the aim of this study was to examine the effects of 12-week strength training on jump height and leg power development in very old people. It was hypothesized that resistance training may induce greater jump height and power improvements compared to non-training group.

Methods

Subjects

The population of the study consisted of very old people, older than 85 years. The sample consisted of 40 subjects, including 20 (11 male and 9 female; age: 86.33±1.59 years; body mass: 74.2±15.0 kg; stature: 168.93±10.6 cm; mean±SD) in the training group and 20 (9 male and 11 female; age: 86.36±1.91 years; body mass: 66.33±10.6 kg; stature: 168.0±9.6 cm; mean±SD) in the control group. The exclusion criteria of the study were as follows: having a sensory disability or a physical impairment and participating in a similar accompanying program. All of the participants were aware of the risks and benefits of participating in the study and provided written informed consent before participation.

Testing procedure

Each subject was tested on 2 occasions: 1) prior to commencement of training (pre-training), and 2) one week after the completion of the 12-week training period (post-training). The jump height and peak power output were assessed using the following tests: 1) countermovement jump (CMJ) and (2) squat jump (SJ) performed on a force plate. Each test was preceded by a standard warm-up procedure (5 min cycling). The participants were familiarized with the testing procedure prior to the pre-training session.

Countermovement jump and squat jump

Each subject performed three consecutive CMJ and three consecutive SJ trials with the arms placed akimbo. 1 min of rest was allowed between the consecutive jumping trials and 2-3 min between the CMJ and SJ. The jumps were performed on a force plate (Kistler type 9290AD, Winterthur, Swithzerland; sampling frequency 500 Hz) mounted according to the manufacturer's specifications. The jump height (CMJh and SJh) and peak power output (P_{peak}CMJ and P_{peak}SJ) during the concentric jump phase were calculated from the recorded vertical component of the ground reaction force.

Intervention

The 12-week strength training program included 5-min of warm-up activities as the initial segment, 30-min of exercises with own body weight and with minimal demand for exercise equipment (Table 1), and 5-min of cool down exercises as the final segment. Subjects in the training group were exercising three times per week, while number of repetitions and duration of rest periods were increased every four weeks (Table 1). Control group did not exercise.

Table 1: Strength training program

Exercise	Repetitions 1.-4. week	Repetitions 5.-8. week	Repetitions 9.-12. week	Rest (min) 1.-4. week	Rest (min) 5.-8. week	Rest (min) 9.-12. week
Squats	10	12	15	1	1.5	2
Back extensions	10	12	15	1	1.5	2
Crunches	10	12	15	1	1.5	2
Biceps stick curls (500 gr)	10	12	15	1	1.5	2
Single arm/leg back extensions	10	12	15	1	1.5	2
Step-ups (10 cm)	10	12	15	1	1.5	2
Vertical leg lifts	10	12	15	1	1.5	2
Calf raises	10	12	15	1	1.5	2

Statistical analyses

Statistical analysis was done using the Statistical Package for Social Sciences (SPSS v17.0, SPSS Inc., Chicago, IL, USA). Descriptive statistics were calculated for all experimental data as mean and SD. The data for jump height and peak power were not normally distributed and, therefore, differences between the training and control groups were determined by the Mann-Whitney ranked-sum test and the effects of training program on jump height and peak power were compared using the Wilcoxon signed-rank test. The level of significance was set at $p < 0.05$. Magnitude of treatment effects within groups were estimated by Cohen's effect size (ES; post-training – pre-training divided by the standard deviation of the pre-training). ES of 0.2 was considered as a small effect, 0.5 as a moderate effect and 0.8 as a large effect (Cohen, 1977).

Results

Pre- and post-training descriptive data for the jump heights (i.e. CMJh and SJh) and peak power outputs (i.e. P_{peak}CMJ and P_{peak}SJ) are shown in Table 2.

Table 2: Pre- and post-training descriptive data (means ± SD) and effect sizes (ES) for jump height and peak power output

	Training Group (n = 20)			Control Group (n = 20)		
Variable	Pre	Post	ES	Pre	Post	ES
CMJh (cm)	5.75 ± 5.61	6.30 ± 5.76	0.10*	5.75 ± 4.17	5.76 ± 4.07	0.00
SJh (cm)	4.85 ± 5.19	5.50 ± 5.52	0.13*	5.10 ± 4.23	4.80 ± 3.79	-0.07
P_{peak}CMJ (W)	1653.70 ± 834.75	1683.46 ± 847.35	0.04	1298.77 ± 666.51	1276.53 ± 667.03	-0.03
P_{peak}SJ (W)	1599.07 ± 831.25	1634.90 ± 854.62	0.04	1259.32 ± 669.11	1227.97 ± 652.12	-0.05

Notes: **Significant differences (p < 0.05) within groups from pre- to post-training.* CMJh = countermovement jump height; SJh = squat jump height; P_{peak}CMJ = countermovement jump peak power; P_{peak}SJ = squat jump peak power.

There were no significant differences in the pre-training jump heights (i.e. p=0.793 and p=0.795 for SJh and CMJh, respectively) and peak power (i.e. p=0.499 and p=0.244 for P_{peak}SJ and P_{peak}CMJ, respectively) between the training group and control group. There is a significant post-training effect (Table 2) for the both jump heights (i.e. p=0.006 and p=0.001 for SJh and CMJh, respectively), but not for both peak powers (i.e. p=0.159 and p=0.130 for P_{peak}SJ and P_{peak}CMJ, respectively) in the training group.

Discussion

The main finding of this study is that the 12-week strength training program utilizing their own body weight and with minimal demand for exercise equipment is effective in improving jumping performance (as seen through increased SJh and CMJh). Second, recorded values of the power output (P_{peak}SJ and P_{peak}CMJ) remained unchanged in the training group, compared to the control group, which showed slight decreases.

Training effects on jump height

The most important findings of this study is significant increase in squat jump height (by 11.81%) and countermovement jump height (by 8.73%) following the 12 weeks of body weight strength training program of the very old people. This finding compares well with recent data reported by Raimundo et al. (2009) who observed significant increase in the jump height of 18 postmenopausal women following 32 weeks (3 times per week) of whole-body-vibration training. Furthermore, the results of Roelants et al. (2004) showed an increase of 12.1% in countermovement jump performance in 20 older women (63.9 ± 0.8 years) after 24 weeks of resistance training. Altogether, this finding clearly indicates that the strength training with body weight has the potential of improving vertical jump height in very old people, but apparently to a lesser extent then the mentioned studies. That difference could originate from a shorter duration of the current intervention (12 weeks) compared with interventions in the above-cited studies (24-32 weeks), the lower training intensity, as well as from the large age difference between tested subjects.

Higher CMJh compared to SJh could somewhat be explained by stretch-shortening cycle (Svantesson & Grimby, 1995), regardless of what some studies suggested that the mechanical performance enhancement after pre-stretching is diminished with aging (Bosco & Komi, 1980).

Training effects on power output

Following the training, in the training group the peak power output during concentric phases (P_{peak}SJ and P_{peak}CMJ) remained unchanged, while the control group showed slight, but not statistically significant decrease in power output (Table 2). Our finding in the control group is in line with results of the Anton et al. (2004) study which reported that the ability to develop muscle power decreases significantly with age. Hence, the relatively poor results in jump height, or the impossibility to perform the jump are associated with contractile properties of leg muscles. The age-related decreases in mass and force of muscles are largely attributable to the loss of muscle fibers associated with the decrease in the number of motor units (Lexell et al., 1988) and relative distribution of fast and slow twitch fibers in the leg extensor muscles (Bosco and Komi, 1980). Further, the leg strength and jump height decreases with age due to loss of elastic components of connective tissue (Bosco and Komi, 1980; Zatsiorsky and Kraemer, 2006), but also due to the fear of landing in elderly people.

From the positive results of the CMJh, which includes stretching shortening cycle, is possible to suggest that the implemented resistance training improved intramuscular coordination that brought the utilization of potential elastic energy accumulated during the eccentric portion of the jump. Other mechanisms related to increased jump height could be higher force production, the interaction between the contractile and elastic elements, potentiation of the contractile machinery, and/or activation of stretch reflexes (van Ingen Schenau et al., 1997; Cormie et al., 2010).

As peak muscle power is a strong physiological predictor of functional limitations and disability in older adults (Runge et al., 2000), this study showed that strength training could prevent power loss in very old people and consequently, prolong the quality of their life.

Conclusions

In conclusion, squat jump height and counter-movement jump height increased significantly, and squat jump peak power and counter-movement jump peak power remained unchanged in very old people after 12 weeks of body weight strength training. The study results showed that the 12-week strength training is a safe, suitable, and efficient strength-training method for very old people. It may be helpful in preserving leg muscle power with advancing age and suitable for increasing strength and jump height in the very old people, which may be an important way to increase functional independence and decrease the prevalence of many age-associated chronic diseases.

References

1. Anton, M.M., Spirduso, W.W., & Tanaka, H. (2004). Age-related declines in anaerobic muscular performance: weightlifting and powerlifting. *Medicine and Science in Sports and Exercise*, 36(1): 143-147.
2. Bassey, E.J., Fiatarone, M.A., O'Neill, E.F., Kelly, M., Evans, W.J., & Lipsitz, L.A. (1992). Leg extensor power and functional performance in very old men and women. *Clinical Science*, 82(3), 321-327.
3. Beck, B.R., & Snow, C.M. (2003). Bone health across the lifespan--exercising our options. *Exercise and Sport Sciences Reviews*, 31(3), 117-122.
4. Bosco, C., & Komi, P.V. (1980). Influence of aging on the mechanical behavior of leg extensor muscles. *European Journal of Applied Physiology and Occupational Physiology*, 45(2-3), 209-219.
5. Cohen, J. (1977). *Statistical Power Analysis for the Behavioral Sciences*. New York: Academic Press.
6. Cormie, P., McGuigan, M.R., & Newton, R.U (2010). Changes in the eccentric phase contribute to improved SSC performance after training. *Medicine and Science in Sports and Exercise*, 42, 1731-1744.
7. Doherty, T.J. (2003). Aging and sarcopenia. *Journal of Applied Physiology*, 95, 1717–1727.
8. Evans, W. J. (1995). What is sarcopenia? *The Journals of Gerontology*, 50A, 5–8.
9. Hubal, M.J., Ingalls, C.P., Allen, M.R., Wenke, J.C., Hogan, H.A., & Bloomfield, S.A. (2005). Effects of eccentric exercise training on cortical bone and muscle strength in the estrogen-deficient mouse. *Journal of Applied Physiology*, 98(5), 1674-1681.
10. Hyatt, R.H., Whitelaw, M.N., Bhat, A., Scott, S., & Maxwell, J.D. (1990). Association of muscle strength with functional status of elderly people. *Age Ageing*, 19(5), 330-336.
11. Janssen, I., Heymsfield, S.B., Wang, Z.M., & Ross, R. (2000). Skeletal muscle mass and distribution in 468 men and women aged 18-88 yr. *Journal of Applied Physiology*, 89(1), 81-88.
12. LaStayo, P.C., Ewy, G.A., Pierotti, D.D., Johns, R.K., & Lindstedt, S. (2003). The positive effects of negative work: increased muscle strength and decreased fall risk in a frail elderly population. *Journal of Gerontology*, 58(5), M419-424.
13. Lexell, J., Taylor, C.C., & Sjöström, M. (1988). What is the cause of the ageing atrophy? Total number, size and proportion of different fiber types studied in whole vastus lateralis muscle from 15- to 83-year-old men. *Journal of Neurological Sciences*, 84(2-3), 275-294.
14. Raimundo, A.M., Gusi, N., & Tomas-Carus, P, (2009). Fitness efficacy of vibratory exercise compared to walking in postmenopausal women. *European Journal of Applied Physiology*, 106, 741–748.
15. Roelants, M., Delecluse, C., & Verschueren, S.M. (2004). Whole-body-vibration training increases knee-extension strength and speed of movement in older women. *Journal of American Geriatrics Society*, 52(6), 901-908.
16. Rogers, M.A., & Evans, W.J. (1993). Changes in skeletal muscle with aging: effects of exercise training. *Exercise and Sport Sciences Reviews*, 21, 65–102.
17. Runge, M., Rehfeld, G., & Resnicek, E. (2000). Balance training and exercise in geriatric patients. *Journal of Musculoskeletal & Neuronal Interactions*, 1(1), 61-65.
18. Slade, J.M., Miszko, T.A., Laity, J.H., Agrawal, S.K., & Cress, M.E. (2002). Anaerobic power and physical function in strength-trained and non-strength-trained older adults. *The Journals of Gerontology*, 57(3), 168-172.
19. Svantesson, U., & Grimby, G. (1995). Stretch-shortening cycle during plantar flexion in young and elderly women and men. *European Journal of Applied Physiology and Occupational Physiology*, 71(5), 381–385.
20. van Ingen Schenau, G.J., Bobbert, M.E., & de Haan, A (1997). Does elastic energy enhance work and efficiency in the stretch-shortening cycle. *Journal of applied biomechanics*, 13(4), 389-415.

SKELETAL MUSCLE CONTRACTION TIME AND TONE DECREASE AFTER 8 WEEKS OF PLYOMETRIC TRAINING

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Abstract

Purpose: Plyometric training (PT) is accepted among athletes as a method to improve jumping performance (Marković, et al., 2007). However, only few studies have examined the alterations in muscle fiber composition after PT. Biopsy findings of Malisoux et al. (2006) showed that PT enhances the adaptation of cross-bridge kinetics in vastus lateralis (VL), and is translated into improvements in jumping performance by ~12%. Invasiveness and non-selectiveness of non-invasive procedures used to determine muscle contractile properties were recently overcome by tensiomyography (TMG), which may provide additional insight into the contractile capacity of single skeletal muscle (Šimunič, et al., 2011; Pišot, et al., 2008). Thus, the aim of the study is to examine whether an improvement in jumping performance after 8-weeks (3 weekly sessions) of PT runs in parallel with changes in 5 skeletal muscles contractile properties.

Methods: Using TMG we assessed contraction time (Tc) and the maximal amplitude of radial displacement (Dm) in 20 participants (22.4±4.7 years), randomly allocated in PT group (N=10; PLYO) and a control group (N=10; CTRL). TMG was measured in five lower-limb muscles of the dominant leg: (VL), biceps femoris (BF), tibialis anterior (TA), gastrocnemius medialis (GM) and lateralis (GL). Additionally, we evaluated countermovement jump (CMJ) height improvement on a ground force plate.

Results: CMJ height increased by 12.2% only in PLYO ($p=.015$). Tc, which is related to MHC-1 proportion, decreased in VL (-8.7%; $p<.001$), BF (-26.7%; $p=.032$), TA (-32.9%; $p=.004$), GL (-25.8%; $p=.044$), but not in GM (-8.1%; $p=.158$). The estimated VL MHC-1 proportion decreased by -8.2% ($p=.041$). Dm decreased in BF (-26.5%; $p=.032$), GM (-14.9%; $p=.017$), GL (-31.5%; $p=.017$), but not in TA (-16.8%; $p=.113$) and VL (-6.0%; $p=.654$).

Conclusions: The study evaluated longitudinal adaptations of skeletal muscles in causal sport training research design using TMG. Our findings confirm muscle specific adaptations following PT that was paralleled by increase in jumping performance. Specifically, Tc decreases more in non-postural (TA: -32.9%, and BF: -26.7%) than in postural (VL: -8.7%, and GL: -25.9%) and more in distal than in proximal muscles. Furthermore, Dm decreases more in muscles with lower habitual load (e.g., BF, TA and GL).

References

1. Marković, G. Does plyometric training improve vertical jump height? (2007). A meta-analytical review. *British Journal of Sports Medicine*, 41(6), 349-355.
2. Malisoux, L., Francaux, M., Nielens, H., & Theisen, D. (2006). Stretch-shortening cycle exercises: an effective training paradigm to enhance power output of human single muscle fibers. *Journal of Applied Physiology*, 100(3), 771-779.
3. Pišot, R., Narici, M.V., Šimunič, B., De Boer, M., Seynnes, O., Jurdana, M., Biolo, G. Mekjavić, I.B. (2008). Whole muscle contractile parameters and thickness loss during 35-day bed rest. *Europan Journal of Applied Physiology*, 104(2): 409-414.
4. Šimunič, B., Degens, H., Rittweger, J., Narici, M.V., Mekjavič, I.B., Pišot, R. (2011). Noninvasive Estimation of Myosin Heavy Chain Composition in Human Skeletal Muscle. *Medicine and Science in Sports and Exercise*, 43(9); 1619-1625.

KINESIOLOGY

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Research Methodology

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UNIVERSITY OF ZAGREB
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P VALUES DOWN BUT NOT YET OUT

Will G. Hopkins

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A researcher studying a sample traditionally uses a p value to make an inference or conclusion about an effect or relationship in the data by performing a *null-hypothesis significance test*: $p<0.05$ is regarded as sufficient evidence that the true effect could not be null or zero, and the effect is declared significant, whereas $p>0.05$ implies that the true effect could be zero, and the effect is declared non-significant. Concerns about limitations and misinterpretations with this method of inference have been expressed for nearly 100 years. My own concerns led me to devise a new method based on acceptable uncertainty in the magnitude of an effect. Over the last 15 years this method has developed into several kinds of clinical and non-clinical *magnitude-based inference* that are now used widely in the exercise and sport-science community. Increasing dissatisfaction with hypothesis-based inference in other biomedical disciplines prompted the American Statistical Association to convene an expert panel to report last year on the "context, process and purpose" of p values. The panel did not reach a consensus, but in the resulting policy statement they apparently supported a conservative version of the null-hypothesis test, whereby the researcher can interpret the magnitude only of statistically significant effects. Coincidentally, my colleague Alan Batterham and I published a study comparing magnitude-based inference with this version and with the more conventional version, according to which a significant effect is "real" or substantial, and a non-significant effect is trivial or even null. In our study we simulated many thousands of controlled trials to show that clinical and non-clinical magnitude-based inferences outperform both versions of null-hypothesis testing in respect of lower rates of inferential errors about the true magnitude of effects, higher rates of conclusive outcomes, and lower bias in the magnitude of published effects. Magnitude-based inference is a more powerful and trustworthy alternative to the null-hypothesis significance test.

DIFFERENTIATING RESEARCH PREPARATION IN KINESIOLOGY

Stephen Silverman

Teachers College, Columbia University, New York, USA

This presentation will focus on issues related to student research preparation in kinesiology. The first part of the presentation will focus on how master's and doctoral students require different avenues for research preparation. Next will be a discussion of model for research preparation that differentiates initial versus advanced preparation, including issues that are specific for students at different levels. The presentation will conclude with recommendations for structuring research preparation.

Stephen Silverman is a professor of education and senior advisor to the provost for research preparation at Teachers College, Columbia University. His research focuses on teaching in physical education and on research methods. He has published extensively in research journals and book chapters, and has co-authored 18 books, including multiple editions of three research methods books. Among the many honors he has received are the Alliance Scholar Award from the American Alliance for Health, Physical Education, Recreation and Dance, and being named a fellow in the National Academy of Kinesiology and the American Educational Research Association.

Research Methodology

COMPARISON OF ANTHROPOMETRIC CHARACTERISTICS OF CHILDREN FROM SLAVONIAN REGION WITH WHO STANDARDS

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Abstract

The aim of this paper was to compare percentile values of children in the Slavonia region with the values of the World Health Organization (WHO) and to identify gender differences in the percentage of obese. The sample consisted of a total of 902 children (465 were boys and 437 girls) from 9 preschools, with an average age of 62.39 months (SD=14.98; min=33.66; max=86.40). The body height (stadiometer SECA213) and body weight (scale Omron BF511) was measured and body mass index was calculated. The results of transversal research showed that the differences in the specified period from 33,6 to 86,4 months are 27.2 cm in girls and 25.5 cm in boys, which are differences of 6.8 cm per year in girls and 6.37 cm per year in boys. At the same time the differences in body mass are 8.35 kg in girls and 8.6 kg in boys, or 2.08 kg per year in girls and 2.15 kg per year in boys. Also, the growth of children does not deviate from the reference value represented by the (WHO), children are on average within the boundary value of the 15th and the 85th percentile. Results also indicate that at this age in the sample there are gender differences only in body height, with boys significantly higher than girls by 1.58 cm ($t=2.12$; $p=0.03$). However, gender differences are present in frequencies belonging to each category (underweight, normal, and overweight). The Chi square test showed a different percentage of boys and girls in each category, and this is especially true in the category “underweight” (less than 15th percentile) and “normal” (in the 15-85th percentile) in the variable body height and body weight. Some noticeable differences in the category “overweight” (more than 85th percentile) were obtained in the variable body mass index. Furthermore, the results of this research show that more than 15% of boys and 20% of girls are overweight (BMI above 85th percentile) compared to the values of the (WHO), whereby there is a significant difference in the prevalence of overweight by gender ($\chi^2=49.47$; $p=0.00$).

References

1. Cole T.J., Flegal K.M., Nicholls D. & Jackson A. (2007). Body mass index cut offs to define thinness in children and adolescents: international survey. *British Medical Journal,* 335: 194.
2. Cole, T.J., Faith, M.S., Pietrobelli, A. & Heo, M. (2005). What is the best measure of adiposity change in growing children: BMI, BMI %, BMI z-score or BMI centile? *European Journal of Clinical Nutrition*.59, 419–425**.**
3. De Onis, M. (2004). The use of anthropometry in the prevention of childhood overweight and obesity. *International Journal of Obesity*, 28: 81–85.

METRIC PROPERTIES OF GOAL ACHIEVEMENT SATISFACTION SCALE IN SPORT ENVIRONMENT

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Abstract

To assess satisfaction with goal achievement in sport environment on Croatian sample, Goal achievement satisfaction 14-item scale was developed. The aim of this paper is to present the scale and its metric properties. The scale was applied on two samples. The first sample consisted of 415 kinesiology students and the second sample consisted of 602 athletes from 39 different sports (Hrženjak, 2017). The results show good metric properties of the scale in both samples. Cronbach's alpha coefficients are 0,88 in the students sample and 0,87 in the sample of athletes.

Key words: *goal achievement, sport, athlete's satisfaction*

Introduction

Achievement can be defined as *personal success through demonstrating competence according to social standards* (Schwartz & Sagiv, 1995). Achievement is very important part of every activity in sport, weather it is task or ego oriented. We can conclude that low successful achievement and low competences lead to lower sense of personal accomplishment (Spielberger, 2004). In general we can say that the goal achivement satisfaction is important in different aspects of athletes lives. It has been shown that the satisfaction with achievement is a significant predictor of daily satisfaction (Oishi et al., 1999). Further, Pierce et al. (1993) showed in their research that achievement satisfaction was significantly corelated with self-esteem, and Grove et al. (1997) concluded that achievement satisfaction has significant impact on transition process among athletes. The purpose of this study was to develop a good inventory to measure goal achievement satisfaction which can be specifically used in sport environment.

Methods

The research was conducted on two samples. The first sample consisted of 415 kinesiology students from Zagreb. Research was conducted from November 2015 to January 2016 at the Faculty of Kinesiology during theoretical lectures. The second sample consisted of 602 senior level athletes from 39 different sports from Zagreb; research was conducted by Hrženjak (2017) from May to September 2016. Subjects were completing set of questionnaires, which also included 14-item Goal achievement satisfaction scale in sport environment. The scale was developed by Boris Balent for the purpose of his doctoral research (Table 1). The items ware constructed to describe goal achivement satisfaction in sport environment. Every item was evaluated on five point Lickert type scale (from 1- Completely disagree, to 5 – Completely agree).

Results and discussion

In Table 1 are metric characteristics of scale items (mean, standard devation, projection on the first principle component, Crombach's alpha coeficient if item is excluded) and item-total score correlation for the kinesiology students sample. In Table 2 we can see those characteristics for the athletes sample.

Table 1: Means and standard deviations (SD), item-total correlations (rit), projection on the first principle component (K1) and Cronbach's alpha coeficients if item excluded of 14 items of Goal achievement satisfaction scale in sport environment for the first sample (kinesiology students)

Item	Mean	SD	rit	K1	Alpha-
So far I have achieved most of what I set out for my life.	2,99	1,07	0,45	0,54	0,87
I am satisfied with my achievement in sport.	3,25	1,02	0,75	0,83	0,86
I think I should have achieved more in sport.	3,74	1,05	0,44	-0,51	0,88
Even though I can still progress, I am in general satisfied with what I have achieved in sport.	3,19	0,99	0,65	0,76	0,87
When I compare myself with others, I am not satisfied with what I have achieved.	2,62	1,10	0,59	-0,64	0,87
Despite of failures that has been happening, in general I think I have achieved a lot in sport.	3,30	0,93	0,65	0,75	0,87
I often set out goals for myself that I do not achieve at the end.	2,49	1,05	0,47	-0,51	0,88
Concidering the level that I have been engaged in sport at, I am satisfied with what I have achieved.	3,49	0,96	0,59	0,68	0,87
I often regret tha fact that I did not win more medals.	3,14	1,28	0,41	-0,46	0,88
I can tell rightfully that my achievements in sport are excellent.	3,07	1,04	0,68	0,77	0,87
I can be proud of what I have achieved so far.	3,63	0,99	0,70	0,78	0,87
I regularly recieve recognition for my achievements.	2,90	1,13	0,44	0,53	0,88
Generally I often do not succeed in achieveing goals that I set out.	2,32	0,98	0,47	-0,51	0,88
It ennoys me that often something goes wrong so I cannot achieve goals that I have set out.	2,83	1,12	0,49	-0,53	0,88

Table 2: Means and standard deviations (SD), item-total correlations (rit), projection on the first principle component (K1) and Cronbach's alpha coeficients if item excluded of 14 items of Goal achievement satisfaction scale in sport environment for the second sample (athletes)

Item	Mean	SD	rit	K1	Alpha-
So far I have achieved most of what I set out for my life.	3,25	1,13	0,46	0,57	0,86
I am satisfied with my achievement in sport.	3,72	0,94	0,66	0,76	0,86
I think I should have achieved more in sport.	3,52	1,21	0,51	-0,54	0,86
Even though I can still progress, I am in general satisfied with what I have achieved in sport.	3,68	1,08	0,63	0,74	0,86
When I compare myself with others, I am not satisfied with what I have achieved.	3,58	1,03	0,60	-0,67	0,86
Despite of failures that has been happening, in general I think I have achieved a lot in sport.	2,59	1,26	0,64	0,75	0,86
I often set out goals for myself that I do not achieve at the end.	2,58	1,12	0,42	-0,45	0,87
Concidering the level that I have been engaged in sport at, I am satisfied with what I have achieved.	3,72	1,06	0,61	0,73	0,86
I often regret tha fact that I did not win more medals.	2,86	1,38	0,45	-0,49	0,87
I can tell rightfully that my achievements in sport are excellent.	3,47	1,06	0,62	0,73	0,86
I can be proud of what I have achieved so far.	3,97	0,93	0,65	0,75	0,86
I regularly recieve recognition for my achievements.	3,35	1,10	0,29	0,38	0,87
Generally I often do not succeed in achieveing goals that I set out.	2,40	1,08	0,46	-0,49	0,86
It ennoys me that often something goes wrong so I cannot achieve goals that I have set out.	2,71	1,24	0,53	-0,56	0,86

All item in both samples show good metrical characteristics. Standard deviations show satisfactory variablity of the results. Corelation with first principle component as well as item-total corelations showed that there is no item whish do not belong to the set, so this items are good masures od Goal achievement satisfaction in sport environment.

Table 3: Metric charactoristics of Goal achievement satisfaction scale in sport environment for the first sample (kinesiology students) and second sample (athletes

	Students sample	Athletes sample
Cronbach's α coeficient	0,88	0,87
First egenvalue of item correlation matrix and the persantage of total variance	5,74 41,02	5,61 40,07
Number of eigenvalues exceding 1	3	2
Average inter-item correlation	0,36	0,35
Total score mean	44,68	47,99
Standard deviation of total score	9,24	9,70
Minimum total score	17	20
Maximum total score	69	70

Crombach's alpha reliability coefficient of the scale for the first sample (Kinesiology students) shows value of 0,88, and for the second sample (athletes) 0,87 (Table 3). First eigenvalue of item corelation matrix explains satisfactory 41,02% for the first sample, and 40,07% for the second sample. Means of total scores are 44,68 and 47,99 respectevely. In both sample minimal observed total score is higher then theoretical minium total score. In athlete sample maximal value 70 is observed, which is the sam value as maximum teoretical value.

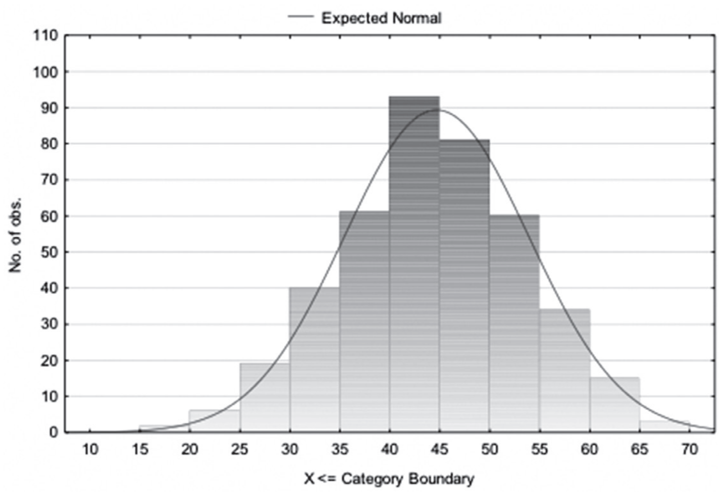

Figure 1: Distribution of total result of Goal achievement satisfaction scale in sport environment on the sample of 415 Kinesiology students; theoretical normal destribution is represented by line.

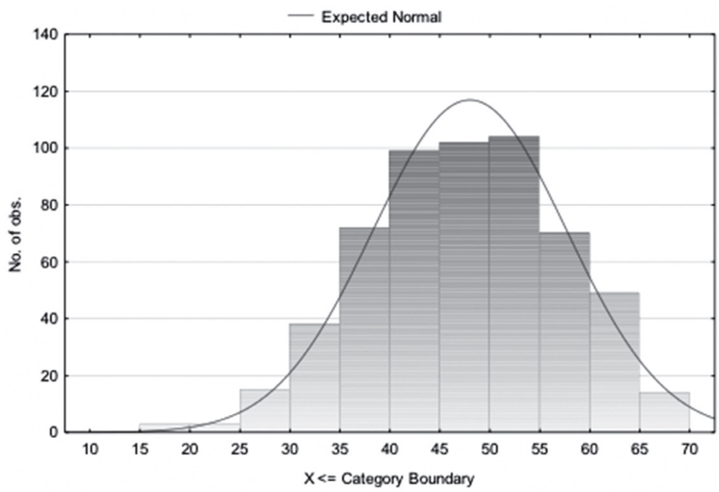

Figure 2: Kolmogorov-Smirnoff test show that distibution of results from both samples do not statisticaly differ ftom theoreticly normal distribution (d1=0,03654, p1>0,20; d2=0,04144, p1>0,20), respectivly.

Conclusion

The results of analysis of metric properties of *Goal achievement satisfaction scale in sport environment* conducted on both samples show that all 14 items are good measure of Goal ahievement satisfaction is sport enviromnent; total result show high value of reliability and exeptable distribution statisticaly not different from normal. It can be concluded that the scale can be used for both inividual assesment as for the research.

References

1. Grove, R. J., Lavallee, D., & Gordon, S. (1997). Coping with retirement from sport: The influence of athletic identity. Journal of Applied Sport Psychology, 9, 191-203.
2. Hrženjak, M. (2017). Povezanost faktora motivacije sportaša s procjenama trenerovih karakteristika. Doktorska disertacija (unpublished), Zagreb: Kineziološki fakultet.
3. Oishi, S., Diener, E., Suh, E. & Lucas R. E. (1999). Value as a Moderator in Subjective Well-Being. Journal of Personality, 67:1, 156-182.
4. Pierce, J.L., Gardner, D.G., Dunham, R.B. & Cummings, L.L. (1993). Moderation by organization-based self-esteem of role condition-employee response relationships. Academy of Management Journal, 36:2, 271-288.
5. Schwartz, S.H., & Sagiv, L. (1995). Identifying culture-specifics in the content and structure of values. Journal of Cross-Cultural Psychology, 26, 92-116.
6. Spielberger, C. (2004). Encyclopedia of Applied Psychology, Academic Press.

THE MEASURE OF INTRINSIC AND EXTRINSIC MOTIVATION IN TENNIS

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Summary

A questionnaire was designed to estimate the quality and intensity of motivation of tennis players (Kumburić, 2015), based on the model of Deci and Ryan (1985). The designed questionnaire consists of 38 items that form six subscales, including six regulatory styles described by Deci and Ryan (1985). The analysis of the measurement properties of questionnaire was done on the sample of 174 junior tennis players aged from 15 to 18 years. The analysis show that the newly designed questionnaire has overall Cronbach alpha reliability of α=0.849, which implies that the questionnaire is applicable for practical purposes. The analysis of the measurement properties of subscales showed Cronbach alpha reliability α=0.74 for intrinsic motivation subscale, α=0.563 for identified motivation subscale, α=0.657 for integrated motivation, α=0.61 for introjected motivation, α=0.628 for external motivation, and α=0.582 for amotivation subscale. The reliability of the subscales is not adequate for the individual application (e.g. to estimate the profile of a player).

Key words: *motivation, tennis, analysis of metric properties, reliability*

Introduction

Motives are generally defined as generators of the behavior, which is directed to some goal (Petz, 2005). There are a number of reasons for human behavior, described by different theories of motivation. Over the last decade, research in the field of sport psychology, as well as interventions for developing high quality motivation, are predominantly done based on Self-Determination Theory (Niven & Markland, 2016; Sebire et al., 2016).

Self-Determination Theory by Deci and Ryan (1985) defines basic human needs, a need for autonomy, competence, and relatedness, and ways to satisfy them. Ryan and Deci (2000) noticed that intrinsically motivated behaviors satisfy need for autonomy and competence, while extrinsically motivated behaviors very often do not. They noticed that extrinsic motivation includes different types of regulatory styles, and therefore defined continuum from amotivation to intrinsic motivation including four interpolated types of extrinsic motivation: external regulation, introjection, identification and integration (Figure 1).

Preferable outcomes of behavior generated by motives perceived as having internal or somewhat internal locus of causality were proved in exercise and sport (Vlachopoulos et al., 2000, Friedrichs et al., 2015); therefore, it is important to know not only the intensity, but also to understand the quality of motivation of athletes.

The purpose of this work is to introduce a questionnaire designed to estimate the quality and intensity of motivation in tennis (Kumburić, 2015) based on the model of Deci and Ryan (1985).

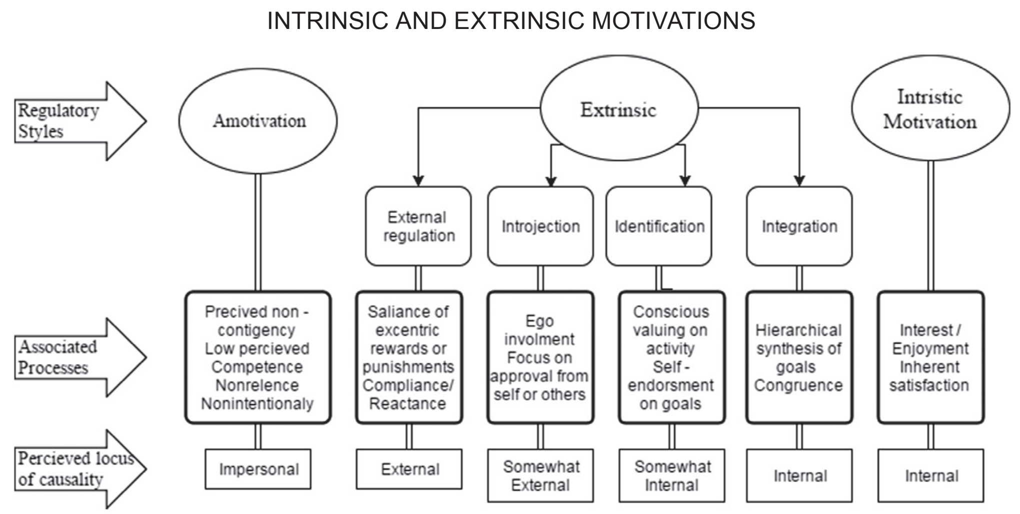

Figure 1: Graphic representation of intrinsic and extrinsic motivations, from Ryan, R. M. & Deci, E. L. (2000).

Methods

The designed questionnaire consists of 38 items that form six subscales, including six regulatory styles described by Deci and Ryan (1985); the responses are given on the 5-point scales.

The analysis of the measurement properties of questionnaire was done on the sample of 174 junior tennis players aged from 15 to 18 years, with mean age of 17,6 years, with SD of 0,61. Questionare was used on Croatian National Championship U18, and on ITF U18 tournament in Umag (Grade 1). After individually given instructions to each subject, filling out the questionnaire took less than 10 minutes. Data analysis was done by Statistica 12 software.

Results and discussion

Measuring properties 38 items of newly constructed questionnaire can be found in Table 1.

The variability of the response is satisfactory, answers on 37 items are in maximum range 1-5. It may also be noted that the dominant number of items has a standard deviation greater than 1. A majority of items has a noticeable projection on the first component (K1) and great number of items have a medium to high correlation with the overall summarized results.

Table 1: Metric properties of the items of the measure of intrinsic and extrinsic motivation in tennis

Item	Mean	Min	Max	SD	RIT	K1
1. Going to tournaments is not always a pleasure, but I do it because it is good for personal experience.	3,14	1	5	1,42	0,098	0,112
2. Tennis is my greatest pleasure.	4,56	2	5	0,64	0,573	0,708
3. I have a pangs of conscience when I miss training	3,79	1	5	1,13	0,373	0,468
4. I take care to have a good night's sleep because night entertainments are not for tennis players.	4,11	1	5	1,07	0,527	0,640
5. I don't want to disappoint my friends with defeat.	2,76	1	5	1,37	0,160	0,075
6. It is my pleasure to win point after a long rally.	4,48	1	5	0,90	0,261	0,323
7. I want to prove to everyone that I'm the best.	3,93	1	5	1,14	0,378	0,351
8. Tennis training makes me happy.	4,42	1	5	0,78	0,543	0,669
9. I enjoy the rally on the court.	4,25	1	5	0,94	0,345	0,458
10. I live healthy so that I could be better at tennis.	4,13	1	5	0,94	0,551	0,687
11. Tennis is more important for me than education.	3,30	1	5	1,31	0,348	0,385
12. Physical traninigs are boring but they make me better tennis player.	3,34	1	5	1,45	0,303	0,303
13. Tennis requires too much sacrifice.	3,49	1	5	1,23	0,010	-0,045
14. Early morning training is hard, but useful.	3,99	1	5	0,97	0,289	0,320
15. Tennis will make me famous.	3,25	1	5	1,21	0,303	0,344
16. My coach is proud of me, so Iam regular on trainings.	3,40	1	5	1,29	0,406	0,444
17. As a tennis player I don'tt allow myself sloppy lifestyle.	4,07	1	5	1,02	0,529	0,652
18. In my career parents expect only victory from me.	2,07	1	5	1,16	0,161	0,076
19. I could use my time better than playing tennis.	2,04	1	5	1,15	0,244	-0,366
20. I take care of diet in order to be a better tennis player.	3,60	1	5	1,13	0,558	0,652
21. For me is important that audience loves me	2,97	1	5	1,39	0,338	0,284
22. I don't get angry at the tennis judges because real tennis players don't do that.	3,48	1	5	1,20	0,041	0,072
23. People appreciate me more because I am a tennis player.	3,45	1	5	1,08	0,191	0,163
24. I like to perform a good strong service.	4,40	1	5	1,04	0,346	0,395
25. I play tennis because there is a lot of money.	2,37	1	5	1,30	0,135	0,053
26. In tennis I can truly express myself.	4,06	1	5	0,99	0,601	0,718
27. I do my best when one of my friends is sitting in the stand.	3,53	1	5	1,27	0,280	0,260
28. Tennis is great because I travel a lot.	3,90	1	5	1,13	0,321	0,340
29. I trainin tennis because there is a chance that I get a very good sponsor.	3,28	1	5	1,13	0,361	0,313
30. I take care of my diet because that makes me tennis player.	3,66	1	5	1,21	0,610	0,675
31. Glory will make my life easier after career.	3,39	1	5	1,15	0,381	0,392
32. I do not drink alcohol because tennis players don't do that.	3,78	1	5	1,48	0,284	0,382
33. Everyday training does not make sense.	1,87	1	5	1,25	0,150	-0,287
34. I hope to be a famous tennis player.	3,98	1	5	1,19	0,497	0,606

35. Sometimes I think that tennis is not for me	2,21	1	5	1,23	0,359	-0,498
36. Tennis can make my life easier.	3,55	1	5	1,25	0,046	0,035
37. Tennis makes me more nervous than I usually am.	2,93	1	5	1,34	0,164	-0,266
38. I don't miss trainings because I am a tennis player.	4,17	1	5	0,97	0,378	0,502

Legend: min = minimal item result value; max = maximal item result value; SD = standard deviation; RIT = item correlation with the overall summary result of the subscales of "intrinsic motivation", α = Cronbach's coefficient if individual item is expelled, K1 = the first principle component of the matrix of item correlations.

The first eigenvalue of correlation matrix of 38 items is 7,738 and explaines 17,99% of total variance. The Cronbach alpha reliability of total result is α=0.849, which implies that the questionnaire is appropriate for practical purposes and individual application.

Table 2: Metric properties of 5 items of the subscale measuring amotivation

Item	RIT	α	K1
13. Tennis requires too much sacrifice.	0,205	0,595	-0,421
19. I could use my time better then playing tennis.	0,294	0,547	-0,581
33. Everyday training does not make sense	0,363	0,510	-0,665
35. Sometimes I think that tennis is not for me	0,613	0,359	-0,847
37. Tennis makes me more nervous than I normally am	0,251	0,576	-0,519

Legend: RIT = item correlation with the overall summary result of the subscales of "intrinsic motivation", α = Cronbach's coefficient if individual item is expelled, K1 = the first principle component of the matrix of item correlations.

The first eigenvalue of correlation matrix of 5 items describing *amotivation* is 1,944 and explains 38,88% of total variance. Cronbach alpha reliability is low α=0.582, and scale should be expanded.

Table 3: Metric properties of 7 items of the subscale measuring external regulation

Item	RIT	α	K1
15. Tennis will make me famous.	0,416	0,564	0,688
25. I play tennis because there is a lot of money.	0,424	0,559	0,623
28. Tennis is great because I travel a lot.	0,240	0,619	0,378
29. I trainin tennis because there is a chance that I get a very good sponsor.	0,422	0,564	0,649
31. Glory will make my life easier after career.	0,461	0,550	0,749
34. I hope to be a famous tennis player.	0,354	0,585	0,571
36. Tennis can make my life easier.	0,088	0,669	0,113

Legend: RIT = item correlation with the overall summary result of the subscales of "intrinsic motivation", α = Cronbach's coefficient if individual item is expelled, K1 = the first principle component of the matrix of item correlations.

The first eigenvalue of correlation matrix of 7 items describing *external regulation* is 2,324 and explains 33,20% of total variance. Cronbach alpha reliability is α=0.628, and is too low for wider use.

Table 4: Metric properties of 8 items of the subscale measuring introjection

Item	RIT	α	K1
3. I have a pangs of conscience when I miss training.	0,180	0,615	-0,295
5. I don't want to disappoint my friends with defeat.	0,326	0,577	-0,531
7. I want to prove to everyone that I'm the best.	0,377	0,564	-0,631
16. My coach is proud of me, so Iam regular on trainings.	0,199	0,614	-0,335
18. In my career parents expect only victory from me.	0,316	0,580	-0,507
21. For me is important that audience loves me	0,446	0,536	-0,692
23. People appreciate me more bacause I am a tennis player.	0,257	0,595	-0,487
27. I do my best when one of my friends is sitting in the stand.	0,390	0,557	-0,609

Legend: RIT = item correlation with the overall summary result of the subscales of "intrinsic motivation", α = Cronbach's coefficient if individual item is expelled, K1 = the first principle component of the matrix of item correlations.

The first eigenvalue of correlation matrix of 8 items describing *introjection* is 2,223 and explains 27,79% of total variance. Cronbach alpha reliability is α=0.610.

Table 5: Metric properties of 5 items of the subscale measuring identification

Item	RIT	α	K1
1. Going to tournaments is not always a pleasure, but I do it because it is good for personal experience.	0,194	0,554	0,377
10. I live healthy so that I could be better at tennis.	0,420	0,422	0,797
12. Physical traninigs are boring but they make me better tennis player.	0,259	0,510	0,437
14. Early morning traninig is hard, but useful.	0,228	0,513	0,506
20. I take care of diet in order to be a better tennis player.	0,471	0,370	0,829

Legend: RIT = item correlation with the overall summary result of the subscales of "intrinsic motivation", α = Cronbach's coefficient if individual item is expelled, K1 = the first principle component of the matrix of item correlations.

The first eigenvalue of correlation matrix of 5 items describing *identification* is 1,912 and explains 38,24% of total variance. Cronbach alpha reliability is low α=0.563.

Table 6: Metric properties of 6 items of the subscale measuring integration

Item	RIT	α	K1
4. I take care to have a good night's sleep bacause night entertainments are not for tennis players.	0,537	0,552	-0,753
17. As a tennis player I don't allow myself sloppy lifestyle.	0,435	0,590	-0,692
22. I don't get angry at the tennis judges because real tennis players don't do that.	0,157	0,685	-0,269
30. I take care of my diet because that makes me tennis player.	0,464	0,574	-0,697
32. I do not drink alcohol bacause tennis players don't do that.	0,420	0,595	-0,638
38. I don't miss tranings because I am a tennis player.	0,319	0,627	-0,546

Legend: RIT = item correlation with the overall summary result of the subscales of "intrinsic motivation", α = Cronbach's coefficient if individual item is expelled, K1 = the first principle component of the matrix of item correlations.

The first eigenvalue of correlation matrix of 6 items describing *integration* is 2,307 and explains 38,46% of total variance. Cronbach alpha reliability is α=0,657, and could be better, at least 0,685, if item 22 is replaced.

Table 7: Metric properties of 7 items of the subscale measuring intrinsic motivation

Item	RIT	α	K1
2. Tennis is my greatest plasure.	0,503	0,664	-0,705
6. It is my pleasure to win point after a long rally.	0,373	0,682	-0,527
8. Tennis traninig makes me happy.	0,646	0,625	-0,820
9. I enjoj the rally on the court.	0,488	0,654	-0,694
11. Tennis is more important for me than education.	0,274	0,730	-0,420
24. I like to perform a good strong service.	0,327	0,697	-0,473
26. In tennis I can truly express myself.	0,485	0,653	-0,703

Legend: RIT = item correlation with the overall summary result of the subscales of "intrinsic motivation", α = Cronbach's coefficient if individual item is expelled, K1 = the first principle component of the matrix of item correlations.

The first eigenvalue of correlation matrix of 7 items describing *intrinsic motivation* is 2,823 and explains 40,34% of total variance. Cronbach alpha reliability is acceptable α=0.740, but could be increased by adding more items.

Conclusion

Analysis of metric characteristic is indicating that the questionnaire designed to estimate the quality and intensity of motivation in tennis, when is used as unit of 38 items is applicable for research purposes and also for individual use. It may also be noted that the subscales are not reliable enough to use for making individual motivational profiles of players. For these reasons, in this case it is proposed to expand the scale with more items.

References

1. Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.
2. Friedrichs, S. A., Bolman, C., Oenema, A., & Lechner, L. (2015). Profiling physical activity motivation based on self-determination theory: a cluster analysis approach. BMC Psychology, 3, 1-12.
3. Kumburić, J. (2015). Procjena motivacije tenisača i tenisačica u dobi od 15 do 18 godina. Diplomski rad, Zagreb: Kineziološki fakultet.
4. Niven, A. G., & Markland, D. A. (2016). Using self-determination theory to understand motivation for walking: Instrument development and model testing using Bayesian structural equation modeling.. Psychology of Sport and Exercise, 23, 90-100
5. Petz, B. (2005). Psihologijski rječnik. Jastrebarsko: Naklada Slap.
6. Ryan, R. M. & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. Contemporary Educational Psychology 25, 54-67.
7. Sebire, S., Jago, R, Kesten, J. M., Edwards, M. J., May, T., Banfield, K., Tomkinson, K., Blair, P. S., Bird E. L., & Powell J. E. (2016). Using self-determination theory to promote adolescent girls' physical activity: Exploring the theoretical fidelity of the Bristol Girls Dance Project. Psychology of Sport and Exercise, 24, 100-110.
8. Vlachopoulos, S. P., Karageorghis, C. I., & Terry, P. C. (2000). Motivation profiles in sport: A self-determination theory perspective. Research Quarterly for Exercise and Sport, 71, 387-397.

THE DEVELOPMENT OF THE GENERAL KNOWLEDGE OF SPORT SCALE

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Abstract

With the purpose to measure general interest toward sport in male Croatian adolescents, the General knowledge of sport (GKS) scale was constructed. The scale consists of 30 questions with the multiple-choice answers; the questions are about the rules of sports, history, events, achievements and athletes, from the world and local sport. The research of metric properties of the scale was done on the sample of 1184 male high school pupils, aged 15 to 20 years, from Istria region of Croatia. The results show that 3 items should be excluded from scale. The remaining 27 questions form adequate measuring instrument, with the acceptable value of Cronbach's alpha coefficient of reliability (0,78). It is concluded that 27-item scale can be useful as a short version of GKS.

Key words: *general information, metric properties*

Introduction

The general knowledge or general information is defined as a part of content of the semantic memory which represents culturally valued knowledge (Lynn et al., 2002). The acquisition of general information is not simple process; very often, the informations are obtained out of formal education system (Zarevski et al., 2002) and learning is influenced by cognitive functioning, personality and interests (Zarevski et al., 2015).

The general knowledge can be viewed as an unitary construct at the top of the hierarchy of a number of domains (Zarevski et al., 2014). Lynn et al. (2002) described twenty domains of general knowledge; using factor analysis, six factors of higher order were recognized: (1) current affairs, (2) family, (3) physical health and recreation, (4) fashion, (5) arts and (6) sciences. When described by three wide domains (Lynn et al., 2009), general information divides into (1) general culture (national and world history, and arts), (2) natural and social sciences (natural and social sciences, medicine, and world's religions and customs) and (3) current affairs (politics, business, technology, sports and entertainment).

The analyses of gender differences in the general knowledge of specific domains (Lynn et al., 2002; 2009; Zarevski et al., 2007; 2014) show that the acquisition of specific informations is related to gender-stereotyped interests. Male adolescents in Croatia show more general knowledge about sport than females (Zarevski et al., 2007), which can be interpreted that interests have strongest impact in knowledge acquisition in that specific field. In this work, the development of General knowledge of sport (GKS) scale is presented; the scale is constructed with the purpose to measure general interest toward sport in male Croatian adolescents.

Methods

The research was done on the sample of 1184 male high school pupils aged 15 to 20 years (mean age is 17,19 years) from Istrian region of Croatia. In the sample, 1173 subjects have complete results.

The subjects were given the second version of Benassi's General knowledge of sport scale (GKS), developed for his doctoral research. The scale consists of 30 questions with the multiple choice answers; the questions are about the rules of sports, history, events, achievements and athletes, from the world and local sport (Table 1). Correct answers were scored 1, and incorrect 0; omitted answers were treated as missing values. The total result of the scale was defined as unweighted sum of correct answers.

The measurements were done in the schoolrooms during regular classes, anonymously and voluntarily. Ethics approval of the research was obtained by the Faculty of Kinesiology's ethics committee; the permissions were acquired from The Ministry of Science and Education and from the authorities of each high school.

Data analysis was done using software package Statistica 13.

Results and discussion

In the Tables 1 and 2 are metric properties of the items of GKS scale and of the total result, respectively. The levels of difficulty of the scale questions vary, from very easy (questions 13, 18, 20) to very difficult (questions 1, 7, 28), and cannot be connected to specific content of the question (Table 1). Values on the first principle component, as well as item-total correlations show that at least one of the items does not belong to the set. The question “What is the name of the lightest class of Olympic senior boxing?” correlate neither with first principle component, nor with total result. The other two questions, number 8 and 17, show low values of the correlations and should be extracted from the scale. The content of questions number 7 and 8 is knowledge about box and modern pentathlon, which are les popular sports in young males in Croatia (Prot, 2002); item number 17 is about artistic gymnastics.

The metric characteristics of the total scores including 30, 28 and 27 questions are in Table 2. The results show that items 7, 8, and 17 do not contribute to the measuring value of the GKS scale; with or without them, value of Cronbach’s alpha coefficient of reliability varies minimally, from 0,76 to 0,78. The shortest version has acceptable metric properties: the total score results vary from 3 to 27, mean (16,4) is properly placed and standard deviation is high enough (4,5); Kolmogorov-Smirnov test is d=0,062, meaning that the distribution of the total result do not differ significantly from the expected normal distribution (Figure 1).

It is very difficult to form the test of any general knowledge with small number of questions; for example, General knowledge test (Irwin et al., 2001) consists of 216 questions; TOI-2001 scale (Zarevski, 2001) consists of 125 items. Therefore, the 27-item GKS scale can be used as convenient short measure of sport interests in adolescent males in Croatia.

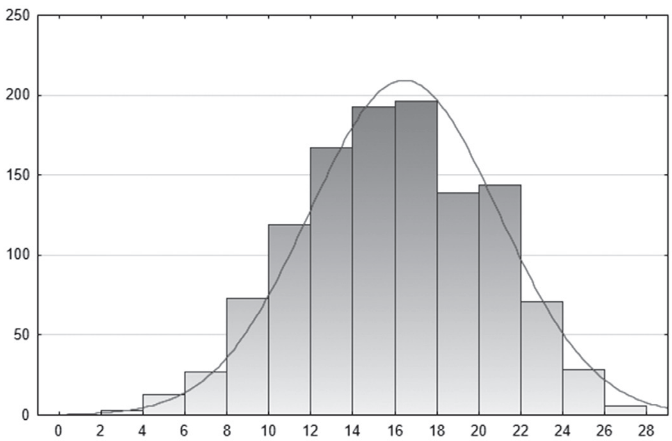

Figure 1: Distribution of the total result of 27-item version of GKS scale. On the horizontal axis are the category boundaries of the results; on the vertical axis are frequencies of the results. Full line represents the expected normal distribution.

Table 1: Descriptive statistics, values on first principle component and item-total correlations of General knowledge of sport scale items

	Question	Mean	SD	K1	Rit
1.	Who is Croatian coach with the greatest number of trophies?	0,188	0,391	-0,389	0,307
2.	What is the distance of a marathon race?	0,396	0,489	-0,298	0,252
3.	At the Games of the XXX Olympiad, London 2012, Croatia won golden medal in which team sport?	0,714	0,452	-0,475	0,372
4.	Who is the greatest Croatian athlete of the 20th century?	0,548	0,498	-0,249	0,190
5.	How many points are needed in volleyball fifth set?	0,552	0,498	-0,357	0,285
6.	For which sport it is said that it is the most important unimportant thing in the world?	0,744	0,436	-0,359	0,267
7.	What is the name of the lightest class of Olympic senior boxing?	0,155	0,362	-0,045	0,031
8.	The modern pentathlon comprises five different events: fencing, swimming, riding, running and ...	0,530	0,499	-0,158	0,109
9.	How high is a basketball hoop from the ground? |	0,481	0,500	-0,384	0,309
10.	Who is the fastest athlete in the world today?	0,951	0,216	-0,405	0,293
11.	Who was the captain of national football team at 1998. World Cup (France) when Croatia earned the third place?	0,404	0,491	-0,544	0,437
12.	What is the length of an Olympic size swimming pool?	0,677	0,468	-0,405	0,323
13.	What is the name of the stadium which is the home venue of football club Hajduk (Split)?	0,911	0,284	-0,473	0,342

14.	Which formula one driving team is the most successful of all time?	0,678	0,468	-0,279	0,207
15.	What year were the first modern Olympic Games (Athens, Greece) held?	0,490	0,500	-0,241	0,189
16.	It is believed that the cradle of football is...	0,424	0,494	-0,270	0,211
17.	Which of the following apparatuses does not belong to men's artistic gymnastics?	0,446	0,497	-0,168	0,147
18.	What is the name of the most successful Croatian sport family?	0,943	0,231	-0,402	0,270
19.	Which Italian football club is nicknamed "old lady"?	0,660	0,474	-0,565	0,450
20.	Ivano Balić was the best player in the world in which sport?	0,931	0,254	-0,440	0,313
21.	Which Grand Slam tennis tournament is played on the clay court?	0,378	0,485	-0,530	0,428
22.	In which sport yellow and red card do not exist?	0,530	0,499	-0,318	0,241
23.	From which sport are sisters Ana and Lucija Zaninović?	0,693	0,461	-0,421	0,335
24.	The host of the 21. FIFA World Cup in 2018. is...	0,673	0,469	-0,432	0,325
25.	Which of the following disciplines does not belong to fencing?	0,606	0,489	-0,226	0,183
26.	Who is the motorcycle road racer nicknamed "The Doctor"?	0,828	0,378	-0,425	0,298
27.	At the moment, world's champion team in rugby comes from...	0,709	0,455	-0,412	0,325
28.	What is the name of the president of GNK Dinamo Zagreb?	0,165	0,372	-0,313	0,244
29.	How far from the goal is the goalkeeper area in handball?	0,595	0,491	-0,337	0,258
30.	How many players are on the ice during a hockey game?	0,565	0,496	-0,325	0,240

Legend: Mean = proportion of correct answers, SD = Standard deviation, K1=value on the first standardized principle component, Rit=item–total correlation.

Table 2: Metric properties of the total result in 30, 28 and 27-item versions of General knowledge of sport scale

Number of items	30 (full set of items)	28 (items 7 and 8 extracted)	27 (items 7, 8, and 17 extracted)
Number of valid cases	1173	1175	1179
Mean	17,586	16,894	16,446
Standard deviation	4,699	4,595	4,496
Minimum value	3	3	3
Maximum value	30	28	27
First eigenvalue of correlation matrix and percentage of total variance	4,18140 (13,938%)	4,16869 (14,888%)	4,14685 (15,359%)
Average inter-item correlation	0,099	0,111	0,114
Cronbach's alpha coefficient of reliability	0,757	0,764	0,766
Standardized Cronbach's alpha coefficient	0,767	0,776	0,777

To obtain the value of internal consistency coefficient of 0,80, the scale should be extended to 35 items, with average inter-item correlation of 0,11; for the alpha coefficient of 0,85, scale should consist of 49 items.

Conclusion

It can be concluded that reliability and other metric properties of presented versions of GKS scale are acceptable. The scale in 27-item version can be useful when it is important that a scale is as short as possible. The next step in developing GKS scale should be forming the extended version, to ensure higher reliability.

References

1. Irwing P, Cammock T, Lynn R (2001). Some evidence for the existence of a general factor of semantic memory and its components. Personality and Individual Differences. 30: 857-871.
2. Lynn, R., Irwing, P. & Cammock, T. (2002). Sex differences in general knowledge. Intelligence. 30: 27-39.
3. Lynn, R., Ivanec R. & Zarevski, P. (2009). Sex differences in general knowledge domains. Collegium Antropologicum (33) 2: 515-520.
4. Prot, F. (2002). The structure of sport interests of children. In R. Pišot, V. Štemberger, F.Krpa & T. Filipi (Eds.), *Proceeding book of 2nd International Science and Expert Symposium, Ljubljana, 2002, "A Child In Motion"* (pp.43-45). Ljubljana: Faculty of Education, University of Ljubljana.

5. Zarevski, P. (2001). Test opće informiranosti - 2001. Odsjek za psihologiju. Zagreb: Filozofski fakultet.
6. Zarevski, P., Ivanec, D. & Matešić, K. (2015). Why, when and how to use general knowledge tests? Suvremena psihologija. 2: 211-217.
7. Zarevski, P., Ivanec, D., Zarevski, Z., & Lynn, R. (2007). Gender differences in general knowledge: Four Croatian studies. Suvremena psihologija, 10, 213-221.
8. Zarevski, P., Kovač, M. & Matešić, K. (2014). Gender differences in general knowledge: Do residential status and the type of school matter? Review of Psychology, (21) 2: 131-135.
9. Zarevski,P., Kujundžić, S. & Lasić, A. (2002). Opća informiranost pripadnika različitih socio-demografskih skupina. Revija za sociologiju. (33) 3-4: 159-168.

AMPUTEE GAIT SYMMETRY ANALYSIS WITH ANKLE HEIGHT W.R.T. SHANK ORIENTATION DURING STANCE PHASE

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Purpose: Most of lower limb amputees are using energy storage and return(ESR) foot after 21st century. The flexural stiffness of ESR foot is very important because it generates ankle joint flexion movement. There is no methodology to define appropriate stiffness during stance phase of gait for designing of prosthetic foot. We suggest a methodology to evaluate flexural stiffness during stance phase applicable to design.

Methods: The relation between ankle height and shank orientation (AHSO) during stance phase is describing a dynamic stiffness of foot intuitively because the method of mechanical test for evaluating stiffness of foot is almost same as AHSO relation. We evaluated AHSO curves of an amputee gait with eight prosthetic feet. AHSO relations of amputee side are compared with sound sides.

Results: Shape of AHSO curve is similar with that of rollover curve. It represents three characteristics: forefoot stiffness, heel stiffness, shank angle range of stationary ankle height. Three prosthetic feet; KorecLP, Pacifica, and Renegade showed more symmetric results in three characteristics relatively when calibrating shank angle offset. KorecSP2, KorecSA and Elite showed differences in forefoot stiffness. KorecLK and KorecSP showed differences in heel stiffness. KorecSA, KorecSP, and KorecLK showed that the shank angle range of stationary ankle height of amputee sides have bigger than that of sound sides.

Conclusions: AHSO relations of different prosthetic feet are analyzed and it represent various characteristics of feet. Pacifica feet showed best results in symmetry but it was corresponded to the individual participated. The statistical analysis of AHSO relation of normal will be very useful in prosthetic foot design due to the AHSO relation is applicable to the mechanical test directly.

Research Methodology

Acknowledgement

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References

1. Hansen, A. H., D. S. Childress, and E. H. Knox. “Prosthetic foot roll–over shapes with implications for alignment of trans–tibial prostheses.” Prosthetics and Orthotics International 24.3 (2000): 205-215.

RELATIONSHIPS BETWEEN LEG MUSCLE FIBER TYPE DISTRIBUTION AND MOTORIC PERFORMANCES

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Purpose: The aim of the current study was to examine relationship between leg muscle fiber type distribution and motoric performances.

Methods: Twenty-three active physical education students (age: 21.47±2.52 years, body mass: 72.31±10.87 kg, height 175.13±5.92 cm body mass index: 23.80±3.94, and body fat: 13.67±6.83) volunteered to participate in this research.

Results: The 30m performance was negatively correlated to (r=-.596, p=.003) and countermovement jump performance (CMJ) was positively correlated to (r=.588, p=.003) % fast twitch (FT) leg muscle fibers distribution for the participants. Also, there is statistically significant correlation The Yo Yo-1 recovery test performance was positively correlated to (r=.303, p=.160) and VO_{2max} values was positively correlated to (r=.303, p=.159) % slow twitch (ST) leg muscle fibers distribution for the participants. However, this level of correlation was not statistically significant. Lastly, wingate anaerobic peak torque performance was negatively correlated to (r=.-127, p=.564) %FT leg muscle fibers distribution for the participants.

Conclusion: In accordance with prior researches, we found correlation between the %FT leg muscle fiber distribution and CMJ, 30m sprint performance. In addition, a positive correlation was present between Yo Yo-1 recovery test performance, VO_{2max} values and %ST leg muscle fiber distribution. As has been demonstrated often, the two primary muscle fiber types in human skeletal muscle have different metabolic pathways as well as several neuromotoric control mechanism. A possible explanation for such a different metabolic patways could be partly explain the significance of FT fibers in sprint (1,2) and strength type activities (such as CMJ) and ST fibers in endurance tasks (3).

References

1. Bar-Or O., Dotan R., Inbar O., Rothstein A., Karlsson J., Tesch P. Anaerobic capacity and muscle fiber type distribution in man. mt J Sports Med 1: 89-92, 1980.
2. Komi P.V., Rusko H., Vos J., Vihko V. Anaerobic performance capacity in athletes. Acta Physiol Scand 100: 107-114, 1977.
3. Bergh U., Thorstensson A., Sjödin B., Hulain B., Piehi K., Karlsson J. Maximal oxygen uptake and muscle fiber types in trained and untrained humans. Med Sci Sports 10: 151-154, 1978.

ON THE SEGMENTATION OF SCANNED 3D HUMAN BODY MODELS

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Analysing the human body in three-dimensional (3D) space is becoming more and more popu-lar due to the large number of available 3D scanning solutions. Using 3D body models enables detection of many different body parameters which cannot be assessed using 2D images only. Once a 3D body model is generated, it is usually segmented so that specific body parts can be further analysed. In this paper we propose a new approach to the segmentation of the human body. Our anthropometry-based approach can successfully segment various body-types into six main segments – head, torso, left and right arm, and left and right leg. The proposed method has been tested successfully on standard benchmark models and on 3D point cloud data acquired from a low-cost 3D scanner.

Key words: *anthropometry, human body segmentation, SL scanning system*

Introduction

Advances in 3D scanning technologies for the purpose of creating a human 3D body model give us the possibility of analysing the human body in its true three-dimensional form. Observing all three dimensions, instead of only two, enables better automatic anthropometric measurements, detection of changes in the body shape, pose estimation, etc.

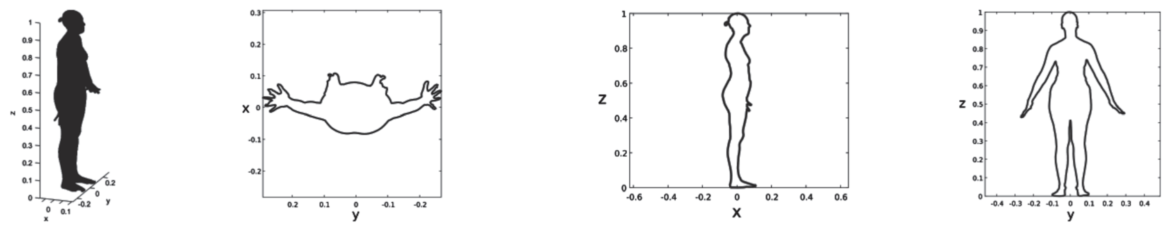
Several types of imaging techniques can be used in 3D full body scanning systems. The most popular are laser line (LL) and structured light (SL) systems, but multi-view camera systems and millimetre waves are also used in specific cases (Daanen and Ter Haar, 2013). LL scanners and SL scanners can both give an accurate and dense 3D reconstruction, but laser-based scanning time is usually above ten seconds while SL systems (the approach we used) can acquire data in only a few seconds, depending on the system setup (Petković et al, 2016). The shorter data acquisition time is advantageous for individuals who have difficulty in standing still. Often 3D full body scanners are used for anthropometric measurements which may be used in a wide range of applications, for example in medicine (Giachetti et al., 2015), sport (Daanen et al., 2016), and in the garment industry (JoonWoo et al., 2014). The scanners also have applications in kinematic movement analysis (Mahnić et al., 2014). In many of these applications the measurements must be on specific parts of the human body and thus the acquired data must be segmented into the different body parts.

There are two main approaches in human body segmentation (Werghi, 2007). The first approach is for segmentation of the body in an arbitrary posture and is usually done using feature extraction techniques, clustering or fuzzy logic. The second approach deals with models in a standing position with arms and legs slightly separated from the body, and here the segmenta-tion is usually based on anthropometric information and/or topological analysis.

In this paper we use the second approach. We first explain our method of segmentation and then we apply it to some standard benchmark human body models downloaded from the inter-net. Subsequently we apply our method to data acquired using our own low-cost SL-based 3D scanning system.

Methods

We propose an approach that segments the human body into six body parts – head, torso, left arm, right arm, left leg and right leg – and which is based on the analysis of the anthropometric body characteristics. Due to a possible misalignment of the scanning system and the scanned human body, the first step is aligning the 3D model with an appropriate coordinate system using the first three principal component vectors calculated using PCA (principal component analysis) of the point cloud. A coordinate system aligned with these vectors is chosen such that the x-axis is positive running from posterior to anterior, the *y*-axis from right hand to left hand, and the z-axis from the feet to the head. The origin of the coordinate system is on the horizontal plane through the soles of the feet (the lowest point of the body) and at a point directly below the centre of mass of the body. The model is isotropically scaled so the maximum height is normalized to 1 (Fig. 1a). Then the body can be divided into the required sections by employing anthropometric knowledge about ratios of body parts and total height. In the segmentation process we use body projections in 2D planes (Fig. 1b-d) but we combine those 2D projections to obtain the final segmentation in 3D space.



(a) 3D body model *(b) yx-plane projection* *(c) xz-plane projection* *(d) yz-plane projection*

Figure 1: Human body model in the chosen coordinate system (a) and contours of its 2D projections (b-d).

The head is segmented in the *yz*-plane. We modified the approach used by Wen et al. (2012). We observe the top 25% of the body, i.e. the interval z=[0.75,1] on the normalized model in the chosen coordinate system. By taking a horizontal cross-section at z=0.95 of the body contour in the *yz*-projection plane, two auxiliary points on the head section are created: *TR* (top-right) and *TL* (top-left) as shown in Fig. 2. Points *TR* and *TL* are connected to another set of auxiliary points (*BR* and *BL*) which are located as the lowest points of the observed contour section. The neck points (*NR* and *NL*) which are used to segment the head and neck from the rest of the body are determined as the contour points that are farthest (in the corresponding body side) from the *TR-BR* and *TL-BL* lines respectively. Approximations of the acromion points (*AR* and *AL*) are determined as the points that are farthest (in the corresponding body side) from the *BR-NR* and *BL-NL* lines respectively. These approximations of the acromion points will be used later for the separation of the arms from the torso.

The armpit points are detected in the *yz*-plane projection following the approach proposed by Wen et al. (2012). For the complete segmentation of the arms we propose using *yx*-projections of the body to define segmentation lines that separate the arms from the torso. Starting from the contour slice at z=0.9 and using a slice step Δ=–0.005, we analyse the contours of each slice between z=0.9 and z=0.35. Let $c(x, y)$ be the contour function of the observed slice. We propose using an *indicator function* (y): $f(y) = \begin{cases} 1, \exists x \ c(x,y) = 1 \\ 0, \textit{otherwise} \end{cases}$. The section of the indicator function that is equal to zero is the section where the arm is separated from the torso. The middle point of that section is used as the "arm separation point" at the observed slice. Final lines that separate the arms from the torso are the lines that connect arm separation points for each arm across all observed slices combined with the lines that connect the armpit points and the acromion points (Fig. 3).

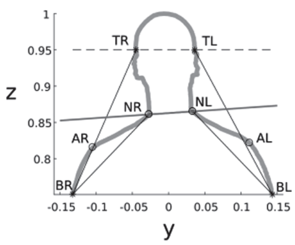


Figure 2: Segmentation of the head from the torso.

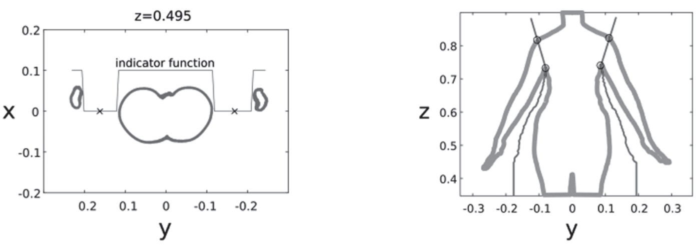


Figure 3: Segmentation of arms. Left: An example of the indicator function. Right: Final segmentation of arms.

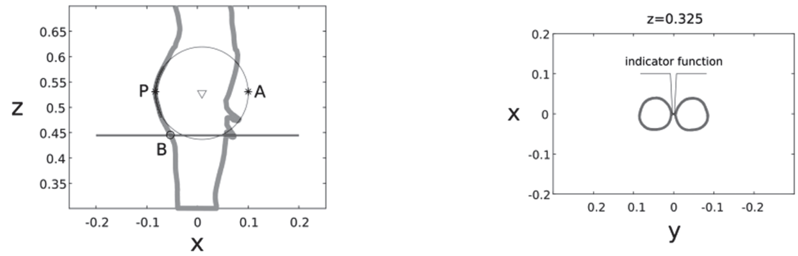


Figure 4: Segmentation of legs using analyses in the (a) xz-projection plane and in the (b) yx-projection plane.

Segmentation of the legs is carried out by analysing *xz*- and *yx*-projection planes of the body segment in the interval z=[0.3,0.7] (Fig. 4a). In the *xz*-projection plane the legs are separated from the torso using the modified approach of Wen et al. (2012): first the most protuberant posterior point (*P*) on the contour is located and then a circle is fitted through a set of its neighbouring points (in the interval ±5% of body height from the point *P*), using the least mean squares method. On the fitted circle, we create a virtual anterior point *A* such that ($\overline{AP}$) is the circle diameter. All contour points below the point *P* are candidates for the final segmentation point that separates legs from the torso. We search for the point that represents the lowest point of the bottom. It, (point *B*), can be found as the point on the outline that is below point *P* and is closest to the virtual point *A* on the fitted circle. For the separation of the left and the right leg we again propose using an indicator function *f* and projections of the body slices in the *yx*-projection plane. The indicator function can be considered a code word if we replace all consecutive repeating zeros with the code '0', and all consecutive repeating ones with the code '1'. The code word is then evaluated. starting from the slice at z=0.7 where the code word is '10101' (because arms are separated from the torso due to the required standing position) and moving downwards using a slice step Δ=–0.005, until the indicator function eventually gives a code word of '101'. The midpoint of the first section where the code word of the indicator function becomes '101' represents the crotch point. By combining the separation points in the *xz*- and *yx*-projection planes, 3D planes for the separation of the legs from the torso are determined.

Results

We first tested the proposed segmentation method on seven models from the 3D mesh segmentation benchmark (Chen et al., 2009) which met the requirement for an upright standing posture with arms and legs slightly apart. Fig. 5 shows that the segmentation for all seven models was successful.

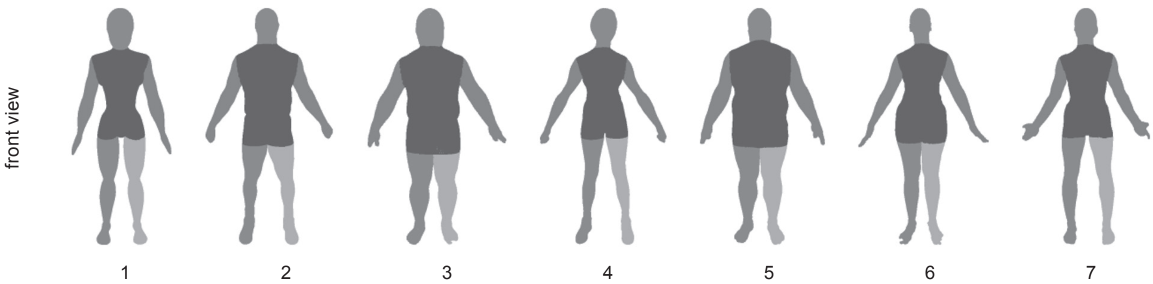
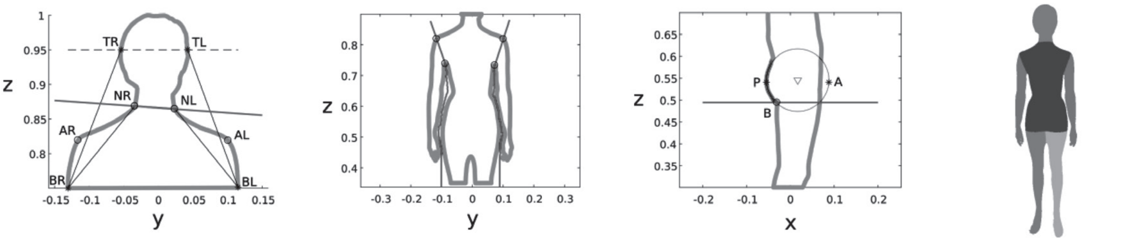


Figure 5: Front views of seven successfully segmented models from the (Chen et al., 2009) benchmark.



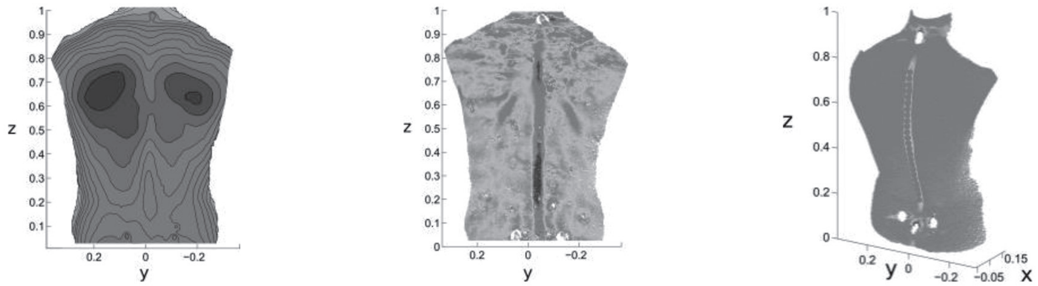
(a) head segmentation *(b) arms segmentation* *(c) legs segmentation* *(d) front view*

Figure 6: An example of the body segmetation for the mannequin model reconstructed using SL system (a-c) and the final segmentation from the front view (d).

We then used a SL system as a low-cost 3D scanning solution for obtaining a 3D reconstruction of a mannequin. Such a system requires only a projector and a camera which are calibrated. The projector shines a coded pattern onto the object surface and that projection is captured using the camera. After decoding the pattern on the captured image (or images), a triangulation method is used for computing 3D positions of the surface. In this work, we used a time multiplexing SL strategy using a pattern that is a combination of sinusoidal fringes and Gray code. This approach is a good choice when the object of interest is static and a dense 3D reconstruction is required. Our SL system is comprised of a DLP projector (Acer S1383WHne) and two cameras (PointGray Grasshopper3 23S6C) with Kowa LM8JCM lenses. The projector and cameras were mounted on a vertical pole with the top camera capturing the upper body, and the bottom camera the lower body. We were limited to only one scanning pole but by moving the pole around the mannequin and taking multiple scans, we obtained a full 3D body scan. The acquired point cloud was post-processed; it was first filtered in order to remove outliers and background points and then a Poisson surface reconstruction using MeshLab (Cignoni et al., 2008) was performed to ensure a uniform quality and point density. This data was then successfully segmented using our developed method. Fig. 6 shows the main segmentation steps (a-c) and the resulting body segmentation (d) of the reconstructed 3D mannequin model.

Discussion

The proposed approach for the body segmentation is based on analysis of the 3D body model using a basic a-priori anthropometric knowledge of the human body. Our method uses anthropometric information to determine which part of the full 3D body model (i.e. which intervals of the -axis) should be analysed in order to segment a head, torso, arms and legs. Those intervals are chosen to be rather wide but even so the segmentation remained successful. Figs. 5 and 6 demonstrate that the proposed segmentation is successful for various body types, both on standard benchmark models and on data acquired with a low-cost scanner. A drawback of our approach is its sensitivity to outliers and the quality of the 3D reconstruction. This problem is usually avoided by using a high quality scanner, a good filtering and an adequate mesh (or point cloud) reconstruction. Some approaches (Han and Nam, 2011) successfully deal with the problem and correct the detected feature points (such as crotch and armpit points), if necessary, by conducting additional analysis and considering other shape characteristics of the arms and legs. Successful body segmentation allows further body analysis to be performed – segmented arms or legs can be individually used to calculate muscle circumference; a torso can be used to compute the waist circumference, or to analyse back shape and posture as shown in Figure 7.



(a) *(b)* *(c)*

Figure 7: An example of the back shape analysis using a segmented torso. (a) Posterior torso depth map. (b) Back shape curvature analysis (mean curvature). (c) Detection of the spinal midline.

Conclusion

In this paper we have presented an approach to 3D human body segmentation based on anthropometric information in order to segment a full 3D body model into six parts: head, torso, left and right arm, and left and right leg. We have shown that the proposed method successfully segments various body-types as long as the person is in standing position with arms and legs slightly separated. Also we have shown that there is no need for expensive LL scanners which are often used in the garment industry; a simple SL system using off-the-shelf components gives accurate and adequate 3D body reconstructions which can also be successfully segmented. After this basic body segmentation step, segmented parts can additionally be used for more detailed segmentation or for specific body-part analysis.

Acknowledgements

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References

1. Chen, X. et al. (2009). A Benchmark for 3D Mesh Segmentation. *ACM Trans. Graph.,* 28(3).
2. Cignoni, M. et al. (2008). Meshlab: An open-source mesh processing tool. *In Eurographics Italian Chapter Conference*, pp. 129-136.
3. Daanen, H.A.M. and Ter Haar, F.B. (2013). 3D whole body scanners revisited, *Displays*, 34(4), pp.270-275.
4. Daanen, H.A.M. et al. (2016). Changes in the Volume and Circumference of the Torso, Leg and Arm after Cycling in the Heat Determined Using 3D Whole Body Scanners. *In Proc. of 7th Int. Conf. on 3D Body Scanning Technologies*, pp. 45-53.
5. Giachetti, A. et al. (2015). Robust Automatic Measurement of 3D Scanned Models for the Human Body Fat Estimation. *In IEEE J. Biomed. Health Inform.*, 19(2), pp. 660-667.
6. Han, H. and Nam, Y. (2011). Automatic body landmark identification for various body figures. *Int. Journal of Industrial Ergonomics*, 41(6), pp. 592-606.
7. Mahnić, M. et al. (2014). Comparative Analysis and Adjustments of Anthropometric Parameters on System for Kinematic Movement Analysis and 3D Body Scanner. *Proceedings of 7th International Scientific Conference on Kinesiology*, pp. 165-169.
8. Petković, T. et al. (2016). Software Synchronization of Projector and Camera for Structured Light 3D Body Scanning. *In Proc. of Int. Conf. on 3D Body Scanning Technologies*, pp. 286-295.
9. Wen, Z. et al. (2012). Study on Segmentation of 3D Human Body Based on Point Cloud Data. *Second Int. Conf. on Intelligent System Design and Engineering Application*, pp. 657-660.
10. Werghi, N. (2007). Segmentation and Modeling of Full Human Body Shape From 3-D Scan Data: A Survey. *In IEEE Trans. Syst., Man, Cybern., Part C*, 37(6), pp. 1122-1136.
11. JoonWoo, J. et al. (2014). Automatic human body segmentation based on feature extraction. *International Journal of Clothing Science and Technology*, 26(1), pp. 4-24.

AN ANALYSIS OF THE JUDGING CRITERIA IN RHYTHMIC GYMNASTICS

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Abstract

To reach the highest objectivity obtainable, FIGs Technical Committee changes the grade assigning rules every four years, rules concerning levels of complexity when putting together exercises (choreography), the number of judges in a single judge's committee or the number of judges committees.

I this experiment data used for the purpose of this research are the official results of Croatian Individual Championship held in 2016, in the category of junior cadets. All five judges' assessments were used as well as three judges whose assessments were left after the deduction of the lowest and highest grade (by standard procedure), for the assessment of how demanding the free compositions without apparatus, rope, ball and hoop, were.

Metric characteristics of the judges were calculated based on the grades on 23 gymnasts in an exercise without apparatus, 18 gymnasts in a rope exercise, 18 in an exercise with the ball, and 21 gymnasts in an exercise with the hoop.

It is concluded that the grades assigned by judges D2, D5 and D3 most often the three grades based on which a final grade for each exercise is calculated. However, when noticing correlation values of judges with the final results, the judges that correlate the most are D2, D3 and D4, which is a more realistic indicator of the grades they assigned and the final ranking matching.

Keywords: *rhythmic gymnastics, judging, evaluation*

Introduction

The issue of assessment in rhythmic gymnastics (RG) can be observed in two directions. The first one is an evaluation of the forming of judging committees with a set competency framework, and the second the evaluation of technical requirements, choreography ideas, musical accompaniment as well as apparatus. Since the establishment of rhythmic gymnastics, i.e. since the first official competition in 1963. to the present day, the FIG Technical Committee provides a Rule Book in which the question of the assessment of competitive teams is formally regulated. However, the objectivity of said assessment has been brought into question since the very beginning. (Ste-Marie, D.M. 2000, Seltzer and Glass, 1991)

Successful performance of an individual competitive composition depends on the valid and in effect rule book put together by the International Gymnastics Federation (FIG), judicial assessment, the degree of the gymnasts preparedness and on the contemporary sports trends. (Jastrembskaia, N., Titov, Y., 1999)

In its first official Rule Book, every judge graded the exercise on a scale from 1-10 (Koturović, B., 1976). With this kind of assessment the subject of the evaluation was whether one competitor was better than the other according to a subjective grade by the judges, and the results of the competition only had the form of a ranking scale, which only showed the order of the competitors and not the difference in quality of their performances. (Wolf-Cvitak, J., 2004). As rhythmic gymnastics evolved, the assessment system changed and adjusted, too. Up until 1985, judges graded with 1-10 grades when a distribution of grades was introduced – it was divided into composition (7 points) and performance (3 points). Within the 7 points judges assessed the number and value of difficulty elements, technical value of the composition, originality within new elements or the relation between them, and within the 3 points judges assessed general impression that the gymnast leaves with the amplitude of her movement, elegance, coordination, confidence, how dynamic the performance is, expression and individuality. This assessment style favored gymnasts whose exercises contain more difficulty elements and the quality of it, while gymnasts with an evident individuality and exercising aesthetic achieved more modest results in competitions. To make the assessment process as objective as possible, FIG orders a mandatory licensing process for judges, as well as sanctioning those who assess poorly, in a way that is not objective or biased. Such judges could be expelled from the competition.

The Rule Book that was in effect until the start of 2017, ordered rules as to bring back judges committees in two groups of judges: judges assessing difficulty and judges assessing performance, in relation to that the maximum final grade for one exercise is 20. Difficulty exercises (D) consist of body exercises, dancing steps combination, dynamic elements containing rotation and ejection – DER (earlier referred to as risk) and prop mastery. Body exercises (jumps, rotations, balancing) are represented minimum 2 and maximum 4 from each group. Fundamental and other technical groups are defined. Judges D assess according to a form containing difficulty exercises in the ordered in which they are being performed at the competition. Performance judges assess errors of artfulness and of performance. With this Rule Book gymnasts are forced to perform an exercise full of isolated and combined elements of difficulty, elements of DER and mastery.

Also, which is especially true for younger categories, an emphasis is put on so called dance elements that were introduced in order to give this dimension in the choreography idea more of an impact and to reintroduce dancing to rhythmic gymnastics.

Methods

Data used for the purpose of this research are the official results of Croatian Individual Championship held in 2016, in the category of junior cadets. All five judges' assessments were used as well as three judges whose assessments were left after the deduction of the lowest and highest grade (by standard procedure), for the assessment of how demanding the free compositions without apparatus, rope, ball and hoop, were.

Metric characteristics of the judges were calculated based on the grades on 23 gymnasts in an exercise without props, 18 gymnasts in a jumping rope exercise, 18 in an exercise with the ball, and 21 gymnasts in an exercise with the hoop.

Data was processed using Dell Statistica for Windows, version 13.

Results

Table 1: Descriptive Statistics 3 judges whose assessments the final result was calculated from

Variable	Mean	Min	Max	Range	Std.Dev.	Skewness	Kurtosis
Dx	2,241	0,600	3,800	3,200	0,670	0,063	-0,597
Dy	2,221	0,700	3,800	3,100	0,715	-0,050	-0,677
Dz	2,225	0,600	3,600	3,000	0,704	-0,010	-0,532

Dx, Dy, Dz - judges whose scores are entered into the final score, Mean - arithmetic mean, SD - standard deviation, Min - minimal value, Max - maximal value, Range - total range, Skewness - asymmetry distribution coefficient, Kurtosis - curvature distribution coefficient

By examining the descriptive statistics results calculated based on the grades given by three judges, whose grades were rank-defining for the competitors, it is evident that the grades ranged from the minimum 0,60 to the maximum 2,24. Indicators of grade distribution go on to show they have accumulated around the mean values, with a slight tendency towards higher results, while the measures of flatness indicate a mild heterogeneity of the grades.

Table 2: Descriptive Statistics all 5 judges

Variable	Mean	Min	Max	Range	Std.Dev.	Skewness	Kurtosis
D1	2,21	0,6	4	3,4	0,716	0,248	-0,461
D2	2,39	1,1	4,1	3	0,665	0,245	-0,558
D3	2,03	0,3	3,8	3,5	0,743	-0,009	-0,496
D4	2,18	0,6	3,8	3,2	0,839	-0,170	-0,843
D5	2,35	0,5	3,9	3,4	0,784	-0,119	-0,859

D1, D2, D3, D4, D5-judges, Mean - arithmetic mean, SD - standard deviation, Min - minimal value, Max - maximal value, Range - total range, Skewness - asymmetry distribution coefficient, Kurtosis - curvature distribution coefficient

By examining the descriptive statistics results calculated based on the grades given by three judges, it is evident that grades for D went between the minimum 0,30 and maximum 2,39. Indicators of grade distribution here also show they have accumulated around the mean values, with a slight tendency towards higher results, while the measures of flatness indicate a mild heterogeneity of the grades.

Table 3: Frequency rating of judges

Variable	Valid N
D1	40
D2	53
D3	48
D4	46
D5	53

Based on the results of all the judges' grades frequencies, it can be observed that grades given by judges D2, D5 and D3 most often made the three grades based on which each exercises final grade was made.

Table 4: Correlations between all 5 judges; p<0,05

	DFIN(5)
D1	0,858575
D2	0,920466
D3	0,892032
D4	0,880947
D5	0,865237

Cronbach Alpha: 0,93; Standardized Alpha: 0,93; Average correlation: 0,73

Correlation results from all five judges indicate significant mutual correlations, although not high considering the specific nature of exercise assessment in rhythmic gymnastics.

Table 5: Correlations between all 5 judges; p<0,05

	DFIN
Dx	0,947686
Dy	0,957135
Dz	0,955921

Cronbach Alpha: 0,95; Standardized Alpha: 0,95; Average correlation: 0,86

By extracting three judges, whose assessments most often made it to the final result calculation, visible and somewhat higher correlations are visible.

Discussion

By examining the results of descriptive statistics (tables 1 and 2) it is evident that assessments from judges at the Croatian Championship for junior cadets in 2016, resided around the lower values (0,30-2,39). Considering that the highest grade for difficulty exercises (D) is 10, a very high grading criteria can be noticed. Considering the quality of rhythmic gymnastics in Croatia and that the analyzed grades were given at a junior cadet's competition, the overall results are satisfactory. Another issue is the correlation between two judges' evaluation of the difficulty of the exercise. Even though results show that all the judges correlations are significant (a correlation of 95%), this kind of distribution is not satisfactory. The correlation level should gravitate towards a value of 1, despite the fact that grades are assigned by a subjective assessment. But, to make the grades as objective as possible and abiding by the propositions ordered by the assessment Rule Book, grades for the same exercise shouldn't be this different.

From Table 3 it is concluded that the grades assigned by judges D2, D5 and D3 most often the three grades based on which a final grade for each exercise is calculated. However, when noticing correlation values of judges with the final results, the judges that correlate the most are D2, D3 and D4, which is a more realistic indicator of the grades they assigned and the final ranking matching.

The fact of the matter is that judges are most often former gymnasts and that they sometimes voluntarily assign a higher grade to a gymnast from their club (Wolf-Cvitak, 2004). This is what often causes a stop to the competition and requires grades to be adjusted based on the supreme judges' request. Sometimes faulty education and an insufficient judging experience are the reason for a bigger difference between two judges' grades. Unfortunately, that kind of practice contributes to a feeling of dissatisfaction in the competitors and their coaches, but also the reason why this sport isn't as popular as it might deserve. This is why the final grade is decided on by the principle of the highest and lowest grade combining so the final grade is the arithmetical middle of the remaining grades.

Conclusion

To reach the highest objectivity obtainable, FIGs Technical Committee changes the grade assigning rules every four years, rules concerning levels of complexity when putting together exercises (choreography), the number of judges in a single judge's committee or the number of judges committees. The newest Rule Book even orders judges from the same committee to settle on a final grade together. All these changes contribute to the fact that the human eye is not a perfect measuring device and that rhythmic gymnastics experts still haven't found and objective way to assess competitors in conventional sports. This is unfortunately the reason why rhythmic gymnastics, although an aesthetically attractive sport, still isn't a discipline a wider audience is too familiar with.

References

1. Brooks, T.J. (2003). Women's collegiate gymnastics: a multifactorial approach to training and conditioning. Journal of Strength and Conditioning Research, 25, 23-37.
2. Dell Inc. (2016). Dell Statistica (data analysis software system), version 13. software.dell.com.
3. Jastrembskaia, N., Titov, Y., (1999.) Rhythmic gymnastics. Human kinetics
4. Hume, P.A., Hopkins, W.G., Robinson, D.M., Robinson, S.M. & Hollongs, S.C. (1993). Predictors of attainment in rhythmicsportive gymnastics. Journal of Sports Medicine &Physical Fitness, 33, 367-377.
5. Hutchinson, M.R., Tremain, L., Christiansen, J., & Beitzel, J. (1998). Improving leaping ability in elite rhythmic gymnasts, Medicine & Science in Sports & Exercise, 30, 1543-1547.
6. Koturović, B., (1976). Ritmičko sportska gimnastika, pravilnik za ocjenjivanje, Gimastički savez Jugoslavije, Beograd.
7. Popović, R. (2000) Evaluation of rhythmic-sports gymnastics research achievements with special aspect on methodological problems. In: 2000 Pre-Olympic Congress International congress on Sport Science-Sports Medicine and Physical Education, (Australia), Brisbane
8. Radisavljević, L., Moskovljević, L., (2011). Osnove ritmike. U: Jevtić B., Radojević, J, Juhas, I., Ropret, R. (ur.) Dječiji sport – od prakse do akademske oblasti (str. 393-407), Beograd:Fakultet sporta i fizičkog vaspitanja
9. Seltzer, R., Glass. W. (1991). International politics and judging in Olympic skating events. Journal of Sport Behaviour, 14 (3).
10. Ste-Marie, D.M. (2000) Expertise in women's gymnastics judging; an observational approach. Perceptual and Motor Skills, 90 (2), 543-546.
11. Wolf – Cvitak, J. (2004). Problemi vrednovanja u ritmičkoj gimnastici. U V. Findak (ur.), Zbornik radova 13. ljetne škole kineziologa RH, Rovinj, 2004, (str. 343-350). Zagreb: Hrvatski kineziološki savez.

ABDOMINAL OBESITY IS A MAJOR DETERMINANT OF SARCOPENIA IN A TRANSNATIONAL POPULATION OF ACTIVE ELDERLY VOLUNTEERS

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Research Methodology

Purpose: Abdominal fat accumulation is associated with insulin resistance and low-grade systemic inflammation, leading to increased cardiovascular risk in obese and non-obese subjects. Recently, a new anthropometric index of visceral fat deposition (A Body Shape Index, ABSI), unrelated to BMI, has been developed.

Methods: 907 active elderly subjects (535 women, aged 66±5y; 371 men, aged 67±5y), who were able to walk, continuously without support, at least 2 km, participated to the PANGeA international epidemiological project. The following indices were evaluated: height, weight, abdominal circumference (AC), fat mass (FM) and fat-free mass (FFM) by bioimpedence, blood pressure, glycaemia, muscle strength (hand-grip) and cardiovascular fitness, as VO2max (cycle-ergometer or 2km-walking test). ABSI was calculated as $AC/(BMI^{2/3}\times height^{1/2})$. Linear regression analyses were performed by Pearson's correlation. $P<0.05$ was considered statistically significant

Results: ABSI was unrelated to BMI in both men and women. ABSI in man was negatively correlated with FFM ($R=-0.16$, $P<0.01$), muscle strength ($R=-0.17$, $P<0.01$) and VO2max ($R=-0.21$, $P<0.001$). In pooled subjects, ABSI directly correlated with systolic blood pressures ($R=0.09$, $P<0.01$) and glycaemia ($R=0.11$, $P<0.01$).

Conclusion: Abdominal fat accumulation is a key determinant of muscle mass, muscle strength, glycaemia, blood pressure and cardiovascular fitness, independently from total adiposity in active elderly subjects.

Acknowledgment

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BOW AND DRILL METHOD (OF FIRE IGNITION) - THE INFLUENCE OF MOISTURE CONTENT IN THE WOOD FROM WHICH MADE BASE AND DRILL ON THE SUCCESS AND ENERGY CONSUMPTION

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Abstract

The aim of this study is to determine the difference in the consumption of energy needed for start the fire with method bow and drill between the use of sets of equipment (base and drill) with low water content and a set of equipment with a higher water content in it. In accordance with the results of the t test, the hypothesis that energy consumption of starting the fire with bow and drill method will not be the same regardless of the humidity of the wood from which built elements of the set of equipment can be rejected. Start the fire with a set of equipment made of wood with a moisture content of 17% will require much more energy (and the outcome will be very doubtful) than start the fire with a set of equipment made of wood with a moisture content of 14.5%. These data suggest that in a situation of survival in nature, for creating a base and drill for method of bow and drill need to seek a tree with the lowest water content.

Key words: *survival in nature, method of ignition of fire, bow and drill, water content*

Introduction

Primitive methods of ignition fire provide kindling fire in all situations when the contemporary sources of ignition such as matches and lighters fail or are unavailable. These methods have been invented long ago in my past, and today, in certain circumstances, can be useful to professional soldiers, scientists, top and recreational sportsmen, campers, scouts, and all the people who find themselves in a situation of survival in nature. The primitive fire starting techniques will allow kindling fire in conditions when there is no possibility to apply modern methods, which can sometimes be crucial for the survival of man in nature. The earliest primitive fire starting methods are based on the friction of wooden surfaces. Friction is the resistance that occurs between the contact surface of two bodies and opposes their mutual movement, and as a result of this resistance, the kinetic energy is converted into heat. The result of friction between the wooden surfaces under high temperature spending wood from base and drill; wood is consumed and produced small charred wood shavings. At a certain temperature wood shavings ignite and create a smoldering embers; the fire lights the by transferring embers on a very combustible materials such as dry grass. Frictional methods can be divided into circular and translational; of circular friction methods are very well known and frequently used method of hand drill, bow drill and pump drill; of the translational method often used fire plow and fire saw. In the circular friction method one wooden body is stationary (base), while the other (drill) runs circular motion around its longitudinal axis. The aim of technique is human movement which produce more friction, and as a result a high temperature between the wooden surfaces. Most of the Indian tribes of North America by the method of hand and drill lit the fire in less than one minute, a tribe of Indians Apaches were known to be particularly effective of quick (Hough, 1890). American Indians Sioux among the first to begin using a bow for faster launch the drill (Hough, 1890). Method of bow and drill is one of the most effective methods of friction; if you make a quality set of equipment and respect the principles of the techniques, methods of bow and drill works in any climate, even in bad weather conditions. This method of kindling fire by friction differs from other techniques of friction in that the drill is not run both arms directly, but one hand and a bow with the string wrapped around drill; by starting the bow back and forth drill continuously runs at a much longer path and greater speed is possible. In addition, because of the pressure to the drill it is possible to produce a higher friction. To apply this method of ignition-fire is necessary to create a set of equipment with all elements. The main elements of the sets are drill, base and bow with string. The base is motionless body cuboid thick 0.5-1.5 cm, a width of about 3-5 cm and length of about 15-30 cm. Drill bit moving body is shaped like truncated-conical, the diameter of about 1.5 to 2.5 cm at one end, about 1.0 to 1.5 in the second, and the length of about 20-25 cm. Drill bit and the base is usually made of the same wood species, which should be dry (12-15% water), must not contain resin and should be relatively soft, or small mass density. Good wood for drill and bases are willow, poplar, ivy, alder, linden tree, elder, sycamore and other types of wood with a mass density of 400-600 kg/m^3. An important element of the set of equipment is the bow length of 50-70 cm with string. A bow can be made of any sufficiently solid wood (no elastic). Although it may be flat, the better it is at least slightly curved; this allows better control of drill. Bearing drill or drill holder is the also an essential piece of equipment; without him it would not be possible to control the drill in position during operation, or ensure a sufficiently large friction between the wooden surfaces exert pressure on the drill; drill holder is made of hard wood, bone or stone.

Primitive methods of lighting fire require selection of a suitable type of wood, and making individual elements of the set (base, drill, bow, string), the application of certain techniques and energy-demanding physical effort. The wood used for the production of elements of the set must not be wet; preferably to not more than 14-15% of water in itself. Due to the application of these techniques in real survival situation would be important to know whether it is possible to light a fire with wood that contains a significant amount of water in it and whether energy consumption justifies such an attempt. The aim of this study is to determine the difference in the consumption of energy needed for start the fire with method bow and drill between the use of sets of equipment (base and drill) with low water content and a set of equipment with a higher water content in it.

Methods

The study included one moderately active male subject aged 49 years. Examinee was healthy, without injuries or illnesses that could affect the implementation of the experiment. The entities of this research are attempts that were created by alternating repetition of work with the base of the drill bit lower moisture content and work with the database and drill more moisture content, alternately, on the same day, with plenty of long pauses in which there has been a complete recovery; seven attempts with a base and drill lower moisture content and seven attempts with base and drill with higher moist. Sets of equipment are made of wood types White willow (lat. Salix alba). Bases and drill bits that were used were identical in size; looking dimensions 4x25 cm, thickness 15 mm and diameter 20 mm drill bit at one end and 12 mm at the other end, and length 25 cm. The wood from which it is made one set of equipment was 14.5% of water in it, and the wood from which it was made the second set of equipment was about 16% of water in it. The work is implemented so that the subject with technique bow drill tried to produce a sufficient amount of wood shavings to fill the groove on the base and then the maximum possible temperature that could ignited wood chips, creating an ember. Examinee is performed the test alternately until it filled estimated number of attempts. Between the of attempts respondent are given breaks to full recovery. The surface temperature of the produced wood shavings was measured by a laser temperature sensor. The variables of this research are:

- temperature of the wood shavings achieved in the bow drill with a set of lower moisture content (TEMP1)
- temperature of the wood shavings achieved in the bow drill with a set of higher moisture content (TEMP2)
- time spent on the maximum temperature with a set of equipment of lower moisture content (TIME1)
- time spent on the maximum temperature with a set of equipment of higher moisture content (TIME2)
- maximum heart rate in the bow drill with a set of equipment of lower moisture content (HRmax1)
- maximum heart rate in the bow drill with a set of equipment of higher moisture content (HRmax2)
- energy consumption in the bow drill with a set of equipment of lower moisture content (EC1)
- energy consumption in the bow drill with a set of equipment of higher moisture content (EC2)

Calculation of energy consumption was performed based on the value of the average heart rate, duration of activity, and the age and weight of the respondents, the equation to calculate the energy consumption during submaximal exercise intensity that is derived by Keytela and associates (Keytel et al., 2005th). The relationship between heart rate and energy consumption is not considered to be reliable under exercise intensity that is less than 41% of VO2max, respectively, which is less than 64% of maximum heart rate (Swan et al., 1998th). To test the hypothesis using the t-test for paired samples package for statistical data processing STATISTICA 7. Acceptance threshold hypothesis was $p < 0.05$.

Results

Table 1 shows the values obtained for each variable.

Table 1: The value of the particular attempts to variables TEMP1 (°C), TEMP2 (°C), TIME1 (s), TIME2 (s), HRmax1, HRmax2, EC1 (Kcal) i EC2 (Kcal)

Attempt	TEMP1	TEMP2	TIME1	TIME2	HRmax1	HRmax2	EC1	EC2
1	259	163	17	33	121	143	10	14
2	264	154	26	48	124	127	6	12
3	266	164	19	41	124	146	8	13
4	260	161	22	44	125	141	11	13
5	257	150	18	46	120	140	8	12
6	259	157	22	51	117	134	7	14
7	261	155	25	49	122	142	9	15
MEAN	260,85	157,71	21,28	44,57	121,85	139,00	8,42	13,29

Table 2 shows the descriptive statistics of the original data

Table 2: Descriptive statistics of the original data

Variable	Descriptive Statistics (Spreadsheet1)				
	Valid N	Mean	Minimum	Maximum	Std.Dev.
TEMP1	7	260,85	257	266	3,13
TEMP2	7	157,71	150	164	5,15
TIME1	7	21,28	17	26	3,45
TIME2	7	44,57	33	51	6,07
HRmax1	7	121,85	117	125	2,79
HRmax2	7	139,00	127	146	6,42
EC1	7	8,42	6	11	1,71
EC2	7	13,29	12	15	1,11

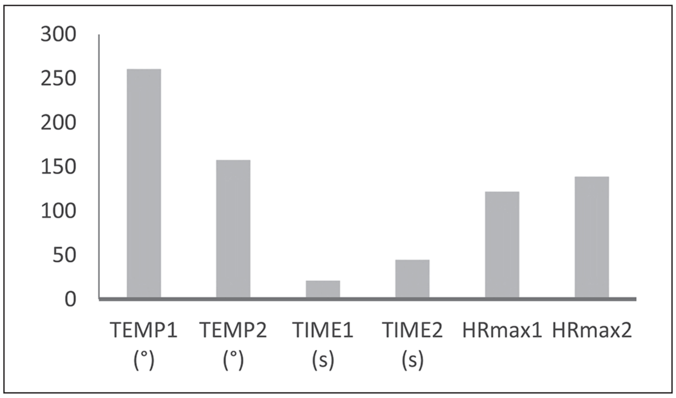
After the data obtained for heart rate and energy expenditure was carried out t-test for paired samples. T-test for variables EC1 and EC2 are shown in Table 3.

Table 3: Results of t-test for varialble EC1 and EC2

Variable	T-test for Dependent Samples (Spreadsheet2) Marked differences are significant at p < ,05000									
	Mean	Std.Dv.	N	Diff.	Std.Dv. Diff.	t	df	p	Confidence -95,000%	Confidence +95,000%
EC1	8,42857	1,718249								
EC2	13,28571	1,112697	7	-4,85714	1,676163	-7,66679	6	0,000257	-6,40734	-3,30695

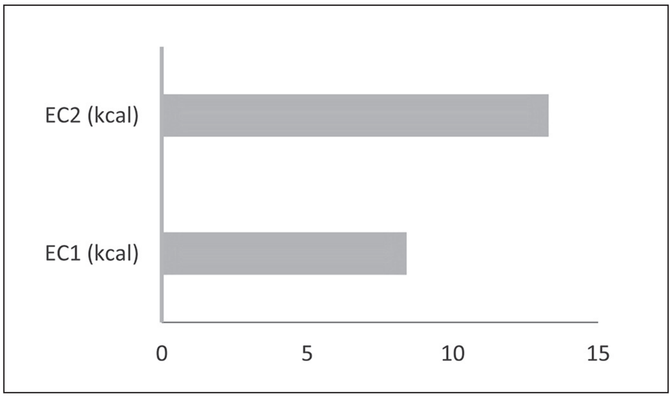
Discussion

In all attempts with set of equipment with lower a moisture content created the an ember. In any attempt with set of equipment with higher moisture content is not created an ember. Original data suggest that the required temperature of wood shavings, to create an ember is about 260°C, measured at the surface of the wood shavings. Original data suggest that it is possible to do in a fairly short period of time, an average of 21.28 seconds, and in a single attempt even just for 17 seconds. The effort that such an attempt requires is not too big, which indicates the value of the pulse, from an average of 121.85 seconds, and energy consumption, an average of 8.42 kcal. These differences are shown in the graph 1.



Graph 1: Differences in temperature, time, maximum pulse achieved in working with different sets of equipment

Descriptive statistics shows that the higher the temperature was achieved with the elements set made of wood with a lower water content; 260,85°C with a set made of wood with lower moisture content and 157,71°C with a set made of wood higher moisture content. The time spent on the operation of the drill bit with a base made of wood moisture content was higher is double the length; 44.57 seconds with a set made of wood with a greater amount of water compared to 21.28 with a base and drill bit made of wood with less water. Descriptive statistics of data shows that the efforts made in start the fire with a set of of equipment made of wood with a higher water content was significantly higher; maximum achieved value of the pulse with a set of wood with with higher water content has reached 139, and the maximum value of the pulse with a set of dry wood has reached 121.85.



Graph 2: Graphic shows the energy consumption in working with different sets of equipment

Energy consumption with a set of of equipment made of wood with lower water content was significantly lower; 8.42 Kcal during work with equipment made of dry wood compared to 13.29 Kcal with equipment made of wet wood. These data are shown in the graph 2. In accordance with the results of the t test, the hypothesis can be rejected; energy consumption of starting the fire with bow and drill method will not be the same regardless of the humidity of the wood from which built elements of the set of equipment.

Conclusion

Start the fire with a set of equipment made of wood with a moisture content of 17% will require much more energy (and the outcome will be very doubtful) than start the fire with a set of equipment made of wood with a moisture content of 14.5%. These data suggest that in a situation of survival in nature, for creating a base and drill for method of bow and drill need to seek a tree with the lowest water content. Set of equipment made of wood with low water content will surely supply the embers, and energy consumption in operation will be significantly lower. For higher quality information is necessary to continue research and try to determine which is the maximum water content in the wood of which shall be built base and drill, allowed to technique produced embers, with a reasonable time spent and consumption of energy. Also it would be interesting to examine the possibilities with different types of wood and sets of equipment of various sizes.

References

1. Blakenship, B., Blakenship, R (1986) Earth Knack – Stone Age Skills for the 21st Century. Gibs Smith Publisher, Salt Lake City.
2. Brace Loring C. (1995). The Stages of Human Evolution. Upper Saddle River, NJ: Prentice Hall.
3. James Steven R. (1989). Hominid Use of Fire in the Lower and Middle Pleistocene: A Review of the Evidence. Current Anthropology, 30: 1-26.
4. Keytel, L.R., Goedecke, J.H., Noakes, T.D., Hiiloskorpi, H., Laukkanen, R., van der Merwe, L., Lambert, E.V. (2005) Prediction of energy expenditure from heart monitoring during submaximal exercise. Journal od sport science. 2005, Mar, 23(3):289-97.
5. Walter Hugh (1890) Fire making apparatus in the U.S. National Musem. U.S. National Museum, 1890.

NEW APPROACH TO HEPTATHLON SCORING

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Abstract

Scoring system of the heptathlon disciplines is lately subject of extended debates about their fairness and validity. The issue is based on a noticeably larger progressive steering and rewarding results in some disciplines and defers others. Difficulties arise from principle of progressive value of the scoring interval, trade-off between the disciplines scores and the non-additivity of the events in the aggregation process. The aim of this study is presentation of new scoring methods (incremental scoring system). Scoring results and function of the (new) incremental scoring system are compared with current scoring system using IAAF heptathlon data the WC, OG, WJC, WYC between 1997 and 2014 and 500 random generated.

Current scoring system in heptathlon has a strong influence on the heptathletes preparation and training, which means that competitions are already shaded by the scoring philosophy. To avoid this feedback between training and scoring system, this study explains construction details of the new scoring system. The new approach assume mathematical function which is more flexible and make process of evaluation more objective in a way to reward maximal individual achievements redistributing the total current score on a new way. Used equation ($s_i - s_{i-1} = \alpha_i \cdot (x_i - x_{i-1})$, $i = 1, \ldots n$) reflects the idea that the improvement in the score is proportional to the improvement in the result and the proportionality factor is greater for the higher quality (better) results. The model is still in the development phase.

Key words: *heptathlon, scoring system, scoring methods*

References

1. Gassmann, F., Fröhlich, M, Emrich, E. (2016). Structural Analysis of Women's Heptathlon. Sports 4, 1, Article 12.
2. Westera, W. (2006). Decathlon, towards a balanced and sustainable performance assessment method. New Studies in Athletics, March/April, pp. 37-48.

ASSESSING THE INSTABILITY OF PASSING AND SHOOTING SITUATIONS IN FOOTBALL

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Research Methodology

Purpose: Vilar *et al.* (2013) calculated the local numerical advantage of defenders versus attackers in sub-areas of the pitch to determine defensive stability or offensive opportunity. This paper determined an instability value at the point in time when a pass or shot took place.

Methods: Analysis consisted of one match between Tottenham Hotspur (home) and Arsenal played on 5 March 2016. The pitch was divided into defensive third (value 1), pre-defensive (2), pre-offensive (3), offensive third (4) and attacking penalty box (5). The number of defenders (excluding goalkeeper) in line and between the ball and the defending goal were coded 1 for 6 or more defenders, 2 for 3 to 5 and 3 for 2 or less. If the attacker defender ratio was >1 or it was =1 and there were 4 or less defenders the situation was coded 2 (unstable) otherwise 1. The Instability value was the sum of the three values.

Results: The match finished 2-2 with Tottenham having 26 shots (17 (65.4%) from instability situations of 7 or more) compared to Arsenal's 8 (5 (62.5%) respectively). Four (50%) of Arsenal's shots took place in maximum instability situations compared to 2 (7.7%) for Tottenham. One hundred and fourteen (17.4%) passes took place in the attacking third and 11 (1.7%) inside the penalty box. However, both teams performed the majority of their passes in situations of low instability (<7) (Tottenham 96%, Arsenal 94.7%) with possessions having an average instability value of 4.4 for Tottenham (SD = 1.1) and 4.5 for Arsenal (SD = 1.0).

Conclusions: This research determined that the vast majority of player possessions took place in situations of relative stability i.e. defending players were not outnumbered and had at least 3 players behind the ball. It seems, therefore, that defences, at the elite level, are well organized and are able to prevent unstable situations arising and hence prevent goals from being scored. This methodology has the potential for classifying possessions, passes and shots into more meaningful metrics which can help discriminate player and team performances better than non-dimensional performance indicators such as frequency of passes or shots.

References

1. Vilar, L., Araújo, D., Davids, K. & Bar-Yam, Y. (2013). Science of winning soccer: Emergent pattern-forming dynamics in association football. *Journal of Systems Science and Complexity*, 26, 1, 73-84.

HIERARCHICAL CLASSIFICATION OF THE METHODICAL MODEL FOR TEACHING SHORT-RADIUS TURN

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Abstract

With the objective of forming a hierarchical classification of the methodical model of the most important exercises for teaching short-radius turn and evaluating the differences among the skiing experts of different skiing education level, conducted was a survey on the total sample of 307 skiing experts from different countries. Through filling out an online survey, the respondents were asked to rate the significance of the exercises comprised in the formed model of the most important methodical exercises for teaching short-radius turn. The methodical model of the most important methodical exercises comprised 5 variables. The participants were divided into three groups on the basis of the degree of skiing education possesed. In accordance with the set study objectives, calculated were the rank-sum values (ΣR) of the most important methodical exercises for teaching short-radius turn, as well as the appropriate empiric level of significance (p) by using non-parametric analogue post-hoc analysis, i.e. a Kruskal-Wallis test (H-test). Statistically significant differences were obtained between the values of ranking the most important methodical exercises for teaching short-radius turn ($H = 193.50$, $p < 0.001$).The results of this study provide an accurate and scientifically-founded methodical setting for teaching short-radius turn. This sets the possible directions of the future studies in terms of constructing the measuring instruments the practical application of which should allow a better selection, as well as a greater choice of modalities and training exercises, in the process of training alpine skiers of various ages and prior skiing knowledge levels.

Key words: *hierarchical classification, skiing experts, short-radius turns*

Research Methodology

Introduction

A successful performance in alpine skiing is based on a learner's capacity for acquiring a functionally dynamic movement pattern which remains stable, yet somewhat adaptable, under various performing conditions and types of skiing slopes. It depends on the quality and the nature of the skiing equipment used but, above all, on the level of skiing education (Tate, 2007), experience, and the teaching methods implemented by the skiing instructor. Acquiring and demonstrating specific skiing skills can be defined as the process of systematically adopting and perfecting a specific structure of dynamic movement, with the aim of efficiently performing in various conditions and types of skiing slopes. All the mentioned factors result from specific divisions and formations of different skiing school programme models (Feinberg-Densmore, 2000; Matković, et al., 2004; Murovec, 2006; Anderson, 2007; Lešnik and Žvan, 2010). The skiing school programme model enables and accelerates the process of acquiring skiing knowledge. The basis of the programme facilitates the adoption of various alpine skiing techniques (Loland, 2009), and ensures the gradual progress of learning to ski. In relation to the above stated, and with the objective of performing rationally and lowering the energy consumption, the skiing elements and methodical exercises being taught should succeed one another in a logical methodical order (Franjko I., 2007). Furthermore, when coordinating their actions, good skiers require less energy to transit across a slope compared to those with lower levels of skiing expertise (Bucher et al., 2014; Maleš et al., 2013). In other words, they need lower levels of energy for performing any of these elements than skiers of lower knowledge level. High quality and professional help of instructors or trainers is the key factor in the process of acquiring and perfecting skiing knowledge. In order to ensure adequate teaching, skiing instructor or trainer should have a high level of skiing knowledge and skills, and also understand the methodical and didactic principles of the training process and the basis of psychological approach of working with people. Nevertheless, all skiing school programmes have several identical postulates on which their operating principles are based (Raschner et al., 2001). The models on the basis of which skiing instructors carry out the training of skiers vary not only depending on the skiing school programme that they implement, but also on their individual methods and working manners. Therefore, the question arises as to how the increasing number of skiing experts of varying degrees of skiing knowledge and from different countries could form a single model for training alpine skiers? How could they structure a hierarchical classification of the model for training alpine skiers and would it determine the differences between them? Based on the results of a study (Kuna, 2016) which established the methodical model of the most important skiing methodical exercises for teaching short-radius turn, the idea of establishing its hierarchical classification emerged. In relation to the said, the following research objectives were set: a) establishing a hierarchical classification of the methodical model for teaching short-radius turn, b) determining the difference between the skiing experts of different levels of expertise in ranking the most important methodical exercises for teaching short-radius turn.

Methods

Based on the formed methodical model of the most important methodical exercises for teaching short-radius turn, filmed were the videos of the five most important short-radius turn teaching methodical exercises. Following this, an online survey was uploaded on a specialized server used for global data collection and an analysis was conducted. For better understanding, the most important methodical exercises for teaching short-radius turn were described and displayed in a gif image format (Graphics Interchange Format). Next, a letter of intent, proposing participation in the study and comprising a link to the survey, was sent to a great number of email addresses of the skiing instructors and assistants of different education level from the Ski Associations of Slovenia, Croatia, and Bosnia and Herzegovina. Collecting the data took six months. With the aim of determining the respondents' profile and experience in working with alpine skiers, the examinees completed the first part of the survey by filling the provided fields with text and numerical values. By choosing among the predefined answers on the scale from 1 to 5, they ranked the importance of the illustrated methodical exercises for teaching short-radius turn. Following a review of the profile and classification variables of the examinees that responded to participating in the online survey, the results of 307 examinees were chosen for data processing, out of which 119 Slovenian, 128 Croatian, and 60 Bosnian-Herzegovinian skiing instructors and assistants of different education levels. Their results of ranking the methodical model of the five most important methodical exercises for teaching short-radius turn conditioned the forming of its hierarchical classification. In order to determine the existence of statistically significant differences among the total number of examinees, regarding the level of their skiing education, the respondents were divided into 3 groups. The first group consisted of the skiing experts of top skiing education level (ST): the members of the Croatian, Slovenian, and Bosnian-Herzegovinian skiing teams and skiing demonstrators, and the Slovenian skiing instructors of 3rd level (N=78). The second group of examinees consisted of the skiing experts of advanced skiing knowledge (SA): the Croatian skiing instructors, and the Slovenian and Bosnian-Herzegovinian skiing instructors of 2nd level N=128. The third group of examinees consisted of the skiing experts of basic skiing education level (SB): the Croatian assistants of skiing instructors, and the Slovenian and Bosnian-Herzegovinian skiing instructors of 1st level N=101. The methodical model of the most important methodical exercises for teaching short-radius turn consisted of five exercises: *OPTSRT (transition from an outward parallel turn to short-radius turns)* - exercise characterized by a gradual transition from a simpler to a more complex skiing element. It is performed in the following manner: a skier, after performing several outward parallel turns, gradually shortens the radius of their turns and, by pronounced lateral movements and movements along the axis of the body, with minimal body rotation, transitions to performing short-radius turns; *SRTHH (short-radius turns with hands on hips)* – is the exercise where the skier learns the short-radius turn technique by holding their hands on the hips. When performing this methodical exercise, the skier is focused on acquiring and harmonizing the characteristic skiing movements on which depends the success of leading and controlling the speed of the skis, as well the harmonious linking of a series of turns in a proper, semi-circular shape; *SRTDSD (short-radius turns in downhill slope diagonally)* - is the exercise where the skier performs short-radius turns skiing aslant to the fall line. By performing short-radius turns aslant to the fall line, the skier learns how to adjust and perform proper turn radii in relation to the slope line. Besides, performing one turn in relation to the other is facilitated due to the closer slope support, which enables better control of the speed of movement, and develops a better sense of rhythm and coordination; *SRTIA (short-radius turns imitating an aerial)* - is the exercise the skier performs the short-radius turn technique by holding the poles placed vertically at the level of their outstretched arms. This exercise allows the skier to easily maintain the proper position of the upper body part, which should be moving perpendicularly to the fall line. Due to their arms outstretched in front of the body, the skier is able to establish and maintain the central position on the skis more easily, thus developing a sense of properly controlling the pressure of the skis and the coordination of the skiing movements by transitioning from one turn to another.

And *SRTWJ (short-radius turns with jumps) – in* performing this exercise, the skier, when transitioning from one turn to another, jumps into the air. For a successful performance of the jump, especially important are emphasized vertical, circular, and lateral knee movements in the turn, leading to as effective performance as possible. Compared to other major methodical exercises for teaching short-radius turn, this exercise is the most complex one in terms of coordination. Therefore, skiing instructors must know how to apply it in accordance with the abilities and capabilities of the student being trained. The participants' assignment was to rank the established expert model of the methodical exercises for teaching short-radius turn according to the significance of applying the exercises. Following this, by means of using a Kruskal–Wallis test (H-test), the rank-sum values of the most important methodical exercises for teaching short-radius turn and the appropriate empiric level of significance (p) were calculated.

Results and Discussion

Table 1 illustrates the rank-sum values of the most important methodical exercises for teaching short-radius turn according to the respondent skiing experts. Based on the obtained data, observed were some statistically significant differences in the ranking of the methodical exercises for teaching short-radius turn. The K-W test (H-test) value and the statistical significance (p) value for short-radius turn were: H=193.50; $p<0.001$.

On the basis of the obtained rank-sum values in evaluating the importance of applying particular methodical exercises for teaching short-radius turn, and grounded on the established statistically significant differences among them, a hierarchical classification was formed. Among the methodical exercises *OPTSRT* (*transition from an outward parallel turn to short-radius turns)* has the greatest significance. The second place in the hierarchical classification of the most important methodical exercises in teaching short-radius turn is occupied by the *SRTIA (short-radius turns imitating.* The third place is occupied by the *SRTDSD* exercise *(fast ski turn in downhill slope).* The fourth place is taken by the *SRTHH* exercise *(short-radius turns with hands on hips).*

Table 1: Rank-sums of the most important methodical exercises for teaching short-radius turn (ΣR), the K-W test values (H-test), and the significance level (p)

Methodical exercises for teaching short-radius turn					
	OPTSRT	**SRTHH**	**SRTDSD**	**SRTIA**	**ΣR**
OPTSRT					**1163**
SRTHH	0.00				**703**
SRTDSD	0.00	0.01			**822**
SRTIA	0.00	0.00	0.00		**968**
SRTWJ	0.00	0.00	0.00	1.00	**949**
H=193.50; **p**<0.001					

On the basis of the obtained results in Table 2, a multiple statistically significant difference can be observed among the groups in evaluating the *OPTSRT* methodical exercise at the level of $p<0.0001$. In evaluating the *OPTSRT* methodical exercise, a statistically significant difference is found between the *SB (basic education level skiers)* and the *ST (top education level skiers)* group. This is the result of a high evaluation value provided by the *ST* group, which considers this exercise the most important one in teaching short-radius turn, compared to the *SB* group, which considers it less important. Given that the group of top education level skiers was selected on the basis of the highest degree of skiing education and experience possessed, it can be assumed that their values in classifying the methodical exercises for teaching short-radius turn are more plausible. However, the question arises as to what the applicative value of the defined hierarchical classification of the methodical exercises for teaching short-radius turn actually is? The answer to this question sets the directions for the future studies in which it would certainly be desirable to conduct an evaluation of the defined model, including the numerous endogenous and exogenous factors that play the crucial role in training alpine skiers.

Table 2: Values of the arithmetic means of the rank-sum (AS ΣR) of the most important methodical exercises for teaching short-radius turn, the Kruskal-Wallis test (H-test) values, and the corresponding empirical level of significance (p) in examining the significance of the statistical differences among the three groups of skiing experts

	SB	**SA**	**ST**	**H**	**p**
	AS ΣR	**AS ΣR**	**AS ΣR**		
OPTSRT	136.50*	152.69	178.82*	12.08	0.00
SRTHH	155.82	148.84	160.12	0.92	0.63
SRTDSD	155.03	162.44	138.81	3.64	0.16
SRTIA	165.76	148.94	147.07	2.84	0.24
SRTWJ	158.58	156.65	143.71	1.50	0.47

Level of statistical difference significance *p<0.001

The results obtained by this study set the possible directions of the future studies in terms of constructing the measuring instruments the practical application of which should allow a better selection, as well as a greater choice of modalities and training exercises, in the process of training alpine skiers of various ages and prior skiing knowledge levels. The main limitations of this study are reflected in the inability to control the respondents when conducting the online survey, due to which it cannot be determined that their answers were entirely realistic.

Conclusion

On the basis of a general review of the results obtained by the study conducted with the objective of establishing a hierarchical classification of the expert model of the methodical exercises for teaching short-radius turn and examining the statistical significance of the differences among the three groups of skiing experts of various education level in its evaluation, it can be determined that the resulting cognitions, at a general level, allow a relatively better planning of the process of training alpine skiers. In particular segments of evaluating the methodical model for teaching short-radius turn, statistically significant differences were found among the defined skiing expert groups. On the basis of this, it can be concluded that the actual value, i.e. position of each defined variable in the methodical model, still needs to be examined and confirmed by further research. Given there are no studies of similar theme, nor a scientifically based methodical postulate for teaching short-radius turn, this study has a special value. This value is reflected in setting the basic structures of the methodical postulates for the future studies in which it would be desirable to include skiing experts from all around the globe and to further specify and evaluate the methodical model of acquiring not only short-radius turn, but also other specific skiing skills.

References

1. Blaž, L., & Žvan, M. (2010). *A turn to move on – Alpine skiing – Slovenian way.* Theory and methodology of alpine skiing; SZS – Združenje učiteljev in trenerjev smučanja.
2. Loland S. (2009). Alpine skiing technique – practical knowledge and scientific analysis. *In: Proceedings (Science and skiing IV, Oxford: Meyer and Meyer Sport).*
3. Raschner, C., Schiefermuller, C., Zallinger, G., Hofer, E., Muller, E., & Brunner, F. (2001). Carving turns versus traditional parallel turns - a comparative biomechanical analysis. *In E.*
4. Feinberg, Densmore, L. (2000). *Ski faster.* Camden, ME: Ragged Mountain Press.
5. Franjko, I. (2007). *Faktori uspješnosti izvedbe skijaških elemenata, [Factors ski execution elements].* Unpublished Master's thesis, University of Zagreb, Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
6. Kuna D., & Dzajic S. (2016). Hierarchical classification metodical model for teaching short ski turn. *Sports Science and Health, 6*(1), 44-52.
7. Maleš, B., Franjko, I., & Kuna, D. (2013). Relations of Biomotor Structures and Performance of Technical Elements of Alpine Skiing in Croatian Ski Instructors. *Collegium antropologicum, 37*(2), 77-82.
8. Matković, B., Ferenčak, S., Žvan, M. (2004). *Skijajmo zajedno. [Skiing toghether].* Zagreb: Europapress holding i FERBOS inženjering.
9. Murovec, S. (2006). *Na kanto: UPS – učenje s podaljševanjem smuči. [The edge: OPS - learning by extending the ski].* Kranj: Format Kranj.
10. Tate, D. (2007). *Parallel dreams alpine skiing: Taking your skiing performance to new levels.* UK: Parallel dreams publishing.

SUMMER BREAK PARADOX: LET THE KIDS PLAY

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Abstract

Purpose

The aim of this study was to determine the effects of summer break on physical fitness in preschool children.

Methods

A total of 90 (38 girls) preschool children aged 4–7 years voluntarily participated in this study. Physical fitness of preschool children was estimated by the following tests: obstacle course backwards, sit and reach, horizontal jump, bent-arm hang, sit-ups; and 20-meter dash. Measurements were taken in early-October (a month after the beginning of the school year) and in early May (a month before the end of school). The third measurement was taken again in early-October (a month after the beginning of the school year). Girls improved their results for horizontal jump ($p<0.05$), sit ups ($p<0.05$), and obstacle course backwards test ($p<0.001$) following the intervention program, with no significant differences between pre-summer and post-summer measurement.

Results

There was a significant increase in obstacle course backwards following exercise intervention, as well as a significant increase in speed, sit and reach and obstacle course backwards ($p<0.05$) following a summer break in overall sample. There is a significant improvement after summer break in sit ups and sit and reach with significant decrease in results for obstacle course backwards following a summer break.

Conclusion

Overall, these results suggest that fitness status of preschool children following a school summer break remained unchanged. Moreover, there was improvement in some tests after summer break. This study provides indirect evidence that health promotion efforts, and policies to increase physical activity, appear to be having a positive impact.

Key words: *children, effects, summer vacation, fitness*

Introduction

In recent years, considerable interest has been directed towards determining physical activity levels amongst children. Research suggests that an active lifestyle during childhood can reduces the risk of health problems in later years (Sallis & Patrick, 1994). During the school day, physical education (PE) and playtime enable children to be engaged in regular physical activity (Dale, Corbin & Dale, 2000; Sarkin, McKenzie & Sallis, 1997). School-based interventions have been shown to improve health measures of children during the school year. Several interventions, such as SPARK (Sports, Play and Active Recreation for Kids), CATCH (Coordinated Approach to Child Health) and M-SPAN (Middle-school Physical Activity and Nutrition) were used in order to increase physical activity levels in children (McKenzie, Sallis, Kolody, et al.,1997; Kelder, Mitchell, McKenzie, et al., 2003; McKenzie, Sallis, Prochaska, et al., 2004). However, recent studies report children lose health benefits during summer. Therefore, it is important to highlight the important roles of summer vacation and the school year in the increasing rates of obesity and decrease in fitness components. For example, if a child entered kindergarten as an overweight, the school promoted weight loss, whereas the summer vacation led to accelerated weight gain. Stratton (1999) investigated sex and seasonal differences in playtime physical activity in a sample of 27 children and found that whilst boys engaged in higher levels of physical activity than the girls in the winter months, there was no difference in their activity levels in the summer months. Aforementioned author found that boys' and girls' activity was higher in the winter months compared with summer (Stratton, 1999).

The structure of the school year provides a unique opportunity to track trends with respect to patterns of childhood fitness components and weight gain. For example, longitudinally tracking measurements of new schoolchildren can serve to cultivate useful data regarding changes in fitness and weight during school months versus summer months. Ridgers, Stratton & Fairclough, (2006) stated that effect of seasonal influences on children's physical activity has attracted some attention. However, further research is required concerning the effects of seasonal breaks on body composition and physical fitness in school children. Moreover, according to authors' knowledge, there are no studies investigating the effects of summer break in preschool children following a one year intervention program. Therefore, the aim of this study was to determine the effects of summer break on physical fitness in preschool children. It was hypothesised that fitness level in children will decrease following the summer break.

Methods

Subjects

A total of 90 (38 girls) preschool children aged 4–7 years voluntarily participated in this study. Children's characteristics are presented in the Table 1. Prior to the enrolment in the study, parents reported their child's health history and current activity status through a questionnaire and only healthy, recreational active adolescents from 4 to 7 years old were chosen. The study was approved by the Research Ethics Committee of the Faculty of sport and physical education in Novi Sad, and written informed consent was gained from both parents and children.

Procedures

Children's anthropometric and fitness measurements were performed early in the morning, at least 12 h fasted and 24 h from the last highintensity exercise effort. All measurements were repeated at the same time of day as close as possible to the resting condition. Measurements were taken in early-October (a month after the beginning of the school year) and in early May (a month before the end of school). The third measurement was taken again in early-October (a month after the beginning of the school year).

Height was measured on a wall-mounted stadiometer to the nearest 0.5 cm. Weight was measured on a calibrated beam balance platform scale to the nearest 0.1 kg. Physical fitness of preschool children was estimated by the following tests: obstacle course backwards, sit and reach, standing broad jump, bent-arm hang, sit-ups; and 20-meter dash. The tests are briefly described in Bala, Krneta, and Katić (2010).

Table 1: Descriptive characteristics of preschool children

	Initial	Before break	After break	p
Age (years)	5.63±1.04	6.38± 0.87	6.76± 0.87	
Body height (cm)	116.97±7.168	119.91±7.40	122.15±7.43*	0.001
Body mass (kg)	21.98±4.35	23.19±4.25	24.01±4.12*	0.043
BMI	15.95±1.94	16.02±1.61	15.99±1.52	0.977

*significantly different from Initial

Statistical analysis

An analysis of variance (ANOVA) with repeated measures was employed using SPSS statistical software version 18 (IBM® SPSS; Charlotte, NC, USA) on all variables to detect the differences between the three conditions, and if significance was found, a Bonferroni post hoc test was conducted to determine where the significance lied between the group comparisons. All the data are reported as means ± SD, and the significance was set at $p < 0.05$.

Results

Descriptive characteristics in all measured periods are reported in Table 1. Body mass did not vary after the exercise program, and remained stable along the whole period. Significant difference was noted between initial measurement and final measurement following the summer break (Table 1). BMI did not vary significantly between all three periods after the program and after summer break week.

Comparison of test results obtained in May with those obtained in October of the previous year revealed improved and unchanged values in physical fitness tests. There was a significant increase in obstacle course backwards following exercise intervention (Table 2), as well as a significant increase in speed, sit and reach and obstacle course backwards ($p<0.05$) following a summer break.

Table 2: Physical fitness test results change during school and after summer break (Means±SD)

	Initial	Before break	After break	p
Speed	5.40± 8.61	5.33± 6.39	5.00±5.7** *	0.001
Horizontal jump	116.30± 26.94	118.67± 19.47	121.54 ±21.46	0.337
Flexed arm hang	9.83± 10.9	12.37 ±12.85	12.66 ±12.02	0.170
Sit ups	19.78±10.38	19.95±9.31	22.87±9.8	0.093
Sit and reach	38.98± 8.2	37.75 ±8.19	41.72 ±7.9**	0.009
Obstacle course backwards	26.72± 9.73	22.55± 7.25*	25.59 ± 8.92**	0.001

*significantly different from Initial; ** significantly different from Before break

Table 3 shows the results for boys following the exercise intervention and summer break. Boys improved their results for speed ($p<0.05$), sit ups ($p<0.05$), and obstacle course backwards ($p<0.001$) following the intervention program. There is a significant improvement after summer break in sit ups and sit and reach with significant decrease in results for obstacle course backwards following a summer break (Table 3).

Table 3: Change in physical fitness test results among boys (Means±SD)

	Initial	Before break	After break	p
Speed	5.47 ±0.85	5.23 ±0.60*	5.36 ±0.59	0.027
Horizontal jump	114.78±25.03	119.14±21.92	123.49±21,75	0.363
Flexed arm hang	9.05±9.95	11.08±11.67	13.78±13.99	0.117
Sit ups	17.80±9.66	19.04±10.01*	23.70±9.81** *	0.05
Sit and reach	35.76±7.60	35.47±7.8	40.85±8.37** *	0.001
Obstacle course backwards	24.19±6.85	20.58±5.62*	25.76±8.8**	0.001

*significantly different from Initial; **significantly different from Before break.

Table 4 shows the results for girls after exercise intervention and summer break. Girls improved their results for horizontal jump ($p<0.05$), sit ups ($p<0.05$), and obstacle course backwards test ($p<0.001$) following the intervention program. There is a significant difference between initial measurement and after summer break in speed, horizontal jump, sit ups and obstacle course backwards following a summer break (Table 3).

Table 4: Change in physical fitness test results among girls (Means±SD)

	Initial	Before break	After break	p
Speed	5.65± 0.74	5.44 ±0.60	5.41 ±0.69*	0.029
Horizontal jump	108.73±22.35	117.94±15.11*	119.54±19.60*	0.007
Flexed arm hang	12.40±11.16	14.41±14.48	10.90±8.33	0.316
Sit ups	16.55±10.03	21.26±8.16*	21.31±10.08*	0.011
Sit and reach	40.53±8.54	41.35±7.59	43.92±6.6	0.063
Obstacle course backwards	29.82±11.68	25.14±8.30*	25.4±9.1*	0.001

*significantly different from Initial; ** significantly different from Before break.

Discussion

To our knowledge, this is the first study that has investigated the effects of a summer break on physical fitness in preschool children. Preschool children following a multidisciplinary program did not showed significant decrease in physical fitness during the summer months. Although every child has a different environment these findings were not surprising, because most children report high levels of physical activity during the summer. Contrary to our findings, Carrel, et al. (2007) stated that benefits obtained during schoolbased fitness interventions may be lost during the extended summer break in obese middle-school children. The major weakness of a seasonal research design is that all children are out of school at more or less the same time. The main result of our study was the importance of maintaining children's activity levels through the whole year. It could be speculated that play based outdoor activities are sufficient to increase fitness levels. Similar studies which have focus on environmental explanations and Body weight gain were quite consistent for adults. According to Von Hippel, Powell, Downey & Rowland (2007) children gain BMI fastest during summer vacation, whereas adults gain BMI fastest during the winter holidays. The BMI in our children remain stable during all three measurements.

Conclusion

Overall, these results suggest that the school summer break has a positive impact on the fitness status of preschool children. This study provides indirect evidence that health promotion efforts, and policies to increase physical activity, appear to be having a positive impact. Outdoor playgrounds and health promotion programs that address health behaviours during the summer months seems to significantly contribute to the maintains of fitness levels in preschool children.

However, to address the significant and real effect of summer break on fitness parameters, future studies should use accelerometers or pedometers in order to measure PA during summer break, and also to compare the PA during school and summer break. Moreover, future inquiries are needed to address the issue of winter break effects on fitness levels and weight gain.

References

1. Bala, G., Krneta, Ž., & Katić, R. (2010). Effects of kindergarten period on school readiness and motor abilities. *Collegium antropologicum*, 34(1), 61-67.
2. Carrel, A. L., Clark, R. R., Peterson, S., Eickhoff, J., & Allen, D. B. (2007). School-based fitness changes are lost during the summer vacation. *Archives of pediatrics & adolescent medicine*, 161(6), 561-564.
3. Dale, D., Corbin, C. B., & Dale, K. S. (2000). Restricting opportunities to be active during school time: do children compensate by increasing physical activity levels after school?. *Research quarterly for exercise and sport*, 71(3), 240-248.
4. Kelder, S. H., Mitchell, P. D., McKenzie, T. L., Derby, C., Strikmiller, P. K., Luepker, R. V., & Stone, E. J. (2003). Long-term implementation of the CATCH physical education program. *Health Education & Behavior*, 30(4), 463-475.
5. McKenzie, T. L., Sallis, J. F., Kolody, B., & Faucette, F. N. (1997). Long-term effects of a physical education curriculum and staff development program: SPARK. *Research Quarterly for Exercise and Sport*, 68(4), 280-291.
6. Mckenzie, T., Sallis, J., Prochaska, J., Conway, T., Marshall, S., & Rosengard, P. (2004). Evaluation of a Two-year Middle-school Physical Education Intervention: M-span. *Medicine & Science in Sports & Exercise*, (8), 1382-1388.
7. Ridgers, N. D., Stratton, G., & Fairclough, S. J. (2006). Physical activity levels of children during school playtime. *Sports medicine*, 36(4), 359-371.
8. Sallis, J. F., & Patrick, K. (1994). Physical activity guidelines for adolescents: consensus statement. *Pediatric exercise science*, 6(4), 302-314.
9. Sarkin, J. A., McKenzie, T. L., & Sallis, J. F. (1997). Gender differences in physical activity during fifth-grade physical education and recess periods. *Journal of Teaching in Physical Education*, 17(1), 99-106.
10. Stratton, G. (1999). A preliminary study of children's physical activity in one urban primary school playground; differences by sex and season. *Journal of Sport Pedagogy*, 5, 71-81.
11. Von Hippel, P. T., Powell, B., Downey, D. B., & Rowland, N. J. (2007). The effect of school on overweight in childhood: gain in body mass index during the school year and during summer vacation. *American Journal of Public Health*, 97(4), 696-702.

ADDITIVE TECHNOLOGY IN THE PRODUCTION OF SPORTS NUTRITION SUPPLEMENTS

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Abstract

Additive technologies have become present at the wider market segment. With great technological development, they enabled application from industrial production, biomedicine, to the production in the segment of food industry. Nutrition of athletes is a crucial segment of recovery which determines the final sports result. Because of the need for great compensation of nutrients, with effect in achieving desired results, athletes often take the best supplements. Today it is not enough to just have an adequate intake of generic supplements, the goal is to have individual approach on daily, weekly and monthly basis. Accordingly, a new approach is achieved in supplement application via additive technology, which enables individual approach with known raw materials, with better quality, tracking and safety at the highest level. Application of additive technology ensures optimal adjustment of food supplementation in relation to the preparation cycles and calendar of the competing athletes.

Key words: *Additive technology, sports nutrition supplements, application of new technologies in kinesiology*

Introduction

Rapid development of biotechnology is going hands in hand with the rapid development of computer and software sciences. Up rise of new technological possibilities, made a room for new cooperations with until then, not connectable areas, from Production Engineering to Medicine (1) and Kinesiology. Additive Technology (AM) are ubiquitous in today's production technologies (3). Unlike traditional conventional types of processing, additive technology applies by adding layers. The physical model is built on the principle of creating layers in one plane, and once completed, production geometry makes z-axis move to create a layer in another plane above the previous. Additive processes can basically be divided by the type of material as shown in Figure 1. The above mentioned processes are some of the used procedures.

AM based on liquids	AM based on powder materials	AM based on solid materials
• DLP – Digital Light Processing	• SLS – Selective Laser Sintering	• FDM – Fused Deposit Modeling
• SL – Stereolitography	• SLM – Selective Laser Melting	• LOM – Laminated Object Manutacturing

Figure 1: Preview of the materials used by AM technologies based on the material type

Overview

Trends are moving to the area of producing dietary supplements, and the described a processes of development AM technologies enables their implementation. It is important to emphasize that the diet of professional athletes a crucial segment of the recovery that determines the ultimate sport performance. Design of food supplements with the help of additive technologies can be divided into several phases (Figure 2).

In the first phase, it is important to make the analysis of the health status / dietary habits of professional athletes. Health status and dietary habits are closely associated with specific physical activity of the athlete. Computer application from the database offers pre-planned features that are then adapted to the needs of specific athlete. The second phase includes computer-aided design of correct ratio of nutrients in order to achieve the objectives set in the previous phase.

A significant difference compared to the hitherto existing principles, is shown by using predefined CAD geometry for the look of the product, while additional information on the parameters include necessary type and amount of nutrients and their exact ratio. The last, third phase includes the technological preparation, production and control of manufactured food supplements.

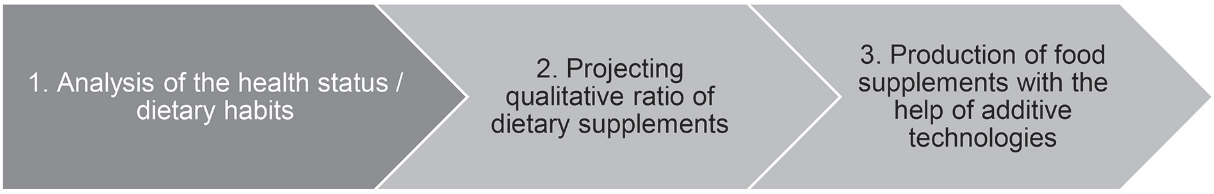

Figure 2: Development phases of projecting dietary supplements with additive technologies

Advantages of using the AM system in the production of food supplements are as follows: current production of dietary supplements thanks to the mobility of the device in a certain place, which reduces the possibility of loss of qualitative features of nutritional elements due to improper storage; custom-made ratio adjusted for each person according to the required parameters (for each specific part of the day can be planned well in advance to design the composition of the food supplement - more od specific supplements in the morning, after training specific blend for increased efforts, etc.), and third; guaranteed quality ingredients used directly from certified container inside the machine. After each cycle of usage based on ID, there is possibility of reports about the spent components during according to input parameters.

Food supplements are considered to be concentrated sources of nutrients (vitamins and minerals), or other nutrients, single or in combination, with physiological effect that has a purpose to additionally enrich a daily diet in order to maintain health (amino acids, essential fatty acids, dietary fiber, plant extracts, microorganisms, edible fungi, algae, bee products and other substances with a nutritional or physiological effect). (4) Vitamin and mineral function in the human body as metabolic regulators, are influencing a number of physiological processes important to sport performance. In the last decade, several studies have shown that there is no significant effect on multivitamin / mineral supplementation over prolonged periods on sport-specific tests of physical performance. (5). However, many athletes regularly use dietary supplementation in order to achieve desired results, including about 85% of elite track and field athletes. (6). It raises a question are they having a balanced nutrition, are they using a right dietary supplement, in a recommended amount?

Sport success depends on many external and internal factors. Important external factor that athletes base on is nutrition and dietary supplements. It has been known to happen that in professional sports, athletes often attempt to go beyond training and use different substances and techniques, in order to achieve a desired result. It includes various dietary strategies, using a number of dietary supplements, with assumption of need, and often, with lack of desired effect, or even a harmful effect on the body. Dietary supplementation in professional sports should not be taken based on "cause and effect", but based on individual need, measurable effect, with daily / weekly adjustment.

"*Supplements commonly used include vitamins, minerals, protein, creatine, and various "ergogenic" compounds. These supplements are often used without a full understanding or evaluation of the potential benefits and risks associated with their use, and without consultation with a sports nutrition professional*" The 2007 IAAF Consensus Conference on Nutrition for Athletics, 2007.

Science behind various athletic performances has progressed significantly with the advancement of technology and research in sport and nutrition. We believe that the challenge is that dietary supplementation should be measured and adjusted to individual needs more frequently with better measurement of the effect. Since some of the supplements can even impair sport performance (5), it is a great disadvantage not to be able to provide on daily / weekly basis adjustments in supplementation therapy for professional athletes. Today it is not enough to just have an adequate intake of generic supplements, the goal is to have individual approach on daily / weekly basis. Accordingly, a new approach is achieved in supplement application via additive technology, which enables individual approach with known raw materials, with better quality, tracking and safety at the highest level. Nutrition of athletes is a crucial segment of recovery which determines the final sports result, thus the supplementation should be on the same level of details, as the exercise and nutrition itself.

We consider as a good addition the above mentioned supplement facts with an example of football, cultural-kinesiological phenomena of today. First of all, philosophy behind most powerful football clubs, for ten or so years now, has been focused at better segment planning of recovery rather than training process; second, it is well known that without adequate nutrition/supplementation and application of recovery methods, it is almost impossible to keep the health of athletes at optimal level, successfully prevent injuries and at the same time achieve expected (top) competitive results; and third, although "football science" made its way to first place in kinesiological area in general, in practice there is no adequate way to applicate research results from area of situational individualized nutrition-supplemented program for every athlete individually. (7). With adaptive technology application in programming of individual nutrition of athletes, it can benefit the global maximization of recovery effects, in regard to energy demands of the game, and physiologic needs of every athlete individually.

Conclusion

Additive technology in projecting of dietary supplements, has an individual approach in supplementation, with measurable effect, where dietary supplements are made based upon a daily need of athlete. It is important to have a strategic approach, where supplementation provides best result with no harmful effects. In professional sports, adjustments must be made quickly, with great precision. There should be better scope of supplementation for professional athletes depending on gender, type of sport, individual goals, current physical status, individual nutrition, allergies, needs and other external factors. One way that this need can be fulfilled is using a supplement application via additive technology, which enables individual approach with known raw materials, with better quality, tracking and safety at the highest level.

References

1. Pacurar, R. et al.: "*Estimating the life-cycle of the medical implants made by SLM titanium-alloyed materials using the finite element method*", 17th International Conference on Innovative Manufacturing Engineering, IManE, Lasi; Romania, 2013
2. Maričić S., Perinić M., Kovačević Pavičić D.: "*Uvod u biotehnološko modeliranje*", udžbenik Sveučilišta u Rijeci, Rijeka 2013.
3. Gebhardt A.: *"Understanding Additive Manufacturing",* Münich, 2012.
4. DIREKTIVA 2002/46/EZ EUROPSKOG PARLAMENTA I VIJEĆA
5. Journal of the International Society of Sports Nutrition, 1(2):1-6, 2004.
6. Maughan, R.J., "The use of dietary supplements by athletes", Volume 25, 2007: The 2007 IAAF Consensus Conference on Nutrition for Athletics
7. Marković G., Bradić A.: "Nogomet-integralni kondicijski trening", Udruga tjelesni odgoj i zdravlje, Zagreb, 2010.

ASSESSMENT OF PHYSICAL ACTIVITIES: A FACTORIAL ANALYSIS BETWEEN DIRECT AND INDIRECT METHODS OF INVESTIGATION

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Abstract

Purpose: The aim of the study was to compare two methods of investigation of the physical activity in adolescents. A comparison between the results of the Physical Activity Questionnaire for Adolescents (PAQ-A) and the measure of the physical activity performed by accelerometers GT3X+ (Actigraph), was achieved. Furthermore the validity of the Evenson (EV) (Evenson 2008), Freedson (FR) (Freedson 2005) and Troiano (TR) (Troiano 2008) algorithms were assessed. The main difference between the three equations consists in the definition of the physical activity levels, particularly between the light and the moderate level.

Methods: Metabolic (METS and KCAL) and biomechanicals (X, Y and Z axis movements) variables were estimated in 85 male and 75 female adolescents (12-19 years old) wearing the accelerometer for 7 days, 24 hours per day. In addition, participants completed the physical activity 7-d self-report questionnaire relative to the same week. Three factorial analysis (FA) with warimax rotation were performed to compare EV, FR and TR. Furthermore each output has been compared to the questionnaire outcomes.

Results: The first factor of the FA explain the 52%-48%-53% of variance for the EV, FR and TR, respectively. and is more sensitive to light activity and inactivity. The second factor explain the 21-22% of the variance and was relative to the moderate-vigorous activity. The third factor explain the 12-13% and was more related to the questionnaire components and the very vigorous activity (FR).

Conclusions: The PAQ-A questionnaire appear to be particularly suitable to estimate the amount of vigorous activity of the participants, while the accelerometers can be used to quantify both light and high intensity activities.

Key words: *Factorial Analysis, PAQ-A, Accelerometer, Physical Activity, Cut-Points, Algorithm*

Introduction

One of the main target in public health research is to understand the physical activity (PA) habits of the population. Several studies to date investigated the PA level of different age groups including adolescents. The methods of investigation used can be classified as: indirect/subjective and direct/objective (Adamo 2009). The indirect method consist of a self-report represented by a questionnaire or a diary, while the most common direct methods are the triaxle accelerometers, cardio-frequency meters and the doubly labelled water method.

The aim of the study was to compare results of the Physical Activity Questionnaire for Adolescents (PAQ-A) (Kowalski 1997) and the measure of the physical activity performed by accelerometers GT3X+ (Actigraph). Many algorithms has been created and are used to elaborate the raw-data obtained by accelerometers. The main difference between the equations consists in the definition of the physical activity levels and in particular between the light and the moderate level. The construct validity of the Evenson (EV) (Evenson 2008), Freedson (FR) (Freedson 2005) and Troiano (TR) (Troiano 2008) algorithms were also assessed.

Methods

Fourteen variables were measured by the accelerometers with different cut-points methods set for the analysis. Biomechanical (VERT-ACC, HORIZ-ACC and LAT-ACC) and metabolic (METS and KCAL) variables were estimated using the Freedson Children and the Freedson VM3 Combination algorithms, respectively. Furthermore the number of steps (N°STEP) and the number of bouts (N°BOUTS) were been calculated and included in the analysis. This variables increase when ten consecutive minutes of any steady-state was achieved. It is essential to divide the accelerometer results into intensity-zones. The choice of the cut-point allows to classify the PA level of the subjects. In the present study the difference between three common cut-points algorithm have been investigated. Both Traiano (TR) and Evenson (EV) identified four activity zones: Sedentary, Light, Moderate and Vigorous, while Freedson (FR) added the Very Vigorous zone.

In addition to the total score of the PAQ-A questionnaire was taken into account also the frequency of the sport activity and named ACTIVITY.

Participants in this study, 85 male and 75 female students between 12 and 19 years old, worn the accelerometer (GT3X+, 100 Hz, Actigraph, Pensacola, FL) for 7 days, 24 hours per day. The adolescents were asked to wear the device at the waist, on L5 vertebra. Participants who did not wear the device for at least twelve consecutive hours, were not considered in the analysis. A Low-Frequency Extension, was used to increase the sensitivity for low-intensity movements. At the end of the 7-day period, participants filled the physical activity 7-d self-report questionnaire (PAQ-A) relative to the previous 7 days. 12 students didn't complete the questionnaire so were not included in the analysis.

Three factorial analysis (FA) with Warimax rotation (SPSS 18.0 version) were performed using to compare EV, FR and TR algorithm. Furthermore each output was compared to the questionnaire outcomes in order to assess the construct validity of the methods of investigation.

Results

Table 1: Matrix of saturation using the Freedson algorithm and the PAQ-A scores

FREEDSON	FACTORS		
	1	2	3
LIGHT	.942		
MODERATE	.911	.211	
SEDENTARY	-.908	-.340	-.122
N°STEP	.854	.368	.146
HORIZ-ACC	.839	.321	.144
LAT-ACC	.787	.389	.294
METS	.731	.549	.312
KCALS	.626	.589	.154
VIGOROUS	.320	.852	
N°BOUT	.115	.829	-.223
VER-ACC	.612	.710	.307
ACTIVITY			.818
PAQ	.195	-.120	.662
VERY-VIGOROUS	.255	.459	.633
% OF VARIANCE	43.7	27.9	13.8

Results of the three FA was collected in three different tables, reported below. The considered variables were either those of the questionnaire (PAQ-A and ACTIVITY), those of the accelerometers (KCALS, MET, N°STEPS, N°BOUT, VERT, HORIZONTAL and LAT accelerations) and those corresponding to the intensity zones identified by the algorithm.

First FA (Table 1) produced a measure of the explained variance of the FR algorithm equal to 81%. The Varimax-rotated matrix of factor loading shown that there are three factors. The first factor explained the 43.8% of the variance. The light (0.92) and moderate intensity activity (0.94) are positively saturated. The second factor explained the 23.9% of the total variance. This factor is well represented by the Vigorous activity (0.85) and by the N°BOUTS (0,83). The vertical and the lateral accelerations, the KCALS and METS are equal saturated in the first two factors. The second factor represents the high intensity physical activity: the vigorous activity indeed, was saturated at 0.85 followed by the N°BOUTS saturated at 0.63 and the vertical acceleration component (VER-ACC) at 0.61. In the third factor (explained by the 13.8% of the variance) the questionnaire variables (ACTIVITY with 0.82 and PAQ-A with 0.66) and the Very Vigorous Activity were saturated of 0,63. The SEDENTARY variable was negatively saturated in each factors.

The second FA (Table 2) was performed with TR algorithm and was saturated by 3 factors that were able to explain the 82.4% of the total variance. The first factor explained the 46.4% of the variance. It was positively saturated with the lower intensity activity zone (0.96 light, -0.93).

Table 2: Matrix of saturation using the Traiano algorithm and the PAQ-A scores

TRAIANO	FACTORS		
	1	2	3
LIGHT	.965		
SEDENTARY	-.932	-.263	-.112
N°STEP	.868	.336	.132
HORIZ-ACC	.857	.284	.118
LAT-ACC	.821	.336	.266
METS	.773	.498	.292
KCALS	.674	.538	.119
VERT-ACC	.671	.652	.287
N°BOUT	.110	.879	-.168
MODERATE	.595	.708	
ACTIVITY			.831
PAQ	.220	-.173	.697
VIGOROUS	.398	.484	.536
% OF VARIANCE	46.4	22.2	13.8

Sedentary and 0.87 N°STEP). below were the raw-data of the accelerations in the three directions (0.9; 0.8 and 0.7 for the x, y and z axis, respectively) and the metabolic variables (METS and KCALS). The second Factor explain the 22.2% of the variance and is represented by the N°BOUT with saturation value of 0.88, followed by the Moderate Activity (0,71) and the Vertical acceleration (0,65). The third factor explain the 13.8% of variance, with the saturation value of 0,83 for the ACTIVITY and 0.70 for the PAQ-A total score. The Vigorous Activity was saturated at 0.54. The vigorous activity was highly saturated in the first factor, but was present in each factor.

Table 3: Matrix of saturation using the Evenson algorithm and the PAQ-A scores

EVENSON	FACTORS		
	1	2	3
LIGHT	.962		
SEDENTARY	-.909	-.265	
HORIZ-ACC	.869	.275	
N°STEP	.861	.351	.128
LAT-ACC	.824	.348	.223
METS	.780	.508	.227
KCALS	.682	.535	
VERT-ACC	.677	.666	.200
MODERATE	.621	.519	
N°BOUT	.103	.876	-.167
VIGOROUS	.415	.795	.181
ACTIVITY			.830
PAQ	.198		.778
% OF VARIANCE	46.7	23.5	11.8

The FA of EV's algorithm (Table 3) shown again that three factors were represented, with a total variance of 82%. The first factor explained the 46.7% of the variance, represented by the light activity (0.96), the sedentary (-0,91), and the horizontal axe values (0.87). Lower values were found for METS (0.78) and KCAL (0.68). The second Factor explain the 23.5% of the variance and is represented by the N°BUOT (0.88) and by the vigorous activity (0.80). The third factor is saturated at 11.9%, mainly with the questionnaire value: 0.83 for the Activity and 0.78 for the PAQ-A score.

Discussion

The FA performed on the FR, TR and EV algorithms for the assessment of the PA, always resulted in three factors. In addition, for each algorithm the matrix was almost totally saturated with 81% for FR, 82.4% for TR and 82% for EV algorithms. The first factor represented the Volume of the PA and explain around the 43.8%, 46.4 and 46.7% of the variance in the three FR, TR and EV, respectively. This factor may represents an index of sedentary and low intensity activity. The metabolic variables were saturated with values between 0.53 and 0.78 in the first two factors. The second factor explained the 22-24% of the variance and was correlated with the N°BOUTS, the MODERATE and the vigorous activity and the vertical accelerations. This factor is an index of the intensity of the PA and is composed by the PAQ-A questionnaire score and by the ACTIVITY variable. Using FR algorithm the third factor was saturated by the very vigorous activity, using TR by the vigorous activity while using EV become saturated in the second factor.

Conclusion

All three algorithms analysed shown a correspondent factorial solution. The vigorous and the very vigorous activity are analysed in a different way using the three algorithms and are always in relation to the questionnaire. The PAQ-A questionnaire resulted particularly suitable to estimate the amount of vigorous activity of the participants, while the accelerometers can be used to quantify both light and high intensity activities. The vigorous activity was better remembered by the subjects and so better reported filling the questionnaire. The relation between the PAQ-A questionnaire and the accelerometers could be explained by the last assert. In conclusion all the algorithms had shown a good validity of construct even with different classifications of the physical activity levels.

References

1. Adamo, K. B., Prince, S. A., Tricco, A. C., Connor-Gorber, S., & Tremblay, M. (2009). A comparison of indirect versus direct measures for assessing physical activity in the pediatric population: a systematic review. *International Journal of Pediatric Obesity*, *4*(1), 2-27.
2. Evenson K., Catellier D., Gill K., Ondrak K., McMurray R., 2008, *Calibration of two objective measures of physical activity for children*, Journal of Sports Sciences, 26(14), 1557-1565.
3. Freedson P., Pober D., Janz, K., 2005, *Calibration of accelerometer output for children*, Medicine and Science in Sports and Exercise, 37(11), S523.
4. Kowalski K. C., Crocker P. R., Kowalski N. P., (1997). *Convergent validity of the physical activity questionnaire for adolescents.*, Pediatric Exercise Science, 9(4), 342-352.
5. Troiano R., Berrigan D., Dodd K., Mâsse L., Tilert T., McDowell M., 2008, *Physical activity in the United States measured by accelerometer*, Medicine and science in sports and exercise, 40(1), 181.

DIFFERENCES IN FUNCTIONAL AND ANTHROPOMETRIC TRAITS BETWEEN SLO & ITA OLDER ADULTS

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Abstract

Purpose: Aging is complex physiological process affected by various intrinsic and extrinsic factors. It is followed by wide range of structural and functional changes from cellular to tissue level (Tchkonia et al., 2010) which is more pronounced with advancing age. The consequences of aging process are reflected in reduced physical fitness and results in difficulties in daily life functional abilities. However, those inevitable biological alterations might be mitigated by lifestyle of an individual, giving a priority to regular physical activity and balanced diet. Bearing in mind that different environment leads to diversity of human life habits, we aimed to compare functional and anthropometric traits in older adult's population of Slovenian and Italian citizens.

Methods: We measured functional traits (i.e., maximal aerobic capacity (VO2max); grip strength (GS) and flexibility) along with body mass index (BMI) and waist circumferences (WC) in the older adults population of Slovenian (N=449; 67.4 ± 5.3 years of age) and Italian (N=458; 66.6 ± 4.7 years of age) citizens, of which 36.5% and 45.2% were man, respectively.

Results: In generally, our assessed population was overweight (BMI ranged from 26.1 ± 3.9 to 27.7 ± 3.3, for Italian women and Slovenian man, respectively), with no differences between both countries. Slovenian women had higher VO2max ($p<0.001$), GS ($p<0.001$), better flexibility ($p<0.001$), as well as higher BMI ($p=0.024$) as compared to Italian women. Both groups did not differ in WC ($p=0.143$). Furthermore, Slovenian men had higher VO2max ($p<0.001$), GS ($p=0.030$) and larger WC ($p=0.005$) as compared to Italian men, while there were no differences in flexibility ($p=0.283$). Additional correlation analysis, supported subsequent group analysis, showing that VO2max has moderate positive relationship with GS ($r = 0.40$, $p < 0.001$), while moderate negative correlation was observed between GS and flexibility ($r = 0.28$, $p < 0.001$) and WC ($r = 0.30$, $p > 0.001$), respectively.

Conclusions: Despite overweight prevalence among both populations, it could be concluded that Slovenians has better physical function. However, due greater values of anthropometric traits, our data suggest that they are in greater risk of cardiovascular and metabolic diseases (Huxley et al., 2010) compared to Italian older adults. Possible reasons of observed differences should be sought in life habits and in psycho-socio-economical agents on individual and population level. In the future steps the profound analysis of lifestyle factor will offer us an orientation of lifestyle intervention, which could offer significant benefit in risk factors, associated with development of chronical uncommunicable disease.

References

1. Tchkonia T, Morbeck DE, Von Zglinicki T, Van Deursen J, Lustgarten J, Scrable H, Khosla S, Jensen MD, Kirkland JL. Aging cell. 2010 Oct 1;9(5):667-84.Huxley R, Mendis S, Zheleznyakov E, Reddy S, Chan J. Eur J Clin Nutr. 2010 Jan 1;64(1):16-22.

INTERRATER RELIABILITY IN SCHOOL-BASED FITNESS TESTING

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Abstract

Purpose: The aim of this study is to determine the capabilities and reliability of the measurer in assessing the motor status of children included in a specially selected sample of children aged 4 to 7 years, after the training of educators by the relevant institutions.

Methods: The sample consisted of 1359 children (621 boys and 738 girls) from different schools in Vojvodina, 64 preschool children and 1295 elementary school students, aged 8 to 12 years. However, for the purpose of this study, i.e. determination of the reliability of the timekeepers in the application of the tests a sample of 64 preschool children was used. Data collection was performed in gyms in cities in Vojvodina.

Results: In a sample of children aged 4-7 years, high correlation coefficients in all timekeepers (confidence interval from 0.890 do 0.965) and high intraclass coefficient (0.935) are observed for the test Obstacle course backwards. Hand taping test has also showed high correlation coefficients for all timekeepers (confidence interval from 0.961 do 0.981) and high intraclass coefficient (0.972).

Conclusion: Based on the results of monitoring the development of motor skills and physical growth of children and students, it can be concluded that, after the training course, kindergarten teachers, class teachers and PE teachers have reached a level of training, which is sufficient in terms of monitoring the physical development of children and students.

Key words: *children, school, teachers, fitness, testing*

Introduction

Until recently, the measurement of motor skills and abilities of preschool children were performed only in cases when it was suspected that there were problems in child development (Perez, 2013). Although the development until age one is almost exclusively measured through motor development indicators, rarely a child goes through some form of motor diagnostics until the school age. Lately, motor development tests have been increasingly applied as well as so-called health oriented fitness tests which involve various tasks and can identify more or less health risks due to motor and anthropometric status. First of all, it is about determining the risk of obesity and metabolic diseases due to lack of physical activity, as well as determining the degree of motor development for a given age. Testing children can provide formative evaluation of the data which is useful for the programme assessment and the team which conduct development programme. The results may indicate areas of the curriculum that need further articulation or resources or areas where teachers or educators need to improve their professional development. If children in the classroom, as a whole, do not make progress in certain areas of development, it is possible that the curriculum needs revision or that the teachers and educators need some additional training. In the implementation of the official evaluation, the data of children combined with the results of the programme are the best indicators of the overall quality and implementation of the curriculum.

Formal tests of motor development are very useful because they provide a frame of reference for the interpretation of the motor development of a child. Information on child's motor development can be useful for teachers to achieve the early learning potential. Such pieces of information are also important in deciding whether a child possesses the basic skills necessary for success in simple school activities. Data on motor development are important in determining when a child should be enrolled in school or he/she should be encouraged through developmental enrichment of the environment. If a child has only motor deficiencies, it is more likely that the observed motor problem is temporary and reflects the uneven process of growth that can be easily corrected over time and with training (Šalaj, Vukelja, & Simunovic, 2016).

Due to the importance of physical fitness for the present and future health of children, it is important that interventions use in studies something feasible, as well as to use reliable and valid measures for assessing fitness. Therefore, a couple of systematic reviews on the reliability and validity of physical fitness in preschool children tests have been performed. In short, a lot of articles that examine the reliability have been found and not one that examines the validity and fitness components correlation with health. Based on the previous literature, the importance of fitness test battery at an early age has been discussed. However, it is necessary to test the battery in preschool children first, in order to know how much it is feasible, i.e. the degree of reliability and validity of test. Also, it is necessary to examine whether and to what extent interrogators are trained to assess preschool children. If satisfactory results are achieved, improvements in future studies related to physical fitness in preschool children can occur.

There are some concerns about whether standardised tests work well in young children. The younger the child, the harder it is to get valid results. A preschool child is not able to fully understand the requirements of testing and may unexpectedly respond to testing conditions. The results are heavily influenced by the emotional state of the child and his/her experience, so over time test results may be relatively unstable. To address these limitations, researchers may choose to supplement the results of standardised tests with the results of informal measurements.

While most studies published data on reliability of several fitness tests with the help of the correlation coefficient, the corresponding data, such as system or accidental errors are necessary. Also, studies that analyse the reliability separately for 3, 4 and 5 years are missing, creating a problem, since dramatically rapid developmental changes occur in this period of life. Most important of all, according to the authors' knowledge, is that there are no studies that examine whether different educators, taking part in the teaching process, are capable of carrying out measurements of motor status. Field-based speed tests are usually evaluated with manual stopwatches. However, little information is available about the error between trained vs. untrained raters or between different raters in educational process.

Therefore, the aim of this study is to determine the capabilities and reliability of the measurer in assessing the motor status of children included in a specially selected sample of children aged 4 to 7 years, after the training of educators by the relevant institutions. It was assumed that there was no significant difference between experienced timekeepers and other educators in determining the motor status of children and that the educators were able to perform assessment.

Methods

Subjects

This research is part of bigger study that consisted of 1359 children (621 boys and 738 girls) from different schools in Vojvodina, 64 preschool children and 1295 elementary school students, aged 8 to 12 years. For the purpose of this study, i.e. determination of the interreliability of the timekeepers in the application of the tests a sample of preschool children was used. Data collection was performed in gyms in cities in Vojvodina. Gyms were large enough for the measurement to be conducted under requested conditions required by the measurement of anthropometric measures and motor tests standardisation. The measurement was conducted during physical education classes in kindergartens. Prior to the enrolment in the study, parents reported their child's health history and current activity status through a questionnaire and only healthy, recreational active adolescents from 4 to 7 years old were chosen. The study was approved by the Research Ethics Committee of the Faculty of sport and physical education in Novi Sad, and written informed consent was gained from both parents and children.

Procedures

Children's anthropometric and fitness measurements were performed early in the morning, at least 12 h fasted and 24 h from the last highintensity exercise effort. All measurements were repeated at the same time of day as close as possible to the resting condition. Measurements were taken in early-October (a month after the beginning of the school year).

Height was measured on a wall-mounted stadiometer to the nearest 0.5 cm. Weight was measured on a calibrated beam balance platform scale to the nearest 0.1 kg. Physical fitness of preschool children were estimated by the following tests: obstacle course backwards and hand taping. The tests are briefly described in Bala, Krneta & Katić (2010).

Education of kindergarten teachers, class teachers and physical education teachers

Education of kindergarten teachers, class teachers and physical education teachers was conducted at the Faculty of Sport and Physical Education, University of Novi Sad. All project participants attended practical and theoretical seminar.

Statistical Analyses

All the study variables were normally distributed. The analyses were performed using SPSS v.15 software for windows and the significance level was set at $p < 0.05$ for all the analysis. Analysis of variance (Anova) was used to evaluate the differences among raters. Post hoc testing was performed using the Bonferroni method. Interrater reliability was assessed using intraclass correlation coefficient (ICC).

Results

Obstacle course backwards

Table 1 shows correlation between results obtained from four timekeepers performing the backward polygon test with children 4-7 years of age, as a measure of applied motor tests reliability. Mean values and standard deviations (Mean±SD) of the given values of motor characteristics of students obtained from one testing, intraclass correlation coefficient (ICC), and confidence interval are shown.

In a sample of children aged 4-7 years, extremely high correlation coefficients in all timekeepers (confidence interval from 0.890 do 0.965) and high intraclass coefficient (0.935) are observed.

Table 1: ANOVA and intraclass confidence coefficient of different timekeepers

	Mean±SD	ICC	Confidence interval
Experienced timekeeper	21.59±2.31	0.935	0.890-0.965
Kindergarten teacher	21.32±2.73		
Class teacher	21.57±3.09		
PE teacher	21.91±2.33		

Realised significance levels obtained by using ANOVA exceed the limit of statistical significance ($p > 0.05$), indicating that there are no statistically significant differences between the results of the timekeepers. Also, we found the greatest difference occurs between class teachers and experienced timekeepers (not in the table) but without statistical significance ($p>0.05$).

Table 2: Cross- correlation matrix between timekeepers

	Experienced timekeeper	Kindergarten teacher	Class teacher	PE teacher
Experienced timekeeper	1.000	0.796	0.772	0.988
Kindergarten teacher	0.796	1.000	0.764	0.788
Class teacher	0.772	0.764	1.000	0.742
PE teacher	0.988	0.788	0.742	1.000

Table 2 shows the cross-correlation matrix of correlation between results of timekeepers. Results indicate high reliability between the timekeepers with the value ranging from 0.772-0.998. Maximum reliability is obtained between experienced timekeepers and subject teachers at school (0.975), while the minimum reliability occurs between experienced timekeepers and class teachers (0.772).

Hand tapping

Table 3 shows correlation between results obtained from four timekeepers performing the hand tapping test with children 4-7 years of age, as a measure of applied motor tests reliability. Mean values and standard deviations (Mean±SD) of the given values of motor characteristics of students obtained from one testing, intraclass correlation coefficient (ICC), and confidence interval are shown.

Table 3: ANOVA and intraclass confidence coefficient of different timekeepers

	Mean±SD	ICC	Confidence interval
Experienced timekeeper	17.01±4.39	0.972	0.961-0.981
Kindergarten teacher	16.83± 3.73		
Class teacher	16.76±4.13		
PE teacher	17.23± 4.31		

In a sample of children aged 4-7 years, extremely high correlation coefficients in all timekeepers (confidence interval from 0.961 do 0.981) and high intraclass coefficient (0.972) are observed. Realised significance levels obtained by using ANOVA exceed the limit of statistical significance ($p>0.05$), indicating that there are no statistically significant differences between the results of the timekeepers.

Table 4 shows the cross-correlation matrix of correlation between results of timekeepers. Results indicate high reliability between the timekeepers with the value ranging from 0.877-0.975. Maximum reliability is obtained between experienced timekeepers and subject teachers at school (0.975), while the minimum reliability occurs between experienced timekeepers and class teachers (0.877).

Table 4: Cross- correlation matrix between timekeepers

	Experienced timekeeper	Kindergarten teacher	Class teacher	PE teacher
Experienced timekeeper	1.000	0.877	0.925	0.975
Kindergarten teacher	0.877	1.000	0.850	0.873
Class teacher	0.925	0.850	1.000	0.899
PE teacher	0.975	0.873	0.899	1.000

Discussion

Nowadays, it is difficult to measure motor skills since opinions are divided on what exactly fine motor skills are and how should they be measured. However, experts and scholars in this field have no trouble recognizing the higher and lower levels of motor skills in children. Therefore, one of the goals of this study was to measure the motor skills in children in a way that would be understandable to a variety of professionals who work to improve the motor skills of children and to determine whether they are able to carry out monitoring of motor development in children. Although there were several groups of experts (kindergarten teachers, class teachers, coaches, health professionals and physical education teachers), kindergarten teachers, class teachers and physical education teachers were chosen for several reasons. Everyday experience of coaches can be biased towards children with higher levels of motor skills, as well as in case of health workers, physiotherapists-who may be biased towards children with weak or damaged level of motor skills. On the other hand, most kindergarten teachers, class teachers and physical education teachers work, on a daily basis, with children whose motor skills are developed differently. That is the reason for electing kindergarten teachers, class teachers and physical education teachers who would, by means of their experience, provide data for assessing the reliability of these batteries of tests. When the results regarding the children obtained by kindergarten teachers, class teachers and physical education teachers were compared with the results of experienced timekeepers on the battery of tests of the same children, a high correlation was obtained, both for girls and for boys. The value of obtained correlation (0.935-0.998) provides additional information on the reliability of the timekeeper in this tests. In previously conducted studies involving trained timekeepers, we noticed good test-retest reliability for the collection of physical fitness tests and effects of learning or fatigue were not noticed in subjects in all conducted tests (Ortega et al., 2008). Although the ideal option in every fitness testing is to have gold standard in particular measurement, some other instruments (stopwatch) are commonly used as a measuring instrument, because it is much cheaper and more feasible in certain circumstances, such as schools and basic study population (Hetzler, Stickley, Lundquist & Kimura, 2008).

Although it may seem that the timekeepers or trainers have very different purposes in managing motor tests, there are fundamental principles of measuring that are the basis for the testing, regardless of the purpose and who conducts the test. Timekeepers underwent basic training conducted by the Faculty of Sport and Physical Education, being the most relevant institutions in the country.

Conclusion

Based on the results of monitoring the development of motor skills and physical growth of children and students, it can be concluded that, after the training course, kindergarten teachers, class teachers and PE teachers have reached a level of training, which is sufficient in terms of monitoring the physical development of children and students, and that there are no significant differences in measurement results between the experienced timekeepers and other timekeepers.

References

1. Bala, G., Krneta, Ž., & Katić, R. (2010). Effects of kindergarten period on school readiness and motor abilities. Collegium antropologicum, 34(1), 61-67.
2. Hetzler, R. K., Stickley, C. D., Lundquist, K. M., & Kimura, I. F. (2008). Reliability and accuracy of handheld stopwatches compared with electronic timing in measuring sprint performance. The Journal of Strength & Conditioning Research, 22(6), 1969-1976.
3. Ortega, F. B., Artero, E. G., Ruiz, J. R., Vicente-Rodriguez, G., Bergman, P., Hagströmer, M., ... & Polito, A. (2008). Reliability of health-related physical fitness tests in European adolescents. The HELENA Study. International journal of obesity, 32, S49-S57.
4. Perez, C.A. (2013). Assessing health related fitness in the prechool setting by means of physical performance batteries: a narrative review. Journal of Physical Education and Sport 13(3): 287-297.
5. Šalaj, S., Vukelja, M., & Šimunović, D. G. (2016). Measuring the motor skills of children. In zZbornik radova 25. Ljetne škole kineziologa / Findak, Vladimir (ur.). - Zagreb : Tiskara Zelina, Zelina. 704-709.

TOWARD A MORE COMPLETE HISTORY OF KINESIOMETRICS (KINESIOMETRICS IN ZAGREB RESEARCH METHODOLOGY CIRCLE)

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Abstract

In this paper development of kinesiometrics in Zagreb kinesiology circle is presented.

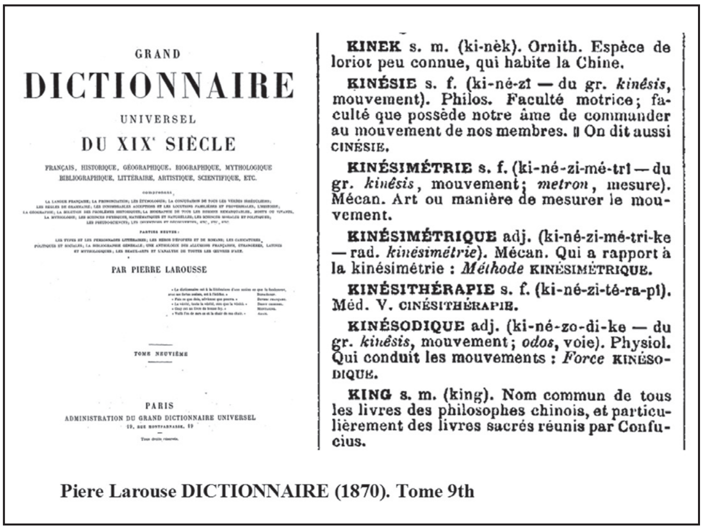
Related to previous experiences in observation and measurement of human movement the term kinesimetrics appeared as ***kinesimetrie*** "kinesimetrie" s.f. (ki-ne-zu-me-tri) – from greek: kinesis, movement; metron, mesur), 19th century Francophone circle. It was Momirović (1968/1969), who introduced the term "***kineziometrija***", "kinesiometry" i.e. "kinesiometrics", in two papers published as outcome of Zagreb methodological circle the term that incorporate measurement theory, statistics, and mathematical analysis in the area of kinesiology. With equivalent goal, but 30 years later, i.e. in 1998., the term "***kinesmetrics***" as a term for a discipline intended to develop and apply measurement theory. This short overview is the core of a more elaborate presentation scheduled for introductory speech for Research Methodology section at 8th International conference on Kinesiology at Opatija 2017.

Key words: *Kinesiometrics, kineziometrija, kinesmetrics, kinesimetrie, Research methods in kinesiology, Zagreb kinesiology circle, measurement theory and application*

Introduction

From the beginning of second part of 19th century appearance of kinesiology, introduced as a francophone term **cinesiologie** (Dally 1857, 1861), as science of movement in education hygiene and therapy further developed through 20th and first decade of 21st century the science of human kinetics i.e. kinesiology ("**kineziologija**", Croatian term).

What is today subsumed under the term kinesiology have been derived and integrated from several main academic streams of development under the different names proposed as: academic discipline of physical education in USA (Henry, 1964; Rarick 1967); human movement studies i Great Britain, Canada and Australia (Whittnig, 1970's); Sportwissenshaft in Germany, or science of physical culture, kinanthropology, anthropomotirka etc. More globalised integration came out from relative independent and distributed polycentric enterprises (Prot, 2015). Development of theory and application of measurement i.e. **kinesiometrics** through 20th and first decade of 21st century transcended kinesiology from the beginnings of scientific treatment of human motor behavior to fully developed academic discipline of science of human movement as it is known today. Three independent experiences or traditions developed similar or almost equivalent term related to the observation and measurement human movement. The first one historically is related to absorption of previous experiences in observation and measurement of human movement the termed as **kinesimetrie** "kinesimetrie" s.f. (ki-ne-zu-me-tri) – from greek: kinesis, movement; metron, mesur), what have been documented by Piere Larouse (1870) Grand Dictionnaire Universel de XIX siecle. Tome 9th page 1211 (Figure 1.) and repeated again in Complement de Dictionarie de l'Academie Francaise(1881), page 659.


GRAND
DICTIONNAIRE
UNIVERSEL
DU XIX' SIÈCLE

PAR PIERRE LAROUSSE

TOME NEUVIÈME

PARIS
ADMINISTRATION DU GRAND DICTIONNAIRE UNIVERSEL

KINEK s. m. (ki-nèk). Ornith. Espèce de loriot peu connue, qui habite la Chine.

KINÉSIE s. f. (ki-né-zî — du gr. *kinêsis*, mouvement). Philos. Faculté motrice; faculté que possède notre âme de commander au mouvement de nos membres. ‖ On dit aussi CINÉSIE.

KINÉSIMÉTRIE s. f. (ki-né-zi-mé-trî — du gr. *kinêsis*, mouvement; *metron*, mesure). Mécan. Art ou manière de mesurer le mouvement.

KINÉSIMÉTRIQUE adj. (ki-né-zi-mé-tri-ke — rad. *kinésimétrie*). Mécan. Qui a rapport à la kinésimétrie : *Méthode* KINÉSIMÉTRIQUE.

KINÉSITHÉRAPIE s. f. (ki-né-zi-té-ra-pî). Méd. V. CINÉSITHÉRAPIE.

KINÉSODIQUE adj. (ki-né-zo-di-ke — du gr. *kinêsis*, mouvement; *odos*, voie). Physiol. Qui conduit les mouvements : *Force* KINÉSODIQUE.

KING s. m. (king). Nom commun de tous les livres des philosophes chinois, et particulièrement des livres sacrés réunis par Confucius.

Piere Larouse DICTIONNAIRE (1870). Tome 9th

Figure 1: The terms KINESIMETRIE and KINESIMETRIQUE as presented in Piere Laruse (1870) Tome 9th, page 1211.

It was Momirović (1968/1969), who introduced the second one term “**kineziometrija**”, “kinesiometry” i.e. “kinesiometrics”, in two papers published as outcome of Zagreb methodological circle the term that incorporate measurement theory, statistics, and mathematical analysis in the area of kinesiology. The term entitles his courese for his lectures delivered at just opened graduate study of Kinesiology during 1971/72. Recorded lecture notes were entitled “Short course in kinesiometry”(“Kratki kurs iz kineziometrije”; Figure 5.). From that moment on kinesiometry became one of methodological sub disciplines of kinesiology (Mraković, Momirović, Hošek-Momirović, Metikoš, Hofman and Prot; 1987). Later on, the term “kineziometrija” had been included and presented in lexicographic literature Sport Lexicon (1984) and Anić and Goldstein (1999, 2002) dictionaries.

With equivalent goal the third one term “**kinesmetrics**” as a term for a discipline intended to develop and apply measurement theory, statistics, and mathematical analysis in the area of kinesiology (Zhu, 2010) appeared independently of previous two mentioned. The term “kinesmetrics” was coined by Weimo Zhu in 1998 when after he created a new doctoral program at the University of Illinois at Urbana-Champaign, USA in 1999. Although the term was introduced almost two decades ago, it is still unfamiliar to a certain number of professional kinsesiologist outside North America and some other English and non English speaking areas.

KINESIOMETRICS - Methodological Contributions from Zagreb Kinesiology Circle

Methodological research and achievements after 1971 in Zagreb methodology circle could be divided into the following three areas of data analysis:

1. **Kinesiometrics** (development of new theoretical and applied measurement models in measurement in kinesiology integrating measurement theory, multivariate statistics, and data analysis)
2. **Multivariate data analysis and statistics** (new models, methods and algorithms for data analysis)
3. **Informatics** (a field of computer science related to the development of new software for information systems, data analysis and management)

Proposed names and labels of these sub-fields were introduced and became part of the standard terminology used in the curricula at graduate and postgraduate studies.

The first recorded use of terms **kinesiometric equivalent** (kineziometrijski ekvivalent), and **kinesiometric mapping** (kineziometrijsko preslikavnje) in kinesiometric sense are in Momirovič (1969) articles: Mathematical Models for Programmed Teaching and Training, page 16; and Education of Professionals for Application of Programmed Teaching and Training, page 3.

It was K. Momirović, who introduced the term “kinesiometry” in his lecture notes for the course entitled “Short course in kinesiometry”(“Kratki kurs iz kineziometrije”; 88 pp) conducted at postgraduate study of Kinesiology during 1971/72, realizing the blueprint from 1969.

K. Momirović has been affiliated to Faculty of physical culture, University of Zagreb, and University Computing Center SRCE (Zagreb), University of Zagreb (Prot at all. 2008). Methods for determination of internal metric properties of measurement instruments were continually in focus of his attention. In measurement theory alternative approaches to classical test theory model are constantly being examined. Based on full assimilation of ideas of Guttman (1953) and

Harris (1962) he generalized the classical test theory, the generalization being that the errors of measurement are permitted to exhibit correlations non constant variability of error of measurements. Guttman ideas on partial image transformation (Guttman, 1953; Kaiser 1963) and Harris (1962), and insight in Guttman-Rao relationships leaded Momirović to new test theory model he named **Guttman measurement model**, to honor Louis Guttman contributions. This, alternative, approach have been applied in construction and reconstruction of composite measurement instruments i.e. composite tests and questionnaires (see e.g., Momirović (1966, 1969, 1972, 1974); Zakrajšek, Momirović and Dobrić (1976, 1977); Momirović and Gredelj (1980); Bosnar (1980); Momirović, Gredelj and Dobrić (1981); Momirović, Pavičić and Hošek (1984); Momirović (1988)). A new general model for the estimation of error of measurement, along with the measures of reliability and representativeness were proposed (Momirović, 1974; Momirović and Dobrić, 1976; Zakrajšek, Momirović and Dobrić, 1977; Momirović, Dobrić and Gredelj, 1978; Momirović and Gredelj, 1980; Momirović, Pavičić and Hošek, 1984). Additionally, upper and lower bound of reliability (under the new general model) were derived (Momirović, 1974, 1975; Momirović, Pavičić and Hošek, 1984). That enabled objective definition and estimation of homogeneity independently from the reliability itself. (Momirović, 1974 and1977).

The algorithms and implementations of programs were constantly improving from the initial SS program (MAPANAL) through the upgraded versions RTT7 (Statistical System, Momirović, 1980), RTT8 (GENSTAT version, Momirović and Prot (1986), along to the last version RTT12G. RTT12G coded in 380 lines of SPSS macro language code has 15 productive sections presents 44 indicators of measurement properties (23 devloped by Momirović & coauthors): Representativeness 6(2); Convergence of indicators 5(5); Reliability(CTT) 5(0); Reliability(PC) 6(1); Reliability(GUTT) 5(5); Homogeneity 6(5); Informativeness 4(3); Representativeness, reliability, and homogeneity of items 3; and Internal validity 4(2).

The achievements in **kinesiometrics**, **multivariate data analysis and statistics** and **Informatics** were reported in 30 papers published in the scientific journal Kineziologija in the period from 1971 to 1984 (Prot, 2016).

Conclusions

The term "**kineziometrija**", "kinesiometry" i.e. "kinesiometrics", appeared as outcome of Zagreb methodological circle incorporating mathematical foundations, multivariate statistics and data analysis in the area of kinesiology. Despite the different terms used: **kinesimetry**, **kinesiometry**, **kinesiometrics** or **kinesmetrics** the unified tretment of subject is obvious.

Published papers in Journal Kineziologija in the period from 1971 to 1984 are pointing out theoretical and practical importance of developments in **kinesiometrics**, **multivariate statistics and data analysis**, and **Informatics**. The leader of that methodological group of authors was profesor Kinstantin Momirović.

Late professors Konstantin Momirović, PhD. (1933-2014) and Petr Blahuš, PhD. (1944-2013) are not physically among us any more to stand for their ideas, but their legacy remains.

References

1. Prot, Franjo (2008) Research Methodology in Zagreb Methodological Circle. Milanović and Prot (eds.) Proccedings of 5. International Scientific Conference on Kinesiology. Zagreb, Croatia: 661-672.
2. Prot, Franjo; Ankica, Hosek; Ksenija, Bosnar; Vesna, Luzar-Stiffler; Vesna, Hljuz Dobric;, Zoran, Bekić; Marijan, Gredelj (2008): Konstantin Momirovic (1932-2004): Biography and Bibliography In: Luzar-Stiffler, V., V. Hljuz-Dobric, Z. Bekic. *Proc. ITI 2008 30th Int. Conf. Information Technology Interfaces*, Zagreb, University Computing Centre – SRCE, pp.200 (CD version: IEEE Cat.No. CFP08498-CDR; ISBN 978-953-7138-13-4; ISSN 13342762).
3. Prot, Franjo; Rado, Pišot and Peter, Blahuš (2015): Kinesiometrics or Kinesimetrics or Kinesmetrics or What's in a name? Abstract Book of 22nd International Symposiun on Biometrics, 28-30 Jun 2015, Dubrovnik, Croatia: 26.
4. Prot, Franjo (2015): Toward a More Complete History of Kinesiology/Human Movement, Sport and Exercise Science. Keynote lecture. Abstract book of 16th Congress of the International Society for the History of Physical Education and Sport, "Coming from the past, working in present, looking to the future: Aims, topics and results of sport history" August 18-22 2005. Split, Croatia: 39.

LOCOMOTOR SKILLS IN 4-YEAR-OLD PRESCHOOL CHILDREN: GENDER DIFFERENCES

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Abstract

Purpose: The aim of this study was to determine the differences between 4-year-old preschool boys and girls in locomotor skills assessing a Test of Gross Motor Development, second edition (TGMD-2) testing battery.

Methods: Sample consisted of 49 preschool children (24 boys and 25 girls), aged 4 years (M = 4.15 decimal years, SD = 0.26 decimal years). They were recruited from a kindergarten in Novi Sad, Serbia and only healthy children with signed parent approval were tested. Three locomotor skills (run, hop and horizontal jump) were assessed using TGMD-2. Descriptive statistics was calculated for all variables and differences between two groups of respondents in locomotor variables were estimated by Mann-Whitney test.

Results: Results of Mann-Whitney test showed that there were no statistically significant ($p > 0.05$) differences in results of all three locomotor variables between boys and girls. Although, boys had better scores in “Run” and “Horizontal Jump” tests, while girls had better score in “Hop” test.

Conclusions: Preschool boys and girls are physically very similar regarding to some biological characteristics such as body type, body composition, strength, and limb lengths. There are no big differences in locomotor skills between them, as well. Therefore, early childhood programs for development and improvement of fundamental movement skills could be the same for both boys and girls at that age.

Key words: *preschool, TGMD-2, physical education, motor development, physical activity, kindergarten*

Introduction

Preschool years are very important period for a child’s development, and improvement of fundamental movement skills (FMS). FMS are normally characterized as locomotor skills (e.g., run, jump and hop) and object control skills (e.g., throw, kick and catch) (Haywood & Getchell, 2009). They are considered as the base of advanced movements required for successful participation in physical activity (PA), such as sports and games (Clark & Metcalfe, 2002).

Common misconception is that children naturally develop FMS competence through process of maturation (Clark, 2005), but they also need practice and instructions to help them learn and develop FMS.

Lifestyles in today’s society are becoming more and more sedentary. Outdoor physical play is being replaced by less physical indoor activities such as playing video games, watching television and browsing the Internet (Tsai & Yang, 2012). Parents drive children to school instead of let them walk or drive a bicycle. The result is decrease in physical activity, which is associated with decreased physical and mental health (Fjortoft et al., 2011).

Appropriate PA throughout childhood has benefits to numerus health-related cardiovascular outcomes, such as blood lipid level and pressure, body fat, psychosocial measures as well as fundamental motor and movement skills (Saakslahti et al., 2004; Fisher et al., 2005; Timmons et al., 2007; Barnett et al., 2014). Moreover, children with motor difficulties also have complications with speech, reading, spelling and arithmetic (Alloway et al., 2009).

Test of Gross Motor Development, second edition (TGMD-2) estimates a child’s performance against a selected set of process criteria for each of motor skills and also compares the individual scores to a normative sample. As such, TGMD-2 is both a criterion-referenced and norm-referenced test (Burton & Miller, 1998). The psychometric properties of the TGMD-2 are well documented. The test manual reports good test–retest reliability and good inter-rater reliability with r values of >0.85, as well as a good to excellent internal consistency with Cronbach’s alpha coefficients of at least 0.85.

The purpose of this study was to determine the differences between 4-year-old preschool boys and girls in locomotor skills assessing a TGMD-2 testing battery.

Methods

Sample consisted of 49 preschool children (24 boys and 25 girls), aged 4 years (M = 4.15 decimal years, SD = 0.26 decimal years). They were recruited from a kindergarten in Novi Sad, Serbia.

None of those children showed neurological and internal diseases or mental and physical abnormalities that could negatively affect motor development and testing. No acute illness has been reported as well. Parents were introduced with study and they signed approval. The study was approved by the local ethics committee and meets the criteria of the declaration of Helsinki.

Three locomotor skills (run, hop and horizontal jump) were assessed using Test of Gross Motor Development, second edition (TGMD-2) (Ulrich, 2000).

Data were analyzed using IBM SPSS Statistics 23. Normality of distribution was checked with Kolmogorov-Smirnov test (KS). Descriptive statistics (Mean (M), Standard Deviation (SD), Minimum Score (Min), Maximum Score (Max)) was calculated for all variables and differences between two groups of respondents in locomotor variables were estimated by Mann-Whitney test.

Results

Kolmogorov-Smirnov test showed that data was not normally distributed, so Mann-Whitney test and descriptive statistics (Table 1) were used to estimate differences between two groups of respondents.

Table 1: Descriptive statistics and results of Mann-Whitney test

VARIABLE	Group	M	SD	Min	Max	Mean Rank	r	$\%_{diff}$	U	p
Run (score)	Boys	2.21	1.351	0	4	27.17	0.154	2.4	248.0	0.280
	Girls	2.00	1.103	0	5	22.92				
	Total	2.10	1.225	0	5					
Hop (score)	Boys	2.21	1.693	0	6	22.08	0.207	4.3	230.0	0.147
	Girls	2.88	1.777	0	6	27.80				
	Total	2.54	1.750	0	6					
Horizontal jump (score)	Boys	2.46	0.977	1	4	25.79	0.057	0.3	281.0	0.690
	Girls	2.29	1.160	0	5	24.24				
	Total	2.38	1.064	0	5					

M – Mean, SD – Standard Deviation, Min – Minimum Score, Max – Maximum Score, Mean Rank – Mean Rank for the two groups tested, U – Mann-Whitney U Test, r – Effect Size, %diff – Percentage difference, p – statistical significance level

Results of Mann-Whitney test showed that there were no statistically significant ($p > 0.05$) differences in results of all three locomotor variables between two groups of respondents. Boys had better scores in “Run” test ($r = 0.154$, small effect size with 2.4% difference) and “Horizontal Jump” test ($r = 0.057$, small effect size with 0.3% difference), while girls had better score in “Hop” test ($r = 0.207$, small effect size with 4.3% difference).

Discussion

As results showed, there were no statistically significant gender differences. Similar locomotor scores between preschool boys and girls can also be found in other studies (Li, 2009; Barnett et al., 2010; Goodway et al., 2010; Badrid et al., 2016). However, some studies of preschool children have found that total locomotor score tends to be higher among girls than boys (Hardy et al., 2010; Legear et al., 2012). Prepubertal boys and girls are physically very similar with minor differences in biological characteristics such as body type, body composition, strength, and limb lengths (Malina et al., 2004). It is more likely that gender differences are associated with children’s socialization which is influenced by family, peers and teachers (Thomas & French, 1985; Garcia, 1994). Small sample size could be the study limitation, as well as only three locomotor tests. Thus, the future studies should include more locomotor tests, as well as object control and coordination tests.

Conclusion

Most of the children attend preschool indicating that kindergartens could be a good place for intervention programs. Preschool years are an optimal period to introduce FMS, because movement patterns are not fixed yet. As there are no differences in locomotor skills or at least they are not so emphasized, early childhood programs for development and improvement of FMS could be the same for both boys and girls. More studies should be conducted considering the other locomotor skills, such as gallop, leap, slide, as well as object control skills (e.g., throw, kick and catch), which could show differences between boys and girls in FMS. Also, a bigger sample size including all preschool years could help distinguish possible differences.

References

1. Alloway, T. P., Rajendran, G., & Archibald, L. M. (2009). Working Memory in Children With Developmental Disorders. *Journal of Learning Disabilities,42*(4), 372-382. doi:10.1177/0022219409335214
2. Bardid, F., Huyben, F., Lenoir, M., Seghers, J., Martelaer, K. D., Goodway, J. D., & Deconinck, F. J. (2016). Assessing fundamental motor skills in Belgian children aged 3-8 years highlights differences to US reference sample. *Acta Paediatrica,105*(6), 281-290. doi:10.1111/apa.13380
3. Barnett, L. M., Beurden, E. V., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2010). Gender Differences in Motor Skill Proficiency From Childhood to Adolescence: A Longitudinal Study. *Research Quarterly for Exercise and Sport,81*(2), 162-170. doi:10.5641 /027013610x13088554297116
4. Barnett, L. M., Zask, A., Rose, L., Hughes, D., & Adams, J. (2015). Three-Year Follow-Up of an Early Childhood Intervention: What about Physical Activity and Weight Status? *Journal of Physical Activity and Health, 12*(3), 319-321. doi:10.1123/jpah.2013-0419
5. Burton, A. W., & Miller, D. E. (1998). *Movement skill assessment*. Champaign, IL: Human Kinetics.
6. Clark, J. E. (2005). From the Beginning: A Developmental Perspective on Movement and Mobility. *Quest*, 57(1), 37-45. doi:10. 1080/00336297.2005.10491841
7. Clark, J. E., & Metcalfe, J. S. (2002). The mountain of motor development: A metaphor. In J. E. Clark & J. H. Humphrey (Eds.), *Motor development: Research and review* (Vol. 2, pp. 62-95). Reston, VA: National Association for Sport and Physical Education.
8. Fisher, A., Reilly, J. J., Kelly, L. A., Montgomery, C., Williamson, A., Paton, J. Y., & Grant, S. (2005). Fundamental Movement Skills and Habitual Physical Activity in Young Children. *Medicine & Science in Sports & Exercise,37*(4), 684-688. doi:10.1249/01. mss.0000159138.48107.7d
9. Fjortoft, I., Pedersen, A.V., Sigmundsson, H., & Vereijken, B. (2011). Measuring physical fitness in children who are 5 to 12 years old with a test battery that is functional and easy to administer. *Physical Therapy*, *91*(7), 1087-1095.
10. Garcia, C. (1994). Gender Differences in Young Children's Interactions When Learning Fundamental Motor Skills. *Research Quarterly for Exercise and Sport,65*(3), 213-225. doi:10.1080/02701367.1994.10607622
11. Goodway, J. D., Robinson, L. E., & Crowe, H. (2010). Gender Differences in Fundamental Motor Skill Development in Disadvantaged Preschoolers From Two Geographical Regions. *Research Quarterly for Exercise and Sport,81*(1), 17-24. doi:10. 1080/02701367.2010.10599624
12. Hardy, L. L., King, L., Farrell, L., Macniven, R., & Howlett, S. (2010). Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport,13*(5), 503-508. doi:10.1016/j.jsams.2009.05.010
13. Haywood, K. M., & Getchell, N. (2009). *Lifespan motor development* (5th ed.). Champaign, IL: Human Kinetics.
14. Legear, M., Greyling, L., Sloan, E., Bell, R. I., Williams, B., Naylor, P., & Temple, V. A. (2012). A window of opportunity? Motor skills and perceptions of competence of children in Kindergarten. *International Journal of Behavioral Nutrition and Physical Activity,9*(1), 29-33. doi:10.1186/1479-5868-9-29
15. Li, L. (2009). Children's gross motor development from ages 3 to 10 in Shandong. *Journal of Shandong Institute of Physical Education and Sports,25*(4), 47-50.
16. Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity*. 2nd ed. Champaign, IL: Human Kinetics.
17. Saakslahti, A., Numminen, P., Varstala, V., Helenius, H., Tammi, A., Viikari, J., & Valimaki, I. (2004). Physical activity as a preventive measure for coronary heart disease risk factors in early childhood. *Scandinavian Journal of Medicine and Science in Sports,14*(3), 143-149. doi:10.1111/j.1600-0838.2004.00347.x
18. Thomas, J. R., & French, K. E. (1985). Gender differences across age in motor performance: A meta-analysis. *Psychological Bulletin,98*(2), 260-282. doi:10.1037/0033-2909.98.2.260
19. Timmons, B., Naylor, P. & Pfeiffer, K. (2007). Physical activity for preschool children–how much and how? *Canadian Journal of Public Health*, *98* (2), 122-134.
20. Tsai, C. Y., & Yang, S. C. (2012) Study on the appearance of childhood games. *Journal of Educational Studies*, *46*(1), 1-19.
21. Ulrich, D. A. (2000). *Test of Gross Motor Development* (2nd ed.). Austin, Tex.: PRO-ED.

IMPACT OF AGING ON CONTRACTILE PERFORMANCE OF WHOLE MUSCLE AND SINGLE MUSCLE FIBERS

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Contractile performance of skeletal muscles, measured as maximal voluntary contraction or as peak power, shows a progressive continuous decline with aging. The decline can be exarcebated by disuse or by intercurrent diseases. The functional impairment finds a first explanation in the progressive decrease of muscle mass. Both the functional and structural declines are more pronounced in lower limbs than in upper limbs.

Muscle fibers represent the active component of skeletal muscles. They share their contribution to muscle mass with connective tissue (present as endomysium, perimysium and epimysium), adipose infiltration, blood vessels. Studies on single muscle fibers allow the identification of their specific contribution to the age-dependent decline of performance.

In our laboratory we carried out comparative analysis on subjects of different ages (young (20-30 y), old adult (60-70 y), oldest old (85-95 y)) measuring whole muscle mass and contractile performance and single muscle fiber dimension and ability to generate force. The results revealed that the age-related decrease in whole muscle performance is due to a combination of preserved intrinsic contractile function with a decrease in size of single muscle fibers. These results may be relevant to design protocols to prevent or slow down the contractile performance decline.

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BASICS OF QUALITATIVE RESEARCH

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Introduction

Brockett and Hiemstra (1991) challenge researchers to expand the knowledge base through qualitative research. This "going beyond the iceberg" (p. 83), through participant observation, or case study, or in-depth interviews, encourages researchers to study in a natural setting. Qualitative research is an inductive process that attempts to understand the meaning of one's process or experience.

Purpose

The purpose of this paper is to outline the basics of qualitative research. Houle (1961) calls on the investigative society to consider a different style of research that will focus on new paradigms by isolating the voice of the individual. Kuhn (1970) similarly invites the research community to go beyond traditional means of research and consider different ways of arriving at evidence. Kuhn encourages researchers to welcome and attempt to understand the anomalies that may occur in one's investigation. Houle adds, "The history of scientific investigation is littered with the wreckage of ideas that once seemed wholly logical…it is time to discover what they [adult learners] are doing" (Houle, 1961, p. 34). Similarly, this research was a discovery of what older adults in this rural setting are doing. Qualitative research has contributed new information, especially from various samples that have been previously overlooked (Mason, 1996). A qualitative perspective can help to capture the nuances by welcoming anomalies in the discussion and by focusing on actual activities. Qualitative research enables scientists to actively participate in problem finding, to clarify the complexity of difficult situations, and to develop new theory. This is the "goodness" of qualitative research (Peshkin, 1993).

In addition, this research was a qualitative design, which "seek[s] to discover and understand a phenomenon, a process, or the perspectives and world views of the people involved" (Merriam, 1998, p.11). Data was collected primarily through interviews, but included some observations and documents. The results of this research were a combination of the data from the interviews and an analysis based on the research questions.

Methods

The method used for this paper was to integrate the essential elements of previous research papers.

Results

The primary instrument in qualitative research is the researcher. The entire design of the study was filtered through my subjectivity. Bogdan and Biklen (1982, 1992) urge researchers to be persistent, flexible, and creative. The character of the researcher is important to consider, for example, as primary researcher I attempted to model the professional nature of this work, respected the participants, and was committed to truth and honesty (Patton, 1990).

The interaction between the sample and the researcher is a vital aspect of the research process. This includes the difficulty of relating to another person, phone calls, interruptions, and surprises during this process. This acknowledges the human side of research from the emotional frustration inherent in the work and extends to friendship that can develop in the process (Cotterill & Letherby, 1994). In addition, Seidman (1998) challenges researchers to have a genuine interest in others. I attempted to get to know the participant during the two interviews, demonstrated an interest in the person, and acknowledged there will be a mutual relationship as a result of this interaction (Lawrence-Lightfoot & Davies, 1997).

In order to arrive at a sample that has been purposively chosen, the researcher must have a set of criteria. This involved carefully creating a list of attributes for the sample based on the purpose of the study and its theoretical lens (Merriam, 1998). Like a coach crafting a team by scouting for specific recruits, the researcher should be diligent to have a sample that reflects the purpose of the study.

The sample selected in qualitative research is the result of a careful, purposive, and collaborative process. Purposeful sampling was used in order to address the problem of this research. Purposeful sampling is a process whereby the researcher carefully chooses participants that will provide information rich cases (Patton, 1990). These cases supplied considerable data for analysis based on the focus on this research.

Collecting data can be compared to walking a tightrope. I attempted to balance between the world of the participant and the research process. The dialectic of joining the participant's world - yet remaining detached, or learning from the participants - yet not becoming like them was a part of the interview process (Bogdan & Biklen, 1992). The data collection involved three methods, primarily interviews, but also documents and observation. I recorded and transcribed the interviews; it is important to consider the impact of using a recorder, as well as becoming familiar with its use (Ives, 1988).

The primary data collection technique for this research was through interviews. Seidman (1998) offers appropriate information for interviewers. Like a prophet preaching a code of conduct, he lists several suggestions for obtaining productive and quality data:

Listen more, talk less…Follow up on what the participant says…Avoid yes, no and leading questions, use open-ended questions…Don't interrupt a response, but follow up with a question…Ask the participant to tell a story about the subject… Keep the participant focused and ask for details…Pretend as if you are someone else, and have him or her talk to you in this way…Don't take things personally… Avoid reinforcing certain responses, especially those that you like… Follow your hunches…Use the interview guide…Tolerate silence…. (pp. 63-77)

In qualitative research, the interview is often the main source of data. Therefore, all aspects of the interview are carefully attended, from the initial walk through the front door to the final transcription. Patton (1990) discusses using an interview guide where topics and issues are specified in advance, yet the interviewer will decide the sequencing and wording during the interview. The outline allows for the collection of data to be somewhat systematic for each respondent, and if there are gaps, they can be anticipated and closed. The interview should remain fairly conversational and situational. The flexibility of this format can allow for change in the sequencing and wording of questions.

In addition, an informal conversational interview can add important dimensions (Patton, 1990). This natural flow from the immediate surroundings permits an informal interview that takes advantage of the context of the moment. This also allows for observation as well as flexibility so the interviewer can adapt the interview to the individual. Observation and documents is also a significant part of this process.

"Data analysis is a process of making sense out of the data" (Merriam, 1998, p. 178), becoming intimately familiar with data (Bogdan & Biklen, 1992), and being able to handle large amounts of information (Patton, 1990). This process is a systematic way for the researcher to learn the details of the data and to organize the material. This process begins during data collection and intensifies during the research. Although there are a variety of ways to analyze data in qualitative research, I incorporated the constant comparative method (Glaser & Strauss, 1967). Continually reviewing biographical information helped me to keep the details on each participant straight.

As I read through the transcribed interview, I was looking for common units of information that are related to the research questions. This inductive analysis took place as soon as possible after the interviews. "Inductive analysis means the patterns, themes, and categories of analysis come from the data; they emerge out of the data rather than being imposed prior to data collection" (Patton, 1990, p. 390).

There were several specific steps to the constant comparative method. I was constantly comparing the incidents in the data and various categories emerged. This was a detailed process where I systematically went through each unit of information. Each interview was separately analyzed; observation and documents added veracity and depth to the findings. I became intimately acquainted with the data in the interviews, field notes, and documents. I considered one data set, such as one interview, and then compared one episode or data bit with another within the same set of data (Dey, 1993). I made detailed notes about specific units of data on separate sheets of paper. In this laborious process, the various units that have something in common were grouped together forming a category. Each category was labeled. These categories reflect regular patterns that are in the data. This process continued until all the notes on the data had been assigned to various categories (Glaser & Strauss, 1967; Merriam, 1998). After this process had been completed within each data set, then comparisons were made across data sets.

Personal biases and personal subjectivity may be reflected in biographical information. I am a white, single, early aged 'senior' male. I am originally from a large family, a small rural town in south Georgia, and as an adult I have lived in various states in the USA and in Central Europe. I have worked in education for 40 years, with one religious organization as well as the university campus. I recognize I needed to be careful to not emphasize or become sentimental toward my particular interests. Taming one's subjectivity creates a more open climate for interaction. Since I have a tendency to be focused on responses that lean toward health, recreation, and religion, personal monitoring enabled me to keep focused on the purpose of the study. I have degrees in social work, counseling, recreation, adult education, and gerontology.

Conclusion

This paper has presented to you the basics of qualitative research. Based on various previous research projects this outline can help to provide the foundation for introduction of using qualitative research. Fakulties of research and sport in this area have overlooked the insight from social science. This is an opportunity to bridge this missing part of our field.

References

1. Bogdan, R. C., & Biklen, S. K. (1992). *Qualitative research for education: An introduction to theory and methods* (2nd ed.). Boston: Allyn and Bacon.
2. Brockett, R. G., & Hiemstra, R. (1991). *Self-direction in adult learning: Perspectives on theory, research, and practice.* New York: Routledge, Chapman, and Hall.
3. Cotterill, P., & Letherby, G. (1994). The "Person" in the researcher. In R. G. Burgess (Ed.), *Studies in qualitative methodology* (pp. 107-136). Greenwich, CT: JAI Press.
4. Dey, I. (1993). *Qualitative data analysis: A user-friendly guide for social scientists.* New York: Routledge.
5. Glaser, B. C., & Strauss, A. (1967). *The discovery of grounded theory.* Chicago: Aldine.
6. Houle, C. (1961). *The inquiring mind.* Madison: University of Wisconsin Press.
7. Kuhn, T. (1970). *The structure of scientific revolutions.* Chicago: University of Chicago Press.
8. Ives, E. D. (1988). *The tape-recorded interview: A manual for fieldworkers in folklore and oral history* (2nd ed.). Knoxville, TN: The University of Tennessee Press.
9. Lawrence-Lightfoot, S., & Davis, J. H. (1997). *The art and science of portraiture.* San Francisco: Jossey-Bass.
10. Mason, J. (1996). *Qualitative researching.* San Francisco: Sage.
11. Merriam, S. B. (1998). *Qualitative research and case study applications in education.* San Francisco: Jossey-Bass.
12. Patton, M.Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage.
13. Seidman, I. (1998). *Interviewing as qualitative research: A guide for researchers in education and the social sciences.* New York: Teachers College Press.

PSYCHOSOMETRIC PROPERTIES OF THE LITHUANIAN VERSION OF LEADERSHIP SCALE FOR SPORTS

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Abstract

The main factor influencing the effectiveness of training sportsmen is an ability of a coach to specialize and individualize athlete‘s physical, technical, and tactical training. The effectiveness of sports training is related to coach leadership. The concept of leadership depends on the person‘s ability to effectively use control and management skills in changing situations and ensure the effectiveness of management (Brown, 2001). Leadership as a process of influence on individuals and social groups pursuing specific goals in the field of physical activity is evident during the processes of goal setting and decision making, motivating sportsmen, giving feedback, managing a group of sportsmen and building relationships in a team (Weinberg & Gould, 2007). The aim of the research was to adapt the Lithuanian version of Leadership Scale for Sports and determine the validity of the instrument. Objects and methods of investigation. The participants of the research were basketball players from 12 to 18 years old (n-230) who volunteered to take part in the research. The objects of the research were chosen using “convenience’ sampling. A Lithuanian version of Leadership Scale for Sports (LSS) Chelladurai, Saleh, 1980) was prepared. The participants of this research had to evaluate the statements of Leadership Scale for Sports using the 5-point Likert scale, ranging from “strongly disagree” to “strongly agree”. Results**.** Analysis of the inner compatibility of the questionnaire demonstrated a high compatibility of questions according to the phenomenon being measured (Cronbach a -0.950) and confirmed the validity of research method. The rate of inner compatibility of the LSS subscale “Training and instruction” was 0.839, “Social support” – 0.723, “Democratic behavior” – 0.683, “Positive feedback’ – 0.651, ‘‘Autocratic behavior’ – 0.506. The analysis of subscale relationships demonstrated a strong correlation between “Social support” and “Positive feedback” subscales (r=0.852, p<0.01), “Democratic behavior” (r=0.724; p,0.01) and subscales “Training and instruction” and “Democratic behavior” (r= 0.740, p<0.01). A reverse correlation between subscales “Autocratic behavior” and “Social support” (r=-0.451, p,0.01) and “Training and instruction” was determined.

Key words: *leadership styles of coaches, basketball, validity*

A CLINICAL DEFINITION OF SARCOPENIC OBESITY IN A TRANSNATIONAL POPULATION OF ACTIVE ELDERLY VOLUNTEERS

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Research Methodology

Purpose: Sarcopenia affect life quality, morbidity and mortality in the elderly with a prevalence of 25%. There is a lack of agreement on body composition indices to assess such a condition in daily clinical practice. body composition, more than BMI, is a primary determinant of health and a better predictor of mortality risk than BMI. Kyle et al. (2003) have defined the values of fat-free mass index (FFM index) for each BMI categories. We aimed to define a new index for sarcopenia using anthropometric, bioimpedance and muscle strength strength (hand-grip) data in a healthy and active elderly population.

Methods: 907 active elderly subjects (535 women, aged 66±5y; 371 men, aged 67±5y), able to walk continuously without support, for at least 2 km, participated to the PANGeA International Epidemiological Project. Body mass index (BMI, kg/m^2), abdominal circumference (AC, cm), fat mass index (FM index, kg/m^2) and fat-free mass index (FFM index, kg/m^2) and FM-to-FFM ratio, assessed by bioimpedance, hand-grip strength (HG, kg), and cardiorespiratory fitness (VO_2Max, cycloergometer) were evaluated and correlated.

Results: FFM index, FM index and FM-to-FFM ratio significantly correlated with BMI both in men and women ($p<0.001$, R=0.78 for men, R=0.70 for women; $p<0.001$, R=0.84 for men, R=0.94 for women; $p<0.001$ R=0.68 for men, R=0.85 for women, respectively). All individuals within the lowest (BMI vs FFMindex ratio and BMI vs FM index) or the highest (or FM-to-FFM ratio) quartile were considered sarcopenic. Correlation between FFM index and BMI significantly predict sarcopenia with 85% accuracy as well as correlation between FM/FFM ratio and BMI. Men and women with predicted sarcopenia showed lower muscle strength cardiorespiratory fitness and muscle mass as compared to the non-sarcopenic volunteers ($p<0.0001$ for all comparisons).

Conclusion: FFM index and FM/FFM ratio are promising indices of sarcopenia in healthy elderly volunteers.

Acknowledgment

This study was performed in collaboration with prof. Rado Pišot, PhD, head of Science and Research Centre, Koper, Slovenia.

METRIC PROPERTIES OF THE ATTITUDE TOWARD FEMALE BOXING SCALE

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Abstract

The aim of this study is to establish the metric properties of the Attitude toward female boxing scale (FBA, Vaci, 2013) on adult population. The study was conducted on 563 midlife adults of both sexes aged 40 to 65 years, from different parts of Croatia. The participants were given questionnaire with FBA scale incorporated into the Attitude toward combat sports scale (SBS, Bosnar et al., 1996) and a seven-point scale of general attitude toward boxing (BOX7). The FBA scale show excellent metric properties. Cronbach's alpha coefficient of reliability is high α=0,85; the face validity of the scale is confirmed by correlations with SBS and BOX7 scale.

Key words: *combat sports, gender stereotypes, midlife population*

Introduction

The development of female sport was severely endangered by the gender stereotypes. Krane et al. (2004) pointed out that due to gender stereotypes, female athletes are living in two cultures; in sport culture, dominant values are stereotyped "masculine", in their larger social culture women are under pressure to show "femininity". Many of sports are viewed to be acceptable for men, and not for women. In population of Croatia, "masculine" sports are rugby, boxing, wrestling, ice hockey, weight lifting, body building, moto and aero sports, rowing, football etc. (Prot and Bosnar, 2006; Prot and Žugaj, 2011). In the research on the sample of university students with different majors, participants were asked to assess femininity or masculinity of 70 sports on the 7-point scale where 1 denotes "feminine sport" and 7 is "masculine sport" (4 is neutral point); boxing was rated 6,26 (Bosnar and Žugaj, 2008). Vaci (2013) found that even kinesiology students have more positive attitudes towards male boxing than female boxing. Interviewing Hungarian female members of national team in rhythmic gymnastics, Béki and Gál (2013) experienced that female rhythmic gymnasts expres stereotypes and prejudices about female boxers, even when they do not have any personal experience. Based on interviews and media in the United States, Fields (2008) states that „In contrast to the negative attitude toward female pro boxers, the attitude toward female amateurs has been surprisingly positive" (p.129) what is explained by difference in believes about motives of two groups of female boxers. Gender stereotypes in sports, combat sports in a particular, are of general interest to be understand to promote gender equity in more realistic way. The aim of this study is to evaluate the Attitude toward female boxing scale (FBA) as practical tool for the study in the field.

Methods

The study was conducted on 563 midlife participants from different parts of Croatia. The data were collected by students during holidays while they were at home; students used snowball sampling technique, where first in the chain were their parents and neighbors. The sample consists of 283 males and 279 females (one with missing data) aged 40 to 65 years; the most of them are married (77,6%), and have in average 2,08 children; the most of them are employed (74,56%); 53,65% completed high school and 37,61 of sample graduated at the university.

The questionaire which was used in this research consisted of The attitude toward female boxing scale (FBA, Vaci, 2013), The attitude toward combat sports scale (SBS, Bosnar et al., 1996), and a seven-point scale of general attitude toward boxing (from 1 = „I hate boxing" to 7 „I adore boxing"). In this study, the eight items of FBA scale were hiden among 20 items of The attitude toward combat sports scale. The FBA scale was constructed by Nataša Vaci (2013) in the research of gender differences in kinesiology students; on that sample scale had adequate metric properties. It consists of 8 items with responses on the 5-point scale, from 1 = „strongly disagree" to 5 = „strongly agree" (Table 1). In the calculation of total result, the responses were rescaled in a way that higher value means more positive attitude toward female boxing.

The data analyses were done by software package Statistica 13.

Results and discussion

The results of the item analysis of FBA scale (Table 1) show that all eight items are well chosen; in all items, the full range of responses (1-5) and high standard deviation is observed; all items have adequate values on the first principle component and moderate to high correlations with the total result. The correlations of items range from low to not to high 0,655 (Table 3), giving the average inter-item correlation of 0,425. The spectral analysis of item-correlation matrix resulted in two eigenvalues higher than 1 (Figure 1). The second eigenvalue is almost four times smaller than first; it is very close to 1 (1,082) and possibly is the result of over factorization. The analysis of metric properties of the total result of FBA scale (Table 2) show high Cronbach's alpha coefficient of reliability α=0,85. The distribution of total result (Figure 2) show acceptable variability; it is not significantly different from normal (Kolmogorov-Smirnov d=0,03855).

Validity of FBA scale is examined by correlations between the Attitude toward combat sports scale (SBS, Bosnar et al., 1996), and a seven-point scale of general attitude toward boxing (BOX7, Table 4). The correlations in Table 4 are high enough to confirm face validity of FBA scale.

Table 1: Descriptive statistics, values on first principle component and the item-total correlations of scale items

	Item	Mean	SD	K1	R_{it}	A_{min}
1.	The boxing skills are useful for everybody, and for the women too.	3,78	1,220	-0,496	0,400	0,858
2.	The women who practice boxing are mannish persons.	3,37	1,332	0,717	0,670	0,827
3.	To me, it is very ugly to see woman boxing.	2,98	1,443	0,813	0,682	0,825
4.	The boxing is not an activity for woman.	2,95	1,434	0,785	0,717	0,821
5.	Women practice boxing just to draw attention to themselves, and not because they are good in it.	3,48	1,224	0,776	0,598	0,836
6.	Woman practicing male sport (like boxing) definitely has some personal problem.	3,45	1,282	0,771	0,662	0,828
7.	The boxing practice builds self-confidence and self-esteem in both sexes.	3,62	1,093	-0,547	0,452	0,851
8.	Women should be equal in any aspect of life therefore it is necessary to develop the female boxing.	3,40	1,292	-0,674	0,568	0,840

Legend: SD = Standard deviation; K1=value on the first standardized principle component; R_{it}=item–total correlation; A_{min}=value of Cronbach's alpha coefficient if item is deleted from the total result.

Table 2: The metric properties of the total result of the Attitude toward female boxing scale

Number of items	8
Number of valid cases	543
Mean	27,04
Standard deviation	7,28
Minimum value	8
Maximum value	40
First eigenvalue of correlation matrix and percentage of total variance	3,987635 (49,85%)
Average inter-item correlation	0,425
Cronbach's alpha coefficient of reliability	0,854
Standardized Cronbach's alpha coefficient	,851

Table 3: The correlations of items of the Attitude toward female boxing scale

Item	1	2	3	4	5	6	7	8
1) The boxing skills are useful for everybody, and for women too.	1,000	-,282	-,311	-,286	-,208	-,250	,405	,332
2) The women who practice boxing are mannish persons.	-,282	1,000	,582	,579	,486	,579	-,292	-,439
3) To me, it is very ugly to see woman boxing.	-,311	,582	1,000	,655	,489	,524	-,332	-,401
4) The boxing is not an activity for woman.	-,286	,579	,655	1,000	,534	,550	-,358	-,479
5) Women practice box just to draw attention to themselves, and not because they are good in it.	-,208	,486	,489	,534	1,000	,605	-,245	-,359
6) Woman practicing male sport (like boxing) definitely has some personal problem.	-,250	,579	,524	,550	,605	1,000	-,276	-,428
7) The boxing practice builds self-confidence and self-esteem in both sexes.	,405	-,292	-,332	-,358	-,245	-,276	1,000	,396
8) Women should be equal in any aspect of life; therefore, it is necessary to develop the female boxing.	,332	-,439	-,401	-,479	-,359	-,428	,396	1,000

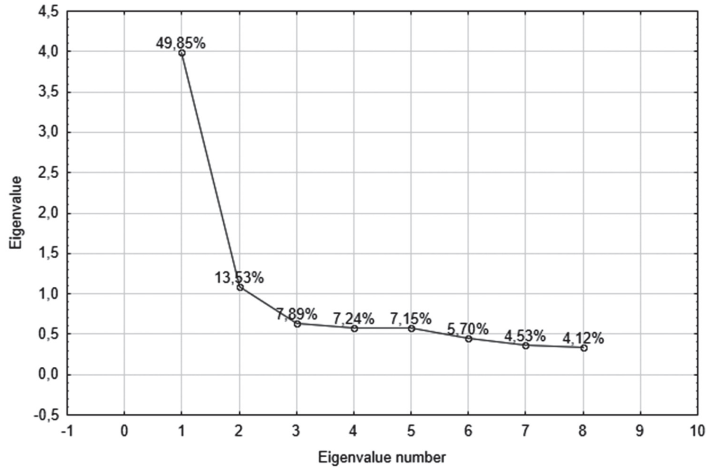

Figure 1: Scree plot of eigenvalues of the correlation matrix of Attitude toward female boxing scale items.

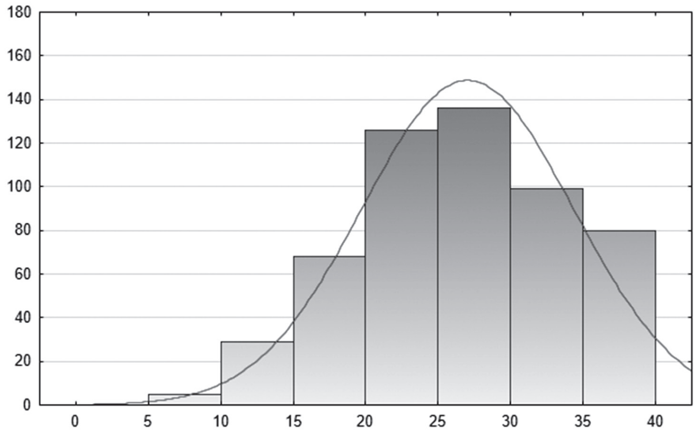

Figure 2: Distribution of the total result of FBA scale. On the horizontal axis are the category boundaries of the results; on the vertical axis are the frequencies of the results. Full line represents the expected normal distribution.

Table 3: The correlations of the total results of the Attitude toward female boxing scale (FBA), The attitude toward combat sports scale (SBS), and a seven-point scale of general attitude toward boxing (BOX7)

	FBA	SBS
SBS	0,715	
BOX7	0,490	0,753

Conclusion

The attitude toward female boxing scale (Vaci, 2013) was evaluated on the sample of midlife adults from Croatian population, and it presented excellent metric properties. In this research, the items of FBA scale were incorporated into the Attitude toward combat sports scale. The next step of evaluation of the FBA scale should be the research in which the FBA scale is used without any connected instrument to avoid context impact.

References

1. Béki, P. & Gál, A. (2013) Rhythmic Gymnastics vs. Boxing: Gender Stereotypes From the Two Poles of Female Sport. Physical Culture and Sport. Studies and Research, 58: 5-16.
2. Bosnar, K., Sertić, H., i Prot, F. (1996). Konstrukcija skale za procjenu stava o borilačkim sportovima. Zbornik radova “5. ljetna škola pedagoga fizičke kulture Republike Hrvatske”. Findak, V., (ur.). Zagreb: Savez pedagoga fizičke kulture, 73-75.
3. Bosnar, K. i Žugaj, S. (2008). Gender Typing of Sports in Croatian University Students. In: Doupona Topič, M. & Ličen, S. (Eds.). Sport & Culture & Society 5th Conference of the European Association for Sociology of Sport.
4. Fields, S. K. (2008). Female Gladiators: Gender, Law, and Contact Sport in America Champaign: University of Illinois Press.

5. Krane, V., Choi, P. Y. L., Baird,S. M., Aimar, C. M. & Kauer, K. J. (2004). Living the Paradox: Female Athletes Negotiate Femininity and Muscularity. Sex Roles, 50: 325-329.
6. Prot, F., Bosnar, K. (2006). Gender differences in sport interests. 26th International Congress of Applied Psychology. Athens, Greece: IAAP.
7. Prot, F., Žugaj, S. (2011) Latentna struktura rodnih streotipa u sportu. Zbornik radova 21. ljetne škole kineziologa Republike Hrvatske. Poreč, 169-175.
8. Vaci, N. (2013). Stav prema ženskom boksu studenata kineziologije. Diplomski rad, Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.

INTERRATER RELIABILITY AND CRITERION VALIDITY OF THE 20M SINGLE SPRINT TEST IN PRESCHOOL CHILDREN

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Abstract

Purpose: Little information is available about the resultant error when compared hand timing with a gold standard for timemeasuring in fitness testing, such as photoelectric cells. Therefore, the aim of this study was to determine the validity and interreliability of speed on a sample of children aged 4 to 7 years.

Methods: A total of 25 preschool children aged 4–7 years voluntarily participated in this study. We measured the time required to cover 20 m on a straight track. This study assessed the interrater reliability for the 20-m running speed tests by comparing the time measured by a trained and untrained rater. Criterion related validity was studied comparing the time measured by the trained raters with the time recorded by the photoelectric cells (the gold standard).

Results: Non-significant differences ($p > 0.05$) were observed between two raters (ES = trivial; CI 90% (-0.19; 0.04; p=0.09), and between photoelectric cells and trained rater (ES = trivial; CI 90% (0.00; 0.13; p=0.86) for 20m running speed test. We found very high Pearson correlation coefficients in cells vs. trained rater (confidence interval from 0.95 to 0.99) as well as high coefficient (0.94) in trained vs. untrained rater.

Conclusion: Previous findings together with those in this study indicate that if we want to achieve high scientific standards at the population level or high precision on an individual level, researcher must be adequately trained in order to provide valid and reliable time measure. To conclude, the time measured manually with a stopwatch seems valid and reliable method for measuring the speed in large studies involving preschool children.

Key words: *fitness, testing, exercise, methodology*

Introduction

The preschool period is very important for the formation of the personality. During this period we build the motor abilities and later, we only learn a variety of modifications and adjustments to various situations in life (Bala, 2002). The growth of children, intellectual and emotional development, behaviour and stages of socialisation should not be seen as isolated elements of an individual. Integral development, as the theory suggests,(Ismail & Gruber, 1971 according to: Bala, 2002) closely relates motor, intellectual and emotional in the development of the child.

Measuring motor skills in preschool children is a complex and difficult task. Based on previous experiences, preschool children find it difficult to respond to stimuli in terms of motor skills, especially those that are expressed verbally. Since the predeterminant of each successful test is providing the maximum of available resources, some authors (Luke & Sinclair, 1991) believe that, in the very beginning, it is necessary to perform selection of children based on motivation and maturity. These authors have encountered this type of problem in the primary school, which adds weight to it since the motor skills in preschool children are being tested. Thus, the test results often tend to be confusing and bewildering. Beside changing and improving the system for monitoring students in physical education classes in other countries, it should be noted that there is no specific uniformly accepted concept and model for monitoring physical and motor skills development of students in schools. It is therefore of great importance to explore the possibilities of monitoring physical and motor skills development of students within physical education classes in the elementary school, as well as of children in kindergartens.

When it comes to assessing most of motor skills in young children, such as, for example, the assessment of cardiorespiratory endurance, this assessment is not the most accurate and the validity of the instruments applied in this age group is highly questionable (Malina et al., 2004). There are some concerns about whether standardised tests work well in young children. The younger the child, the harder it is to get valid results. A preschool child is not able to fully understand the requirements of testing and may unexpectedly respond to testing conditions. The results are heavily influenced by the emotional state of the child and his experience, so over time test results may be relatively unstable. To address these limitations, researchers may choose to supplement the results of standardised tests with the results of informal measurements.

Field-based speed tests are usually evaluated with manual stopwatches. However, little information is available about the resultant error when compared with a gold standard for timemeasuring in fitness testing, such as photoelectric cells. Therefore, the aim of this study was to determine the validity and reliability of measuring as well as of the timekeeper's speed assessing of a special selected sample consisting of children aged 4 to 7 years. It was assumed that between an experienced timekeeper and other educators there was no significant difference in determining the speed and that there was no difference between testing speed by using a stopwatch and photocells.

Methods

Subjects

This research is part of bigger study that consisted of 1359 children (621 boys and 738 girls) from different schools in Vojvodina, 64 preschool children and 1295 elementary school students, aged 8 to 12 years. For the purpose of this study, a total of 25 preschool children aged 4–7 years voluntarily participated in this study. The study was approved by the Research Ethics Committee of the Faculty of sport and physical education in Novi Sad, and written informed consent was gained from both parents and children.

Table 1: Descriptive characteristics of preschool children

Age (years)	5.63±1.04
Body height (cm)	116.91±7.40
Body mass (kg)	21.19±4.25
BMI	18.26±1.61

Procedures

This study assessed the interrater reliability for the 20-m running speed tests by comparing the

time measured by a trained and untrained rater. Criterion related validity was studied comparing the time measured by the trained raters with the time recorded by the photoelectric cells (the gold standard).

20-m running speed test.

This test was used to assess speed . We measured the time required to cover 20 m on a straight track. At the starting line, participants stood in a stationary and comfortable position with their feet behind the starting line (where the first photoelectric barrier was placed). Runners were instructed to start on the whistle sound. All the tests were performed twice with at least 1 minute of rest between attempts. The participants received thorough instructions after which they were also allowed to practice the tests. Subjects received verbal encouragement during the tests, and the best score was retained and used in analysis.Timers were stationed perpendicular to and 6 m from the finish line. Timers were instructed to start their watch on first movement of the player and stop their watch coincident with the upper-body crossing the finish line. There was no communication among timers during the testing.

Statistical analysis

The statistical analyses were carried out using SPSS 19.0 program for Windows (SPSS, Inc, Chicago, IL, USA). Descriptive statistics were generated for all variables. Means and standard deviations (SD) with 90% confidence interval limits (90% CI) were used to represent centrality and spread of data. The normality assumption was checked using Shapiro-Wilk test and all variables showed a normal distribution. Standardized differences in mean were calculated to determine the magnitude of the change between raters. According to Hopkins et al. (2001) effect size (ES) magnitudes of change were classified as trivial (>0.2), small (0.2-0.5), moderate (0.5-0.8); large (0.8-1.60) and very large (>1.60). Reliability of the change in the mean between trials was determined using intraclass correlation coefficient (ICC), typical error (TE) expressed as coefficient of variation (CV%) and smallest worthwhile change (SWC); an Excel spread sheet supplied by Hopkins (Hopkins, 2007) was used for the calculations. ICC values of 0.1, 0.3, 0.5, 0.7, 0.9 and 1.0 were classified as low, moderate, high, very high, nearly perfect and perfect, respectively. The following criteria was used to declare good reliability: CV < 5% and ICC > 0.69 (Buchheit et al., 2011). Appropriate performance usefulness indicators in accordance to the noise of the test result and measurement uncertainty (Hopkins, 2004) was assessed via the magnitude of the SWC. A comparison of SWC (0.2 multiplied by the between-subject SD, based on Cohen's effect size) to TE was used to establish the usefulness of a given dependent variable as follows: "Marginal" (TE > 189 SWC), "OK" (TE = SWC) and "Good" (TE < SWC). The criterion related validity has been established by assessing the relationship between photoelectric cells and trained rater using a Pearson product moment correlation coefficient. Vincent (25) has suggested that an absolute correlation coefficient of 0.5–0.7 is considered low, one of 0.7–0.8 is considered moderate, and one of 0.9 or above is considered high.

Results

Non-significant differences (p > 0.05) were observed between two raters (ES = trivial; CI 90% (-0.19; 0.04; p=0.09), and between photoelectric cells and trained rater (ES = trivial; CI 90% (0.00; 0.13; p=0.86) for 20m running speed test as observed in Table 2. High interrater reliability (ICC > 0.90; TE < 4%) was observed for all measures. The TE for Hand timing rater 1 vs. 2 (TE = 0.21 sec) was similar to SWC and was rated as "OK. However, TE for cells vs. rater 1 (TE = 0.12 sec) was lower than the presumed SWC (SWC = 0.20 sec), consequently these measure were rated as "good".

Table 2: Reliability measure values for 20m running speed in preschool children

	Hand timing rater 1 vs. 2	cells vs. rater 1
ES	-0.11 (Trivial)	0.09 (Trivial)
Diff (90%CI)	-0.08 (-0.19; 0.04)	0.07 (0.0; 0.13)
ICC (90%CI)	0.94 (0.87;0.97)	0.98 (0.96;0.99)
Pearson r(90%CI)	0.94 (0.87;0.97)	0.98 (0.95;0.99)
TE (90%CI)	0.21 (0.17;0.29)	0.12 (0.10;0.17)
CV% (90%CI)	4.0 (3.2;5.6)	2.4 (1.9;3.3)
SWC%	0.21 (1.16)	0.20 (0.7)
Rating	ok	good

ES – effect size; ICC – intraclass correlation coefficient; TE – typical error of measurement; CV – Coefficient of variation; SWC – smallest worthwhile change; CI – confidence interval

In a sample of children aged 4-7 years, extremely high Pearson correlation coefficients in cells vs. trained rater (confidence interval from 0.95 to 0.99) as well as high coefficient (0.94) in trained vs. untrained rater. Moreover, the interrater reliability patterns between raters and between cells and trained rater 20 m speed test are graphically presented in Figure 1.

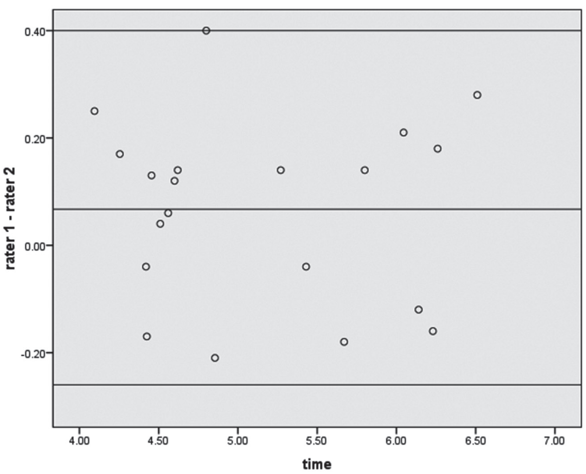

Figure 1: Bland–Altman plots for A) interrater reliability showing the mean difference between untrained rater (rater 2) vs. trained rater (rater 1) for 20-m running speed test. B) Time measurement validity in trained rater vs. cells for 20-m running speed test. The central solid line represents the mean differences (systematic error). The upper and lower dotted lines represent the upper and lower 95% limits of agreement (mean differences ± 1.96SDs of the differences), respectively.

Table 3: Interrater reliability (untrained vs. trained raters) and time measurement validity (raters vs. photoelectric cells) statistics for the 20-m running speed tests in preschool children.

	Systematic error*	95% Limits of agreement†
Interrater reliability (untrained–trained raters)		
20-m Running speed (s)	0.067	-0.27 0.40
Time measurement validity for the trained raters (trained raters–cells)		
20-m Running speed (s)	-0.075	-0.67 0.51

*Systematic error, mean difference.
†95% Limits of agreement; mean difference ± 1.96 SDs of the differences.

Discussion

The main conclusion of this study is that 20 m sprint speed tests delivered valid results when assessed by trained timekeeper. Moreover, it is not likely to be a significant difference between experienced and untrained timers when timing 20m sprint in preschool children. The use of these tests is of interest not only for the research, but also in educational and sports centres. Although the ideal option would be to use photoelectric cells, the stopwatch is commonly used as a measuring instrument, because it is much cheaper and more feasible in certain circumstances, such as schools and basic study population (Hetzler, Stickley, Lundquist & Kimura, 2008).

To our knowledge, the accuracy of time in the speed tests measured manually with stopwatch, as well as inter- rater reliability were not previously researched in preschool children. So, from a scientific point of view it is interesting to know the amount of the error occurring when these field tests are carried out using a handheld stopwatch. The first step was to examine whether this method for time estimation was valid. Therefore, the time required for carrying out a 20 m sprint speed tests was simultaneously measured manually using a stopwatch and automatically with photoelectric cells. The results showed that there was no systematic error in trained timekeepers. Also we studied the mean difference in measuring in trained and untrained timekeepers. Greater reliability (less systematic error) is observed between the trained timekeepers and photoelectric cells. In previously conducted studies involving trained timekeepers, we noticed good test-retest reliability for the collection of physical fitness tests and effects of learning or fatigue were not noticed in subjects in all conducted tests (Ortega et al., 2008). We had slightly less difference in hand and electronic timing than noted previously between 2 experienced timers and electronic time (-0.27 ± 0.06 sec) when sprinting on an outdoor field (Gains, Swedenhjelm, Mayhew, Bird & Houser, 2010). Moreover, significantly less difference (-0.16 ± 0.12 sec) was also noted when subjects ran indoors (Brechue, Mayhew & Piper, 2005; Brechue Mayhew, Piper & Houser, 2008). Another study on an indoor synthetic running track showed that experienced timers had a greater difference (-0.31 ± 0.07 sec) when compared with electronic timing (Mayhew, Houser, Briney, Williams, Piper & Brechue, 2010). Mann, Ivey, Brechue, and Mayhew, (2015) puled the values from several studies and found the average difference to be expected between hand timing and electronic timing to be -0.25 ± 0.09 seconds, approaching the widely accepted value (-0.24 seconds) for differences between hand and electronic timing (Mann et al., 2015). Previous findings together with those observed in this study suggest that to achieve high scientific standards at a population level or high accuracy at individual level, researchers must be properly trained to ensure a valid and reliable measurement of speed. Small sample could be consider as a limitation of this study concerning the fact that small systematic error could be assumed for a mean value in large cohort studies, yet not at individual levels (Hetzler, Stickley, Lundquist & Kimura, 2008).

Conclusion

Previous findings together with those in this study indicate that if we want to achieve high scientific standards at the population level or high precision on an individual level, researcher must be adequately trained in order to provide valid and reliable time measure. To conclude, the time measured manually with a stopwatch seems valid and reliable method for measuring the speed in large studies involving preschool children. The study also recommends the training of researchers to minimise systematic errors and ensure accuracy of measuring. Researches, coaches, kindergarten teachers and physical education teachers are acceptably reliable in terms of time measuring for 20m sprint speed tests using a stopwatch, with appropriate training.

References

1. Brechue, W. F., Mayhew, J. L., & Piper, F. C. (2005). Equipment and running surface alter sprint performance of college football players. *The Journal of Strength & Conditioning Research*, 19(4), 821-825.
2. Brechue, W. F., Mayhew, J. L., Piper, F. C., & Houser, J. J. (2008). Comparison between hand-and electronic-timing of sprint performance in college football players. *Mo J Health Phys Educ Recreation Dance*, 18, 50-58.
3. Gains, G. L., Swedenhjelm, A. N., Mayhew, J. L., Bird, H. M., & Houser, J. J. (2010). Comparison of speed and agility performance of college football players on field turf and natural grass. *The Journal of Strength & Conditioning Research*, 24(10), 2613-2617.
4. Hetzler, R. K., Stickley, C. D., Lundquist, K. M., & Kimura, I. F. (2008). Reliability and accuracy of handheld stopwatches compared with electronic timing in measuring sprint performance. *The Journal of Strength & Conditioning Research*, 22(6), 1969-1976.
5. Hopkins, W.G. (2000). Measures of reliability in sports medicine and science. *Sports Medicine*, 30: 1-15.
6. Mann, J. B., Ivey, P. J., Brechue, W. F., & Mayhew, J. L. (2015). Validity and reliability of hand and electronic timing for 40-yd Sprint in College football players. *The Journal of Strength & Conditioning Research*, 29(6), 1509-1514.
7. Mayhew, J. L., Houser, J. J., Briney, B. B., Williams, T. B., Piper, F. C., & Brechue, W. F. (2010). Comparison between hand and electronic timing of 40-yd dash performance in college football players. *The Journal of Strength & Conditioning Research*, 24(2), 447-451.
8. Ortega, F. B., Artero, E. G., Ruiz, J. R., Vicente-Rodriguez, G., Bergman, P., Hagströmer, M., ... & Polito, A. (2008). Reliability of health-related physical fitness tests in European adolescents. The HELENA Study. *International journal of obesity*, 32, S49-S57.
9. Vincent, W.J. (1999) Statistics in Kinesiology (2nd edition). Champaign, IL: Human Kinetics.

SHOT SELECTION IN SQUASH: A DECISION-MAKING APPROACH USING CLUSTER ANALYSIS

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Purpose: Decision-making can be viewed as emerging from the interaction between two or more players, under environmental constraints, over time, towards specific goals (Araujo, Davids & Hristovski, 2006). Decision-making in squash is examined from the perspective of selecting a shot type. This is determined by the initial conditions (both players' movements and locations during the time preceding a shot) and the intended outcome (between defence and attempting a winner) which is based on the weighting of the importance of the interaction between both players' situations.

Methods: Matches at the 2010 (n = 14) and 2011 (n = 27) Rowe British Grand Prix, held in Manchester, UK were recorded and processed using Tracker software, a newer version of the SAGIT/Squash software (Vučković et al., 2009). Thirty four full-time professional players of mean age 27.7 years (SD = 3.85), ranked in the world's top 75 participated. A two-step cluster analysis using a probability based log-likelihood distance measure (SPSS) enabled both continuous (e.g. distance player B was from the T at the moment player A hit the shot (B distance from T) and categorical (shot type) variables to be used.

Results: Six clusters were named according to the outcome of the shot, from a defensive shot where the player was under a lot of pressure (high) and attempted to create time by playing a slow shot (low opponent pressure; 23.4%) to an attacking shot where the player was not under pressure (low) and attempted to create little time for the opponent by hitting the ball hard (high opponent pressure, attempt winner; 2.0%).

Conclusions: A new methodology for discerning decision-making in a complex environment was presented. Fine-grained differences were apparent, even for the same shot type played from the same court area. This can lead to determining the small differences in expert behaviour beyond the usual expert-novice differences. Future research needs to compare players of different elite standard to determine how the pattern of their decision-making differs. This information can be used by coaches to determine areas for development of their players to reach the next level of performance.

References

1. Araujo, D., Davids, K. W. & Hristovski, R. (2006). The ecological dynamics of decision making in sport. *Psychology of Sport and Exercise*, 7, 6, 653-676.
2. Vučković, G., Perš, J., James, N. & Hughes, M. (2009). Tactical use of the T area in squash by players of differing standard. *Journal of Sports Sciences*, 27(8), 863-871.

EVALUATION OF THE TEACHING METHODS FOR COMPLEX KINESIOLOGICAL ACTIVITIES IN THE EXAMPLE OF BASKETBALL TWO STEP JUMP UP

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Abstract

The purpose of this study was to evaluate effectiveness of the two teaching methods on the example of basketball two step jump up. Fifty pupils participated in this study. Pupils were randomly divided in two subsamples, based on the method applied for teaching the motor task. The first method was the standard procedure (23 pupils), the second method was with video demonstration of motor task by the model (27 pupils). Analysis of variance didn´t show any differences between the groups at initial, acquisition and retention testing. T-test for dependent samples reaffirmed statistical significant result for both groups after acquisition phase. Result of hierarchic multiple regression analysis have shown statistically significant influence of anthropological variables on dependent variable (basketball two step jump up) in initial testing. Both those methods show the effectiveness during learning process.

Key words: *video modeling, skill acquisition, instruction, learning*

Introduction

In every day school practice different teaching methods are in use. From kinesiological point of view, motor learning should be the permanent change of the ability and occurs as an outcome of every day practice or experience (Miletić, 2012). In the domain of education, during Physical Education classes, while passing on information, the description and live demonstration are usually applied for introducing the task. One of the methods to provide information, as a way of learning of the task, is also a video demonstration by a model (an expert). A video modeling of the expert performance or a direct demonstration is the most common form of giving instructions while learning a specific motor task (Dussoulin & Rehbein, 2011). Magill (1993), and also Magill & Schoenfelder-Zohdi (1996) confirmed in their research that participants can learn the skill by observing an expert without getting any detailed feedback. Basketball two step jump up is a complex kinesiological activitiy which consist of the basic technique learned before. It is taken as the task with which we want to estimate efficiency of two teaching methods the first consisted of the standard procedure and the second with video demonstration of motor task by the model. The standard procedure in every day practice on PE classes included parts of the three basic methods (analytical, synthetic and situational) and the value of this methods were obtained in the previous research by Knjaz et al. (2013). The effects of video modeling, in learning certain motor skills were gained by Laguna, (2008) in adopting a new coordination task, Aiken et al. (2012) in basketball free throws, and Vrbik (2015), Vrbik et al. (2015) in the implementation of the motor tests. The aim of this study was to evaluate effectiveness of the two teaching methods on the example of basketball two step jump up and the secondary goal was to see if there any anthropological variables have influence on the grade in initial, acquisition and retention testing.

Methods

Participants and procedure

This study was conducted on a sample of 55 pupils of the first grade attending Industrial trade high school in Sisak. Fifty pupils participated in the full research study, including 23 pupils in the standard procedure and 27 in video demonstration group. The pupils were 187 cm tall on average and had the average weight of 65,1 kg. All the participants in this research attended regular classes of physical education (PE) and they were completely healthy during the tests. The school board also confirmed that this research complied with ethical principles guiding scientific research in human subjects. The study was conducted during October and the first week in September of 2016 and last measure was done at Januar 2017. Data was collected in school gymnasium at basketball court. The basket was positioned 3.05 m above the court and had a rim circumference of 0.46 m. Pupils were randomly divided in two subsamples, based on the method applied for teaching the motor task, which was basketball two step jump up. The first method was the standard procedure which included a description of motor task and a demonstration by the PE teachers and after that methodological guidance focusing on the most common mistakes. The second method was with video demonstration of motor task by the model. The difference was that the pupils in this method were provided to watch video clip of the model all the time during taking the task. All subjects were instructed that their task was to take advantage of the demonstration to overcome and improve the performance of presented motor task and they were told to make 10 trials of the task during acquisition faze. Video clips were recorded on camera Canon MD 255E, Japan. Video demonstration of the task was shown using a laptop (Lenovo B51-30, 80LK, China) and via video projector (Acer P1165, DLP Projector, China) on screen size 1,8m x 2,0m (Sopar, Top Projection, Italy) which was set 5 meters away from pupils, in order to maintain realistic model viewing angle of 18° (Horn et al., 2002). The experiment in this study lasted for 4 weeks, or 6 treatments during PE class. The first treatment, on the first class, included the initial testing of all the pupils in the task. After that on the next four classes during acquisition pupils were divided in two subsamples, based on the method applied for teaching the task. Finally, at the last 6th class, final acquisition testing of the task was made (posttest) and two months after that a third measurement (retention test). All testing were made by the three expert PE teacher with minimal seven years of experience in school practice. The task which they estimated was basketball two step jump up which is complex coordination task used in school practice. Pupils were awarded grades based on the following criteria (Findak, 2001):

- grade 5=motor task was acquired completely. The pupil has no problem in accomplishing motor task and technical performance is extraordinary.
- grade 4=motor task was almost acquired completely. The pupil has no problem in accomplishing motor task but technical performance was not on expected level. The pupil's execution of the task was mainly correct, and his eye contact was on the ball.
- grade 3=motor task was mainly acquired. The pupil is accomplishing the motor task with smaller difficulties. His technical performance is nodding and unsure. The movement and performance of the task is incorrect.
- grade 2=motor task was acquired partly. The pupil has big difficulties accomplishing motor task. Performance of the task was incorrect and during performance he didn't have control of the movement.
- grade1=motor task was not acquired. The pupil can´t perform the task even when he was encouraged by the teacher.

Statistical analyses

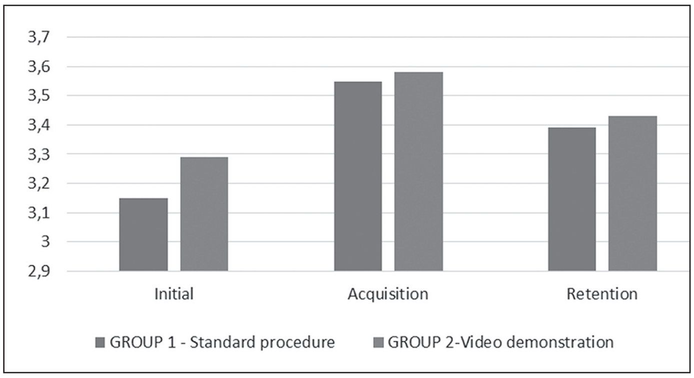
Data analysis was performed using SPSS 13.0. Descriptive statistics are presented as mean±SDs. Correlation between the experts was conducted to see objectivity. Mixed between-within subjects ANOVA was used to analyze the two treatment conditions and the three measurement periods. T-test for dependent samples was used to determine obtained differences in applied teaching method. Hierarchic multiple regression analysis was used in order to determine the influence of anthropological variables on the grade. The level of significance was set at $p \leq 0.05$.

Results

Correlation between the experts in initial, acquisition and at retention testing was steaming from 0,72 to 0,86 and was described as big correlation by Pallant, 2009. Similar results in their research, reliability 0,84, were obtained from Zetou et al. (2002).

Table 1: Descriptive statistics and results of T-test for dependent samples

Teaching method	N	Testing	Mean	Std. dv.	Min.	Max.	p- value
Standard procedure	23	Initial	3,15	0,75	2	4,67	0,000
		Acquisition	3,54	0,75	2,33	5	
		Retention	3,39	0,78	2,33	5	
Video demonstration	27	Initial	3,29	0,96	1,67	5	0,013
		Acquisition	3,58	0,97	2	5	
		Retention	3,43	0,99	2	5	



Higher scores represent better performance.

Figure 1: Mean grade for standard procedure and video demonstration groups for testing in initial, acquisition and retention phase.

Analysis of variance didn´t show any differences between the groups at initial, acquisition and retention testing. Wilks´ lambda=0,98, F (2,47) = 0,40, p=0,68, partial eta squared = 0,017. Significant influence of separate phases of learning on the grade was found, Wilks´ lambda=0,67, F (2,47) = 11,858, p<0,0005, partial eta squared = 0,34, and both groups showed higher increase in results in acquisition phase, and decreasing results in retention. Differences between groups were not found, F (1,48) = 0,103, p=0,75, partial eta squared = 0,002, presuming equal effectiveness of both methods. T-test for dependent samples reaffirmed statistical significant result for both groups after acquisition phase (Table 1 and Figure 1).

Table 2: Results of Hierarchic multiple regression analysis of anthropological dimensions on dependent variable (basketball two step jump up)

Initial testing	R	R²	Adjusted R²	Std. error of estimate
	0,579	0,336	0,262	0.716100
F (4,36)=4,549 p<0,004				

Anthropological dimensions	B	t (36)	p-level
ATV	0,361	2,190	0,035
ATT	0,023	0,134	0,894
SARGENT	0,603	2,644	0,012
SDM	-0,174	-0,775	0,44

Acquisition	R	R²	Adjusted R²	Std. error of estimate
	0,426	0,181	0,093	0,86068
F (4,37)=2,051 p<0,107				

Anthropological dimensions	B	t (37)	p-level
ATV	0,262	1,449	0,156
ATT	-0,042	-0,227	0,822
SARGENT	0,479	1,917	0,063
SDM	-0,162	-0,659	0,514

Retention	R	R²	Adjusted R²	Std. error of estimate
	0,410	0,168	0,081	0,86626
F (4,38)=1,444 p<0,126				

Anthropological dimensions	B	t (38)	p-level
ATV	0,234	1,202	0,201
ATT	0,070	0,382	0,705
SARGENT	0,245	0,986	0,330
SDM	0,097	0,395	0,695

ATV-body height; ATT-body mass, SDM-standing long jump; SARGENT-one step vertical jump

In table 2 results of hierarchic multiple regression analysis have shown statistically significant influence of anthropological variables on dependent variable (basketball two step jump up) in initial testing. Firstly, anthropometric variables were concerned, body height and body weight, which explained 7% of the variance in the grade in initial testing. After concerning two motor variables (standing long jump and Sargent test), 26% of the variance was explained by the complete model. Coefficient of determination which proportion of common variance was 0,262, therefore anthropological variables explained 26% total variance of dependent variable. The most substantial effect on interpretation of dependent variable was connected with Sargent test (Beta=0,603, p=0,012) and body height (Beta=0,361, p=0,030). In acquisition and retention testing, results haven´t shown statistically significant influence of anthropological variables on dependent variable.

Discussion and conclusion

The purpose of this study was to evaluate effectiveness of the two teaching methods on the example of basketball two step jump up. Both groups preformed equally well the task when means were evaluated, and analysis of variance also showed that there were no differences between the groups in initial testing. In testing, after acquisition, analysis of variance didn´t show differences between the groups but the results of arithmetic mean indicating better performance at the video demonstration group. Same results were obtained in study by Watson and Radwan from 2001. where they wanted to determine the difference of how a spinal manipulation skill was acquired and retained using one of three learning methods. Results of that study showed there were no differences demonstrated in acquisition of motor skill between the three learning methods. Similar results in their research were obtained from Mononen et al. (2003) on the example of learning rifle shooting. Four groups received different amount of information concerning performance, but no differences between groups were found. Significant differences appeared two days after acquisition in the number of hits in the group with 100% knowledge of performance, but all differences disappeared ten days after the acquisition. On the contrary, significant differences were found between groups after acquisition phase (Nahid et al., 2013), and after acquisition and retention (Zetou et al., 2002; Al-Abood et al., 2001). Nahid and assistants (2013) did the experiment on the jump shoot element from handball with two methods of learning: combined, which included video demonstration of the mentioned element with verbal cues, and standard, which included only verbal cues. Both methods showed improvement in execution and performance after acquisition, but the obtained results showed significant differences in the shooting angle and shooting accuracy for the combined method. Zetou et al. (2002) compared two different teachings: video demonstration by expert, and video demonstration of self performance. Same verbal feedback was given two both groups, but better results were noticed after acquisition and retention with the expert video demonstration. Better results after acquisition and retention with the expert video demonstration were also obtained in the research made by Al-Abood et al. (2001). Maleki et al. (2010) investigate differences in the gymnastics element between three groups: model observation, model observation with verbal instructions and video demonstration of the model with verbal instructions. All three methods improved the performance, but significant differences were found only after acquisition in the performance for the group which watched the video demonstration of the model with verbal information. After retention, no differences were found between groups. In this study, when we look at descriptive parameters and results of t-tests, both methods made significant changes after acquisition stage. For the purpose of the effectiveness of those methods the retention measurement was made. Retention is a method which affirmed effectiveness of learning process and it showed improvement in motor learning (Miletić, 2012) and it is very important that a learned motor task is retained after period without practice. In this study results of the retention did not show statistically significant differences in accordance to initial testing, but arithmetic means showed improvement. Taking this into consideration, the acquisition of the motor task was proficient, and the method with the expert video demonstration was more efficient.

In this research "formal" learning was conducted and it was determined and realized in standard terms without opponent players in situational conditions. From that point of view, learning new motor task only in situational condition doesn´t effected enough on using motor abilities for learning motor skill (Gruić, 2014). To see how standard procedure and video demonstration of motor task by the model affected the learning process and which anthropological variables were involved during initial, acquisition and retention testing hierarchic multiple regression analysis was used. According to the presented data of regression analysis statistically significant influence of anthropological variables on dependent variable (basketball two step jump up) in initial testing was confirmed. Sargent test (Beta=0,603, p=0,012) and body height (Beta=0,361, p= 0,035) have the most influence on interpretation of dependent variable in initial testing and it explained 26% total variance of dependent variable. After acquisition and retention influence of one step vertical jump (Sargent) and body height were not important on realized basketball two step jump up, the form of instruction, the feedback and how it was passing on to pupils was important motivational factor (Delaš Kalinski et al., 2011; Vrbik et al., 2015). From motivational point of view, basketball two step jump up has several methodologically related elements which the fundamental goal is to score a point. Knjaz et al. (2013) in study said that it is the easiest to deal with those exercises because children are exceptionally motivated and concentrated to achieve higher results.

Basketball two step jump up is complex coordination task and as such complex task pupils learn more by memory, Delaš Kalinski et al. (2011) pointed out that this learning strategy is better and it can be useful for developing more complex and integrated learning strategy. Same method of learning was conducted in the standard procedure. In the second method, with video demonstration of motor task by the model, it was also obtained higher results after acquisition stage. The reasons for better performance could be motivational accompanied with the intent to perform as well as the model. Significant influence on the final result of the performance also lies in good performance demonstration from the model or peers. Lirgg i Feltz (1991), reported better performance in students that watched solid demonstration from teachers or peers on the contrary from those of lower levels of execution. In standard method, students received demonstration of the task before every treatment, but afterwards did not receive any feedback of performance. Accompanied with the concentration drop during standing in the cue, poorer results in the standard method are understandable. Kampiotis & Theodorakou (2006) in their study pointed out that method which included observation of model and oral intervention seemed to be more influential on the level of cognitive acquisition of execution, than method which included only oral intervention or observation of model without any other intervention. Result of that study is opposite with this study, because it showed that oral intervention and observation of model without any other intervention brought to improvement of motor task after acquisition stage. In this study during exercise pupils were given 10 times to make a motor task. To retain a high level of performance over the time without any practice it has to be sufficient frequency of exercising (Delaš Kalinski et al., 2011). Similar results were obtained from Cheraghidocheshmeh et al. (2009). They did a survey with the main goal of establishing efficiency of video demonstration according to verbal instructions on learning and performance in discus and hammer throw. The results showed same results in initial testing. In the acquisition phase, both groups demonstrated significant decrease in hammer and discus throw length, with the video demonstration group having better results than the verbal group.

The results of both teaching method indicated a significant improvement in the task execution by the end of the acquisition stage. There were no differences between the groups in initial testing, acquisition and after retention but the results of arithmetic mean indicating better performance at the video demonstration group at the end of acquisition and retention. Both those methods show the effectiveness and it can be seen from a retention measurement. Presented data of hierarchic multiple regression analysis also showed significant influence of the anthropological variables of body height and sargent test on the grades during initial testing. Besides this variable, for future studies it is recommended to include more measurements with specific tests, more repetitions and more experimental conditions.

References

1. Aiken, C. A., Fairbrother, J. T. & Post, P. G. (2012). The Effects of Self-Controlled Video Feedback on the Learning of the Basketball Set Shot. Frontiers in Psychology, 3 (338), 1-8.
2. Al-Abood, S.A., Davids, K., Bennett, S.J. (2001). Specificity of task constraints and effects of visual demonstrations and verbal instructions in directing learners' search during skill acquisition. Journal of Motor Behavior, 33(3), 295-305.
3. Cheraghidocheshmeh, M., Mossavi, Y., Noroozy, D., Izadi, M. (2009). The comparison of effect of video-modeling and verbal instruction on the performance in throwing the discus and hammer. Procedia Social and Behavioral Sciences 1, 2782-2785.
4. Delaš Kalinski, S., Miletić, Đ. & Božanić, A. (2011). Gender-based progression and acquisition of gymnastic skills in physical education. Croatian Journal of Education, 13(3), 4-25.
5. Doussoulin, A. & Rehbein, L. (2011). Motor imagery as a tool for motor skill training in children. Motricidade, 7(3), 37-43.
6. Findak, V. (2001). Metodika tjelesne i zdravstvene kulture.Školska knjiga, Zagreb
7. Gruić, I. (2014). Odnosi sadržajnog, formalnog i funkcionalnog procjenjivanja izvedbi elemenata tehnike u kompleksnim kineziološkim aktivnostima na primjeru sportske igre: Rukomet. U Findak V. (ur.) Zbornik radova 23. Ljetne škole kineziologa Republike Hrvatske, Poreč, 526-532.
8. Horn, R. R., Williams, A. M. & Scott, M. A. (2002). Learning from demonstrations: the role of visual search during observational learning from video and point-light models. Journal Of Sports Sciences, 20(3), 253-269.
9. Kampiotis, S. & Theodorakou, K. (2006). The influence of five different types of observation based teaching on the cognitive level of learning. Kinesiology, 38(2), 116-125.
10. Knjaz, D., Matković, B. and Janković, S. (2013): The Value of Different Motor Teaching Methods in Working with Basketball Beginners. Croatian Journal of Education, 15(4), 147-167.
11. Laguna, P. L. (2008). Task complexity and sources of task-related information during the observational learning process. Journal Of Sports Sciences, 26(10), 1097-1113.
12. Lirgg, C.D. & Feltz , D.L. (1991). Teacher versus Peer Models Revisited: Effects on Motor Performance and Self-Efficacy. Research Quarterly for Exercise and Sport, 62 (2), 217-224.
13. Magill, R. A. (1993). Modeling and verbal feedback influences on skill learning. International Journal of Sport Psychology, 24 (4), 358-369.
14. Magill, R. A. & Schoenfelder-Zohdi, B. (1996). A visual model and knowledge if performance as sours of information for learning a rhythmic gymnastic skill. International Journal of Sport Psychology, 27, 7-22.
15. Maleki, F., Nia, P. S., Zarghami, M., Neisi, A. (2010). The Comparison of Different Types of Observational Training on Motor Learning of Gymnastic Handstand. Journal of Human Kinetics, 26, 13-19.

16. Miletić, Đ. (2012). Motoričko učenje u funkciji intenzifikacije procesa vježbanja. U Findak V. (ur.) Zbornik radova 21. Ljetne škole kineziologa Republike Hrvatske, Poreč, 56-63.
17. Mononen, K., Viitasalo, J.T., Konttinen, N. & Era, P. (2003). The effects of augmented kinematic feedback on motor skill learning in rifle shooting. Journal of Sports Sciences, 21, 867-876.
18. Nahid, S., Zahra, N.R., Elham, A. (2013). Effects of video modeling on skill acquisition in learning the handball shoot. European Journal of Experimental Biology, 3 (2), 214-218.
19. Pallant, J. (2009). SPSS priručnik za preživljavanje, Mikro knjiga, Beograd
20. Vrbik, I. (2015). Effects of different testing protocols on motor skill tests in primary education. Graduate Theses and Dissertations, Zagreb, Faculty of Kinesiology, University of Zagreb.
21. Vrbik, I., Krističević, T., Sporiš, G. and Madić, D. (2015). The effects of live and video demonstration on the early acquisition of a new motor task. Exercise and Quality of Life, 7(2), 30-40.
22. Watson, T. A. & Radwan, H. (2001). Comparison of Three Teaching Methods for Learning Spinal Manipulation Skill: A Pilot Study. Journal of Manual & Manipulative Therapy, 9(1), 48-52.
23. Zetou, E., Tzetzis, G., Vernadakis, N., Kioumourtzoglou, E. (2002). Modeling in learning two volleyball skills. Perceptual and Motor Skills, 94, 1131-1142.

EFFECTS OF TWO DIFFERENT COMBINED TRAINING ON BODY COMPOSITION IN ADULT WOMEN

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Abstract

Purpose: The aim of this research was to determine the effects of two different types of concurrent training on body composition in adult women.

Methods: Women (range 18–35 years) living in Croatia were selected as subjects. Total of 36 women past all inclusion criteria and were included for further analysis. The subjects were randomized into the group that exercise endurance training before strength training (CBEF), and group that exercise endurance training after strength training (CAFT). The measurements for all subjects took place twice, before training and after 12 weeks of training. Skinfold thickness was measured at seven sites (bicep, tricep, subscapular, suprailiac, abdomen, calf and thigh) by a single investigator. Moreover, total body mass and body mass composition, including Lean mass (kg), Body fat (%), Fat mass (kg), basal metabolic rate (kcal), Body water (kg), Total body water (%), were measured.

Results: Both groups showed significant improvements in fat%, Fat mass and Total body water, bicep, tricep, supraspinale and abdominal skinfold measures ($p<0.05$). Subscapular measures differ significantly after training program only in CBEF group, while thigh differ significantly in CAFT group. The changes of lean mass ($P<0.01$), body water ($p<0.01$) and BMR ($P<0.01$) differed significantly in CAFT group after training program.

Conclusion: The combination of aerobic and resistance training in the same session, either done with aerobic training before or after resistance training, had similar effects in improving fat free mass and decreasing skinfolds measures in adult women and could be a useful strategy for improving health status.

Key words: *concurrent training, recreation, influence, female*

Introduction

In kinesiology, recreation is singled out as a separated department. Unfortunately, in that department there appear a lot of noises in every day practice which are not approached from the scientific point of view. Furthermore, the availability of information to final users is made extremely difficult for many reasons. One of those reasons is handling the information from daily press instead of scientific publications.

Combined or concurrent training is training for both strength and endurance, in an effort to achieve the ultimate physical fitness and optimum athletic performance on both aspects of training. In the last couple of years there have been a great number of researches on the influence of this type of practice on various anthropological features of both men and women (Sillanpää et al., 2009; Arazi, Faraji, Moghadam, & Samadi, 2011; Rossi et al., 2015). It has been stated that combined endurance and strength training may be more effective in improving physical fitness, body composition and metabolic health than either method alone (Sillanpää et al., 2009).These kind of researches have been often done on the military population (Kraemer and et al., 1995) which under specific reasons had a need to develop both strength and endurance.

Further studies have been done on elderly people (Izquierdo and et. 2004. Verny and et. 2008) in order to maintain health status. In two similar studies there have been compared the effects of strength training, and a concurrent training on body composition, strength and endurance (Bell and et. 2000; Ferrauti and et. 2010). Aforementioned authors found that isolated resistance training is more efficient for strength gains than concurrent training.

It is well documented that concurrent endurance training can interfere with strength training-induced strength or muscle mass development during longer training periods (Häkkinen et al., 2003; Hickson 1980; Kraemer et al., 1995; Sillanpää et al., 2008). However, based on the available literature and from the practice there appeared an opportunity for testing various approaches to concurrent training as well as the comparison of different approaches to concurrent training. Therefore, the aim of this research was to determine the effects of two different types of concurrent training on body composition in adult women.

Methods

Subjects

Women (range 18–35 years) living in Croatia were selected as subjects. The 50 volunteers who fulfilled the inclusion criteria and passed the baseline physical examination were randomly assigned, with stratification for age, BMI and menopausal status (pre- or post-menopausal), to two training groups. The project was approved by the Ethics Committee of the Faculty of Kinesiology in Zagreb. All subjects were carefully informed about possible risks and benefits of the project both verbally and in writing, and they signed a consent form before participation. Fourteen women from both groups dropped out due to personal reasons, reducing the number of women completing the study to 36. All physical or psychological diseases, which may have precluded ability to perform the requested strength and endurance training and testing, including pronounced overweight or obesity, impaired glucose tolerance and diabetes, and medications known to influence physical performance or interpretation of the findings were used as exclusion criteria. The subjects were randomized into the group that exercise endurance training before strength training (n = 19), and group that exercise endurance training after strength training (n = 18). The measurements for all subjects took place twice, before training and after 12 weeks of training.

Procedures

Skinfold thickness was measured at seven sites (bicep, triceps, subscapular, suprailiac, abdomen, calf and thigh) by a single investigator to the nearest 1 mm using a Lange caliper (Cambridge Scientific); the average of two trials was used.

Using a BIA tool produced by the Tanita Corporation (Body Composition Analyser, Nutritional Science & Technology, Lake Worth, FL, USA), total body mass and body mass composition, including Lean mass (kg), Body fat (%), Fat mass (kg), basal metabolic rate (kcal), Body water (kg), Total body water (%), were measured.

Training program

During the 12-week training period, both groups trained three times a week with difference in the type of combined strength and endurance training. One group trained endurance training before strength training (CBEF) and other trained endurance training after strength training (CAFT). All training sessions were supervised by MSc students in the Department of Physical activity specialized in the major of Science of Sport Coaching and Fitness Testing.

Endurance training

The intensity of bicycle and treadmill training was controlled by heart rate monitoring (Häkkinen et al., 2006). Training was periodized into the two training cycles and training intensity was progressively increased. During the first training cycle (weeks 1–7) the subjects trained 20 min three times a week under the level of their aerobic threshold. The second training cycle (weeks 8–12) included 30-min training sessions, which were divided into the loading intervals varying in intensity from below the aerobic threshold to above the anaerobic threshold.

Strength training

The focus was to produce muscle hypertrophy and to increase the total muscle mass/fat ratio (loads of 60–80% of 1RM, repetitions 10) (American College of Sports Medicine 2002). Detailed strength training was shown in Table 1.

Table 1: Strength training during 12 weeks

Strength training	
Monday	
Chest:	
Bench press	4x10
Butterfly	4x10
Inclined Dumbbell Bench Press	4x10
Biceps:	
Z bar bicep curl	4x10
Dumbbell Hammer Curls	4x10

Wednesday	
Back:	
Lat pull-down	4x10
Seated cable rows	4x10
One arm dumbbell row	4x10
Triceps:	
Cable Triceps Push Downs	4x10
Dumbbell Overhead Triceps Extension	4x10

Friday	
Legs:	
Leg press	4x10
Quads machine	4x10
Machine Leg Curls	4x10
Shoulders:	
Dumbbell Overhead Shoulder Press	4x10
Dumbbell shoulder flies	4x10

Statistical analysis

SPSS version 14.0 for Windows was used for statistical analyses (SPSS, Inc., Chicago, IL). Within group analyses were performed with paired samples t tests. Statistical significance was assessed at the level of P < 0.05. Data are presented as means ± SD.

Results

Both groups showed significant decreases in body fat%, Fat mass and Total body water, while body mass and BMI showed no changes (Table 1). The changes of lean mass (P<0.01), body water (p<0.01) and BMR (P<0.01) differed significantly in CAFT group after training program.

Table 2: Body composition in both groups following the 12 weeks training program

	CBEF		CAFT	
	Before	After	Before	After
Body mass (kg)	64.62± 7.62	64.18± 7.45	60.04± 6.31	59.53± 5.27
BMI	22.43± 1.45	22.26± 1.39	21.22± 1.84	21.05± 1.61
Lean mass (kg)	47.38± 4.24	48.18± 4.42	44.89± 1.69	46.22± 2.17*
Body fat (%)	27.22± 5.53	23.38± 7.41*	24.65± 6.22	22.00± 5.23*
Fat mass(kg)	17.37± 4.27	16.00± 4.64*	15.16± 5.31	13.32± 4.21*
Bmr (kcal)	1432.47± 123.06	1449.5± 126.95	1364.31±58.45	1390.73±66.24*
Body water (kg)	34.61± 3.13	35.26± 3.24	32.86± 1.25	33.84± 1.58*
Total body water (%)	53.76± 2.91	55.17± 3.55*	55.16± 4.55	57.11± 3.82*

p<0.05; * significantly different from initial testing; CBEF- cardio training before strength training; CAFT- cardio training after strength training; Bmr- basal metabolic rate

Skinfold measures decreased in all measured sights in both groups (Table 2). Both groups showed significant decreases in bicep, triceps, supraspinale and abdominal skinfold measures (p<0.05). Subscapular differ significantly after training program only in CBEF group, while thigh differ significantly in CAFT group. There were no difference for calf measures in both groups following training program.

Discussion

The key findings of the current study was similar effects found in the CBEF group for almost all variables when compared to CAFT group with recreational adult women. Both groups showed significant improvements in fat%, Fat mass and Total body water, bicep, triceps, supraspinale and abdominal skinfold measures (p<0.05). These findings are in agreement with previous studies which suggested that combined training have benefits on the whole and segmental body composition variables (Rossi et al., 2015) as well as protective effect on abdominal obesity (Sillanpää et al., 2009).

Table 3: Skinfold measures in both groups following the 12 weeks training program

	CBEF		CAFT	
Skinfolds	Before	After	Before	After
bicep		7.19± 2.96*	7.17± 2.38	6.26± 1.97*
tricep	19.25± 4.35	17.41± 3.73*	18.02± 4.59	15.77± 3.67*
subscapular	14.70± 3.97	13.51± 3.21*	12.94± 7.15	10.61± 3.98
supraspinale	15.82± 4.61	14.24± 4.53*	15.26±5.59	12.47±4.50*
abdominal	22.39± 4.41	19.31± 3.80*	19.68± 5.37	17.47±3.13*
thigh	25.23± 5.71	24.60± 5.03	26.41±4.91	23.21±5.10*
calf	14.41±5.04	13.93±4.60	15.23± 5.40	14.14±5.17

p<0.05; * significantly different from initial testing; CBEF- cardio training before strength training; CAFT- cardio training after strength training

Sillanpää et al. (2009) observed that 21-weeks of combined exercise have protective effect on abdominal obesity and could be used to explain the effect of the combined training on the metabolic syndrome components in women aged 40 years (Seo et al., 2010). However, Pritzlaff et al., 2000 suggest that higher-intensity may be more effective than low-to-moderate-intensity for inducing the secretion of lipolytic hormones, facilitating greater post-exercise energy expenditure and fat oxidation. One recent study (Rossi et al., 2015) showed some benefits of combined training on the whole and segmental body composition variables. Aforementioned authors concluded that the combination of aerobic and resistance training in the same session, over a relatively short period was effective in improving fat free mass and decreasing whole and segmental fat mass in obese postmenopausal women.

However, more studies must be done to verify the effect of combine exercise on other variables, such as metabolic and hemodynamic. Nevertheless, if the purpose is the improvement of maximal strength, muscle power and performance, prescription of training programs should be taken with some precocious (Leveritt et al., 1999).

Conclusion

In conclusion, the combination of aerobic and resistance training in the same session, either done with aerobic training before or after resistance training, had similar effects in improving fat free mass and decreasing skinfolds measures in adult women and could be a useful strategy for improving health status and preventing some disorders related to sedentary habits as well as minimizing some of the side effects of aging.

References

1. ACSM. (2002). Position stand: progression models in resistance training for healthy adults. *Medicine and science in sports and exercise*, *41*(3), 687-708.
2. Arazi, H., Faraji, H., Moghadam, M. G., & Samadi, A. (2011). Effects of concurrent exercise protocols on strength, aerobic power, flexibility and body composition. *Kinesiology*, *43*(2), 155-162.
3. Bell, G. J., Syrotuik, D., Martin, T. P., Burnham, R., & Quinney, H. A. (2000). Effect of concurrent strength and endurance training on skeletal muscle properties and hormone concentrations in humans. *European journal of applied physiology*, *81*(5), 418-427.
4. Ferrauti, A., Bergermann, M., & Fernandez-Fernandez, J. (2010). Effects of a concurrent strength and endurance training on running performance and running economy in recreational marathon runners. *The Journal of Strength & Conditioning Research*, *24*(10), 2770-2778.
5. Häkkinen K, Alen M, Kraemer WJ et al. (2003) Neuromuscular adaptations during concurrent strength and endurance training versus strength training. Eur J Appl Physiol 89:42-52. doi:10.1007/ s00421-002-0751-9
6. Hickson, R. C. (1980). Interference of strength development by simultaneously training for strength and endurance. *European journal of applied physiology and occupational physiology*, *45*(2), 255-263.
7. Izquierdo, M., Ibanez, J. K. H. A., Hakkinen, K., Kraemer, W. J., Larrion, J. L., & Gorostiaga, E. M. (2004). Once weekly combined resistance and cardiovascular training in healthy older men. *Medicine and science in sports and exercise*, *36*(3), 435-443.
8. Kraemer WJ, Patton JF, Gordon SE et al. (1995) Compatibility of highintensity strength and endurance training on hormonal and skeletal muscle adaptations. J Appl Physiol 78:976-989
9. Leveritt, M., Abernethy, P. J., Barry, B. K., & Logan, P. A. (1999). Concurrent strength and endurance training. *Sports Med*, *28*(6), 413-427.
10. Pritzlaff, C.J., Wideman, L., Blumer, J., Jensen, M., Abbott, R.D., Gaesser, G.A., … Weltman, A. (2000). Catecholamine release, growth hormone secretion, and energy expenditure during exercise vs. recovery in men. Journal of Applied Physiology, 89, 937-946.
11. Rossi, F. E., Buonani, C., Viezel, J., Silva, E. P. D., Diniz, T. A., Santos, V. R. D., ... & Ismael, F. (2015). Effect of combined aerobic and resistance training in body composition of obese postmenopausal women. Motriz: Revista de Educação Física, 21(1), 61-67.
12. Seo, D.I., Jun, T.W., Park, K.S., Chang, H.K., So, W.Y., & Song, W. (2010). 12 weeks combined exercise training is better than aerobic exercise for increasing Growth Hormone in middle-aged women. International Journal of Sport Nutrition and Exercise Metabolism, 20, 21-26.
13. Sillanpää E, Häkkinen A, Nyman K et al. (2008) Body composition and fitness during strength and/or endurance training in older men. Med Sci Sports Exerc 40:950-958
14. Sillanpää, E., Laaksonen, D. E., Häkkinen, A., Karavirta, L., Jensen, B., Kraemer, W. J., ... & Häkkinen, K. (2009). Body composition, fitness, and metabolic health during strength and endurance training and their combination in middle-aged and older women. European journal of applied physiology, 106(2), 285-296.
15. Sillanpää, E., Laaksonen, D.E., Karavirta, A.H.L., Jensen, B., Kraemer, W.J., Nyman, K., & Häkkinen, K. (2009). Body composition, fitness, and metabolic health during strength and endurance training and their combination in middle-aged and older women. European Journal of Applied Physiology, 106, 285-296. dói: 10.1007/ s00421-009-1013-x
16. Verney, J., Kadi, F., Charifi, N., Féasson, L., Saafi, M. A., Castells, J., ... & Denis, C. (2008). Effects of combined lower body endurance and upper body resistance training on the satellite cell pool in elderly subjects. *Muscle & nerve*, *38*(3), 1147-1154.

New Technologies in Physical Education

8th INTERNATIONAL SCIENTIFIC CONFERENCE ON KINESIOLOGY

Editors:
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PHYSICAL EDUCATION AND APPLYING NEW TECHNOLOGIES FOR SCHOOL & SPORT ORGANIZATIONS

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Abstract

Introduction: To be competent in the 21st century, our young generation need to be able to think critically, assess options and make sound decisions. In Physical Education (PE), students have to be trained to be self-directed learners where they use cutting edge technology to assess their condition through evidence based real time data and plan their fitness programme in meeting their physical needs and demands. In local context, primary schools and educational sports institutes such as, Physical Education & Sports Science (PESS), Nanyang Technological University (NTU), Singapore have incorporated technology tools utilising online videos, video games, educational CD productions, camera drones and video analysis software including data analytics in the education curriculum. Such technology has led to the use of real time application of devices that provide sports practitioners immediate feedback to students and/or athletes. Recently thematic applications of technology have seen a rise, especially in sports media broadcasting and communication.

Conclusion: The use of cutting edge technology allows students to enjoy physical activty and simultaneously getting active. Advances in sports technology can aid sports organisations and sports education institutes to deliver and improve many aspects of sports such as performance, marketing and the development of sports. Physical educators can infuse technology in their teaching to enhance their lessons to make it enjoyable and engaging for all students.

Key words: *sports technology, physical education, technology tools, sports performance*

PEDAGOGICAL MODEL OF CHILDREN SWIMMING TRAINING WITH THE USE OF METHOD OF SUBSTITUTION OF HYDROGENOUS LOCOMOTION

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Abstract

The Article shows results of research on development of pedagogical model of children swimming training with the use of method of substitution of hydrogenous locomotion. It is demonstrated that the use of exercises of transformative orientation provided an opportunity to change the overall structure of inefficient locomotion, constituting individual swimming variations. In some cases, changing the entire locomotion or some of its elements seemed inadvisable. In these circumstances, the use of transformative exercises allowed to change only the internal structure of the coordination of locomotion.

As they've got more familiar with transformative exercises, the study of integrating orientation exercises has been being introduced. It allowed to form individual swimming variations in three directions: 1) based on learned locomotion as the basic technique; 2) based on integration of locomotion into existing movement stereotype; 3) on the basis of harmonization of locomotion techniques with breathing.

Key words: *swimming; locomotion; pedagogical model of children swimming training; method of substitution of hydrogenous locomotion.*

Introduction

Nowadays there are serious problems in the definition of sports specialization of children involved in swimming. Early specialization of children allows with a high degree of probability to determine the style of swimming, the most suitable to the child and allowing him to achieve the highest results in sport, in the future. Existing techniques for training children to swim do not have meaningful indicators to measure children's predisposition to a particular swimming style. Existing techniques for training children to swim do not have meaningful indicators to measure children's predisposition to a particular swimming style.

The specificity of the identification of the most effective tools consists in the realization of abilities in children to technically efficiently implement their activities based on individually formed skills movements in water (Irwin, C.C. et al., 2009). However, swimming mastering technique existing nowadays is based on holistically-separation method of teaching techniques of crawl on the chest, on the back or breaststroke accepted in sports training. Dolphin swimming is mastered by children later, as it is technically more difficult method of competitive swimming. Rigid algorithmization of mastering of various methods of sport swimming does not allow to consider individual locomotor experience of children and their natural qualities. Practice shows that it is possible to solve this issue effectively only if you improve children's swimming skills based on prior formed movements. Such approach reflects the need to use method of substitution of hydrogenous locomotion of children while mastering specific sport swimming type (Brenner, R.A. et al., 2009).

Methods

Notion of hydrogenous locomotion was introduced as a part of the study. Hydrogenous locomotion is a simple individual movement that ensures movement of a child's body in water. These movements can be inefficient looking at its velocity characteristics, metabolic cost and technical parameters. However, their use allows not only to keep afloat but also to move in water. In order to choose locomotion that are subject to substitution, notion of locomotion weight was introduced. Locomotion weight is complex characteristics that reflects contribution of specific locomotion into efficiency of individual swimming style. Assessment of locomotion weight was performed using the method of determination of significance factors of specific parameters of each locomotion with the help of technique based on expert principle of determination of marks the essence of which lies in the fact that mark of each parameter is accepted as an average of values given by some number of experts. The process of consolidation of marks of specific parameters was based on the use of arithmetic average.

Calculation of mark of locomotion weight of each locomotion was performed on the basis of classification of methods of qualimetric assessment.

Comprehensive assessment of the value of locomotion weight can be seen as a two-step process: first step – assessment of specific parameters of locomotion; second step – assessment of its locomotion weight.

With the passage of each stage a series of operations that are listed in the algorithm of integrated assessment of locomotion weight is performed (Figure 1).

Sufficiently complete assessment of the effectiveness of locomotion technique was carried out using parameters measured by both quantitative and qualitative indicators.

Timing method was used to determine the speed, tempo and "step" of movement. To register these parameters examinees swam 25 meters' route, passing time was measured by manual stopwatch correct to 0,1 s. Simultaneously number of cycles of rowing movements was recorded by counting.

Dynamometry method was used to measure the traction force developed by examinees while swimming on a leash. Indicators of the traction force were recorded using permanently fixed dynamometer, which was attached to the rope tied to the body of the examinee. The traction force developed by the swimmer, was transferred to a dynamometer. Measurement accuracy was 0.2 kg.

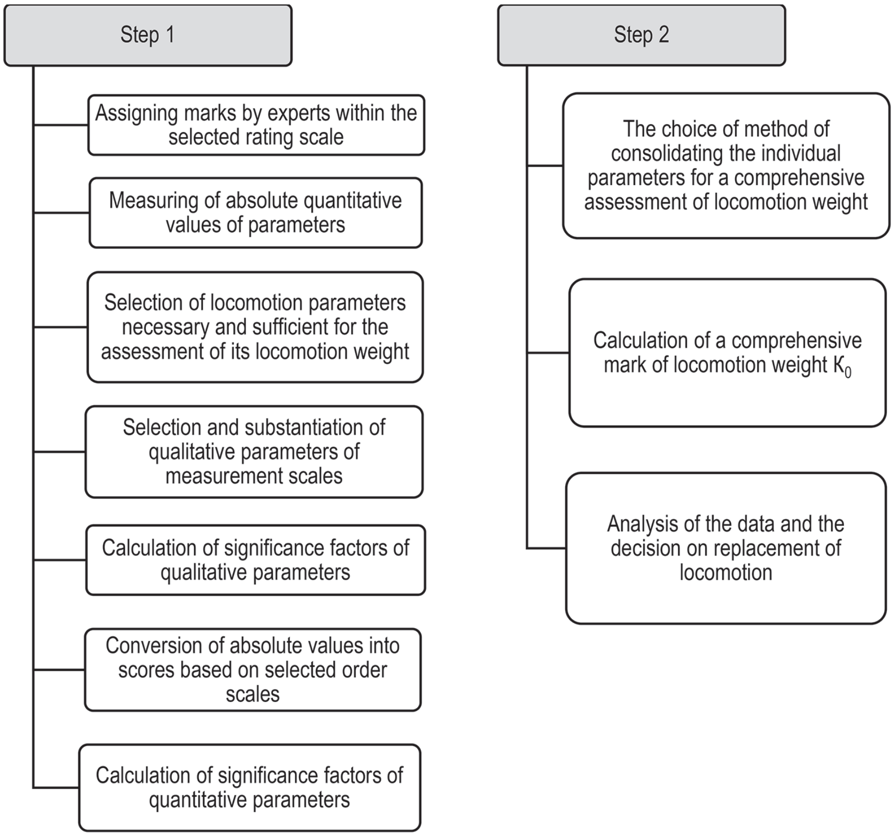

Figure 1: The algorithm of a comprehensive assessment of locomotion weight of specific swimming parameters

Following the obtained results calculation of velocity tempo and "step" of swimming is performed under the following formulas:

(1) V = d / t, where:

V – velocity (m/s); d – distance of swum segment (in m); t – time for passing a segment (in min.).

(2) N = 60 x n / t, where:

N – tempo (cycle/min.); n – number of cycles of rowing movements performed in a time period of passing of control segment; t – time for passing a segment in seconds (in min.)

(3) L = d / n, where:

L – step (m); d – distance of swum segment (in m); n – number of performed cycles of rowing movements.

The rhythmic factor was determined by the ratio of operating phase to the time of the preparatory movements. The density of the stroke, expressed as a percentage, was calculated by the ratio of time of working phase of stroke to time of movement cycle. Coordination coefficient was determined as the ratio of the traction force developed by the hands and feet, expressed as a percentage.

The methods of qualimeter were used to calculate the assessment of locomotion weight based on the developed calculation algorithm. In the course of solving qualimeter problems expert assessment techniques were used, which together with the measuring methods allowed to obtain the most comprehensive amount of information on the studied locomotion.

Pedagogical experiment was held to check efficiency of the developed method. 48 examinees participated in research, they were divided into two groups: experimental group (EG) in an amount of 27 people and control group (CG) in an amount of 21 people. Anthropometric indexes, level of physical and swimming fitness at examinees in both groups were not significantly different. 96 examinees participated in studies to identify and systematize existing hydrogenous locomotion.

During pedagogical experiment, physical exercises of substituting influence were used, in the composition of which stood out transformative exercises designed to change the structure of individual locomotion, and integrative exercises, aimed at uniting locomotion into a coherent individual swimming style. Particular attention was paid to the harmonization of the transformed locomotion with breathing.

At a step of improving of individual swimming variations technique as a means of training influence, physical exercises on the basis of the newly formed locomotion with different positions of a body, arms and legs were used. Chest, back and side positions of the body were used. Hands were fixed up outstretched, pressed along the body with multi-directional position. Legs were held on a fixed support by a partner while standing in the shallow part of the pool. To achieve the greatest effect of training swimming boards were used.

In order to create complicated conditions physical exercises with transportation of the human body surrogate while moving and diving with the help of mastered locomotion were used.

Selected physical exercises had deliberately transforming nature and were carried out by examinees of the experimental group depending on individual motor experience.

Physical exercises with a substituting effect were carried out by trainees in the main part of the session after a warm up in the water, including swimming using the chosen method in free tempo a distance from 50 to 200 m and execution of breathing exercises.

Based on the comprehensive assessment of locomotion weight pedagogical decision was taken on replacement of one or another locomotion.

Data obtained during the experiment were processed by methods of mathematical statistics. For performance of analysis of obtained data, we calculated: arithmetic average ($\overline{X}$); standard deviation (δ); error of the mean (m); statistical significance under Student's t-test.

The list of parameters that describe locomotion technique included such qualitative characteristics as swimming tempo measured by number of strokes performed in a minute and swimming step measured in meters.

Evaluation of the effectiveness of swimming technology using quantitative parameters is the most objective, but does not cover all the essential aspects of movements in swimming.

Rationality of swimming technique was characterized by the following parameters: a streamlined body position with 2-6 degrees' angle of attack; rhythmic full breathing with an energetic inhalation and long exhalation into the water; optimal coordination of movements and breathing; presence of sliding phase ("flood").

Accordingly, the parameters describing the qualitative aspect of specific locomotion are conditions created during swimming for the horizontal body position, breathing production and implementation of sliding phase.

Total number of parameters is six (three – quantitative and three – qualitative parameters).

The traction force was measured during swimming on a leash through of a studied locomotion with a dynamometer and was calculated in kilograms.

The magnitude of the tempo of movement was determined by proportional calculation of the amount of rowing movements performed per minute, during swimming a 25-meter segment.

Swimming step was determined by the ratio of the length of the 25-meter segment of a distance to the number of strokes when swimming it using a studied locomotion.

Based on experimental data and the calculations made summary table of locomotion weights was compiled, which served as the basis for a decision on substitution of one or another locomotion in the individual stylistic variations of swimming.

Results of research

During the research, pedagogical model of teaching children to swim was developed with the use of method of substitution of hydrogenous locomotion.

The experimental method consisted of two steps of substitution of preformed hydrogenous locomotion:

1) step of conversion of locomotor movements of trainees, characterized by low weight locomotion into more effective motor actions, similar to elements of technique of sport methods of swimming;
2) step of integration of newly formed and synergism locomotion into individual variations of movement.

The use of elementary education and preparatory training exercises in the practice on the basis of a holistic-separation method assumes mastering the sport swimming methods element by element, techniques of which, on the one hand, is regulated by the competition rules, and on the other - has a focus on achievement of the highest speed results. An important principle of the use of exercises in this case is the full mastering of the elements of swimming technique, which requires appropriate time costs allocated for education.

Given the ability of the trained contingent of individuals the manifestation of locomotor actions, allowing in some way to move independently in the water, orientation of training funds should be different from the targeted use of exercises of the initial training. In this regard, exercises with a substituting effect, designed to change specific locomotion without substantial conversion of current individual variation of movement in water have been developed.

Inside exercises aimed at the substitution of locomotion exercises of transformative orientation and exercises aimed at integration of specific locomotion into a coherent variation of movement were highlighted.

The use of exercises of transformative orientation provided an opportunity to change the overall structure of inefficient locomotion, constituting individual variations of swimming, or only certain elements of the structure of locomotion. In some cases, changing the entire locomotion or some of its elements seemed inadvisable. In these circumstances, the use of transformative exercises allowed to change only the internal coordination structure of locomotion.

Along with the mastering of transformative exercises, the study of exercises of integrating orientation was introduced. It allowed to form individual swimming variations in three directions: 1) based on studied locomotion as the main part of the technique; 2) based on integration of locomotion into existing movement stereotype; 3) based on harmonization of locomotion technique with breath.

As a result of use of substituting exercises with converting and integrating influence positive dynamics was seen in change of main technical and dynamic characteristics. (Table 1).

Table 1: Dynamics of changes of technical and dynamic characteristics of individual variations of swimming of test persons KG-1 (crawl) and EG predisposed to alternating structure of movements as a result of the pedagogical experiment

Indexes	KG-1 (crawl)	EG			
		P_5		P_6	
		%	P	%	P
Total time of passing a 25 m segment, s	- 5,0	- 17,8	< 0,05	- 3,4	< 0,05
Movement velocity, m/s	4,8	19,2	< 0,01	2,8	< 0,05
“Step” of movement, m	7,0	28,8	< 0,05	23,5	< 0,05
Rate of strokes, cycle/min	- 1,5	- 5,4	< 0,05	- 19,1	< 0,05
Traction force when moving using mastered variation, kg	1,0	39,3	< 0,05	34,5	< 0,05
Traction force during locomotor movements using hands only, kg	6,8	35,1	< 0,01	31,9	< 0,05
Traction force during locomotor movements using legs only, kg	0	4,4	> 0,05	6,7	< 0,05
Coordination factor	- 2,7	4,3	> 0,05	10,8	> 0,05
Rhythm factor	9,6	17,4	< 0,01	20,0	< 0,05
Stroke density, %	- 0,2	2,3	< 0,05	2,6	< 0,05

Experimentally, it was found that the increase of technical and dynamic performance of test persons of the experimental group involved in the method of substitution of hydrogenous locomotion, significantly exceeded the dynamics of similar characteristics of trainees in the control group that passed an initial swimming training.

The largest intergroup differences were obtained between the participants in the experiment, that mastered the technique of movement based on alternating locomotion, and by examinees that were trained a method of swimming crawl on chest.

Those engaged in the method of simultaneous of substitution locomotion surpassed those who passed initial learning to a method of breaststroke in the ability to implement efficient breathing and perform sliding phase after a cycle of rowing movements.

Test persons that passed initial learning to swim breaststroke and crawl on chest, found that time allocated to training was not enough for the complete harmonization movements of hands, legs and breathing into a holistic way to swimming, as evidenced by the results of pedagogical experiment.

Due to existing movement stereotypes trainees in the control group were not always able to adequately reproduce in water preparatory exercises mastered onshore. In some cases, during the passage in water trainees could not repeat movements studied in the hall and returned to the playback of locomotion “convenient” for them. In these circumstances, it was necessary to expand the list of preparatory exercises, mastered in the pool, which also increased the time spent on mastering of the elements of swimming technique.

Conclusion

As a result of use of substitute exercises of transforming and integrating influence the positive dynamics were seen in the change of main technical and dynamic characteristics of individual variations of movement in water. The most positive changes have occurred in increasing the speed and power parameters, coordination and rhythm factors. The changes revealed of technical and dynamic characteristics illustrated qualitative changes that have occurred in the structure of variation of technique of movement as a result of substitution of inefficient locomotion.

References

1. Brenner, R.A., Taneja G.S., Haynie D.L., Trumble A.C., Qian C., Klinger R.M., Klevanoff M.A. (2009). Association between swimming lessons and drowning in childhood: a case-control study. *Archives of Pediatrics & Adolescent Medicine*, 163 (3).
2. Cummings, P., Mueller B.A., Quan L. (2011). Association between wearing a personal floatation device and death by drowning among recreational boaters: a matched cohort analysis of the United States Coast Guard data. *Injury Prevention, 17,* 156-159.
3. Irwin, C.C., Irwin R.L., Ryan T.D. (2009). Urban minority youth swimming ability in the United States and associated demographic characteristics: toward a drowning prevention plan. *Injury Prevention, 15,* 234-239.

THE RELATIONSHIP AMONG MOTOR COMPETENCE, PHYSICAL ACTIVITY AND BODY COMPOSITION IN THE FIRST GRADE STUDENTS

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Abstract

The aim of the study is to establish the relationships among motor competencies and physical activity, weight, height and BMI. This cross-sectional study included 129 first-grade students from Lithuania. Physical activity was measured indicating minutes per week of child's leisure time physical activity and minutes spent in physical education classes. Motor skills were assessed using a battery of motor skills tests MOBAK. Conclusions: Neither object related nor self-movement related motor competence was associated with body composition; object related motor competence was associated, meanwhile self-movement related motor competence was not associated with physical activity.

Key words: *Motor skills, MOBAK, primary school*

Introduction

Research shows that physical activity is an important factor for the prevention of cardiovascular diseases, low bone density and other health problems (Andersen et al., 2006; Valdimarsson et al., 2006; Linden et al., 2007). Scientists agree that motor skills are essential for the physical activity (Barnett et al., 2009). Child's ability to briskly run, jump, catch, throw, or make other physical action, provide opportunities to engage in physical activity in later life. The mastery of motor skills contributes to children's physical, cognitive and social development (Payne & Isaacs, 1995) and is thought to provide the foundation for an active lifestyle (Gallahue & Ozmun, 2006). Motor skills commonly develop in childhood and subsequently refine into context and sport-specific skills (Lubans et al., 2010). Children can perform them without any preparation. Motor skills are essential to the child's growth (Stodden at el., 2008). The early childhood (the period up to 9 years of age) is a critical period for child development. C. Herrmann and E. Gerlach (2014) argues that the main purpose of physical education is development of motor skills. **The aim** of the study is to establish the relationships among motor competencies and physical activity, weight, height and BMI.

Methods

Participants. This cross-sectional study included 129 first-grade students from the several Kaunas and Kaunas district schools (Lithuania). Among first grade students, 68 were boys (52.7 percent.), and 61 were girls (47.3 percent.)

Methods and research procedure:

Physical activity was measured indicating minutes per week of child's leisure time physical activity and minutes spent in physical education classes.

Anthropometric data: height, weight and body mass index (BMI) were determined using the TANITA (TBF-300) body composition analyzer.

Motor skills were assessed using a battery of motor skills tests MOBAK (Herrmann & Gerlach, 2014). The battery contains eight tests. Four of them were designed to measure object (items) movement and were as follows: Throwing, Catching a ball, Bouncing a basketball ball and Dribbling a ball. Another four indicate body control called Self-movement and are the following: Balancing, Rolling, Jumping and Moving sideways. A detailed description of the methodology presented in the Tables 1 and 2. The researcher explained study procedures and demonstrated the tasks to children. Afterwards, students tried every test twice. The results were recorded into study protocol (0 = test failed, 1 = test performed). There were provided two trials of each test, the results were summed up.

Table 1: Detailed description of Object movement tests

Object movement				
	Throwing (1)	**Catching (2)**	**Bouncing (3)**	**Dribbling (4)**
Qualification	Hitting a small target.	Catching a ball.	Bouncing a ball without losing control.	Dribbling a ball without losing control.
Test item	The child throws from a 2 m distance at a target with 6 juggling balls.	The test leader drops the ball, the child catches the ball after the turning point	The child stands behind a marked line and bounces a small basketball along the corridor until the finish line without losing the ball	The child stands behind a marked line and dribbles with the ball along a corridor until the fi nish line without losing the ball.
Criteria	Hitting the target counts as a point. Overhead casts only (elbow high, extension of the forearm).	The ball is to be caught after the rebound when still in the air.	The ball can be bounced with two hands. The ball may not be held or lost. The child must not stop and must bounce the ball at least 5 times. The child may not leave the corridor	The ball can be dribbled with both feet. The ball may not be lost. The child must not stop. At least 5 contacts with the ball. No side steps. The child may not leave the corridor.
Evaluation	6 attempts, amount of hits is recorded.	6 attempts, amount of balls caught is recorded.	2 attempts, amount of successful attempts is recorded.	2 attempts, amount of successful attempts is recorded.
Test set-up	A target is placed at a 1.30 m height. A scratch line is placed 2 m away from the target.	The test leader drops the ball from a 2 m height and 1.30 m distance so that the ball reaches a height of at least 1.30 m after it has touched the ground.	Marking a corridor using tape (5 m x 1 m).	Marking a corridor using tape (5 m x 1 m).
Materials	• 6 juggling balls • 1 target (diameter: 40 cm) • Scratch line	• 1 small rubber ball or tennis ball • Ground markings	• 1 small basketball (size 3, diameter: 17cm) • Ground markings	• 1 (soft) ball (140g, diameter: 18 cm) • Ground markings

Mathematical statistical analysis. Statistical analysis of data was performed using SPSS for Windows 19.0 software (SPSS Inc., Chicago, USA). Means and standard deviations were calculated using descriptive statistics. Motor skills were predicted from weight, height, body mass index and physical activity using regression analysis. Results were considered as statistically significant if their p value was less than .05.

Table 2: Detailed description of Self-movement tests

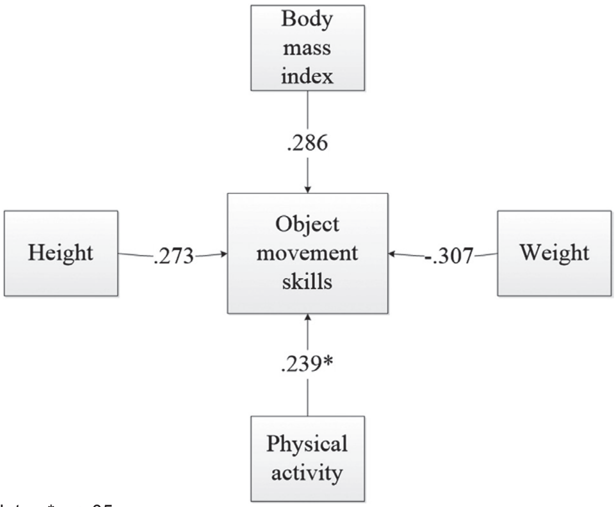
Self-movement				
	Balancing (5)	**Rolling(6)**	**Jumping (7)**	**Moving sideways (8)**
Qualification	**Balancing across a see-saw**	**Rolling forward.**	**Jumping forward continuously**	**Continuous lateral stepping**
Test item	The child balances across a seesawing long bench without leaving the bench.	The child performs a roll forward fl uently and is able to stand afterwards	The child jumps between and beneath the carpet tiles fl uently. The child has to jump on one leg between the tiles and with straddled legs beneath the tiles.	The child starts at the fi rst cone, moves sideways to the second cone and moves sideways back to the fi rst cone without changing his or her viewing direction. Moving back and forth twice counts as one trial.
Criteria	Fluent crossing of the bench without stopping or leaving it. Normal walking (no half steps). The child may not speed up or jump down at the end.	Fluent execution of movement without stopping. No rolling off the sides. Hands can be used for support. The child may not roll or stand up with crossed legs	The carpet tiles are not to be touched. The child must jump fl uently without stopping for more than 1 second. The takeoff leg etween the tiles can be chosen freely	Fluent side shuffl es. The legs never cross; the feet stay parallel to the ground marking and at ground level. The hips stay parallel to the marking.
Evaluation	2 attempts, amount of successful attempts is recorded.	2 attempts, amount of successful attempts is recorded	2 attempts, amount of successful attempts is recorded	2 attempts, amount of successful attempts is recorded
Test set-up	A long bench is placed upside-down on a springboard, forming a see-saw secured with gymnastic mats.	2 gymnastics mats are placed in a row.	4 carpet tiles are placed in a row with a 40 cm gap between them	2 cones are placed on a marking at a distance of 3 m from each other. Sidelines are marked.
Qualification	• 1 long bench (w: 10 cm, l: 4 m) • 1 springboard (h: 18-21 cm) • 4 gymnastics mats	• 2 gymnastics mats	• 4 carpet tiles (40 cm x 40 cm, 4 mm thick)	• 2 marking cones • Ground markings

Results

Table 3 presents descriptive data on predictors - first grade students' body composition and physical activity indicators.

Table 3: Students body composition and physical activity descriptive statistics

Indicator	Minimum	Maximum	Mean±SD
Height	114	148	129.70±6.10
Weight	17.00	49.90	27.24±5.41
Body mass index	12.40	24.70	16.10±2.24
Physical activity min./week	0	525.00	70.00±80.26



Note - *p < .05.

Figure 1: Prediction of object movement competence

The prediction of the object movement skills from the body composition measures and physical activity is presented in Figure 1. Results show that neither of body composition measures was among significant predictors. However object movement skills were significantly related with the physical activity. Higher physical activity predicted better motor skills using object ($p < .05$).

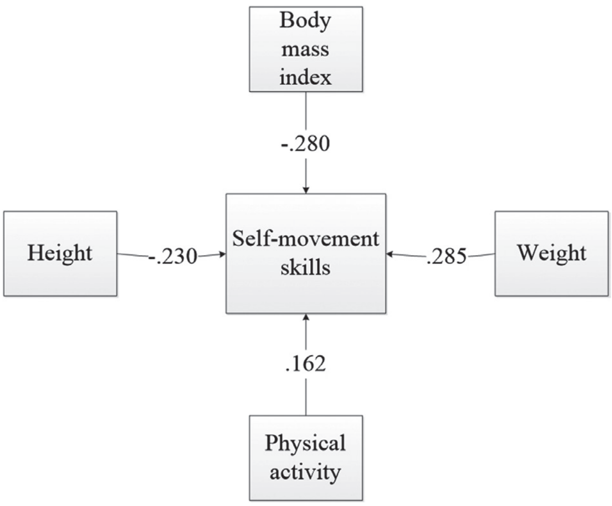


Figure 2: Prediction of self-movement competence

The prediction of the self-movement skills from the body composition measures and physical activity is presented in Figure 2. Results show that self-movement skills could be significantly predicted by neither body composition measures nor physical activity.

Discussion

Research shows that the motor skills are interrelated with physical activity (Herrmann & Gerlach, 2014). The main aim of this study was to analyze the associations between motor skills, body composition measures and physical activity.

Although literature suggest that many cross-sectional studies, as well as ours, found links among motor competencies and physical activity (Lubans et al., 2010), longitudinal study revealed lack of relationship among motor skills at age 4-6 years and physical activity at age 12 (McKenzie, Sallis, & Broyles, 2002). Other study shows that motor skills were only related to moderate to vigorous physical activity, but not to the light physical activity (Fisher et al., 2005). Physical activity in our study was not differentiated and that is probably the reason not obtaining significant relationship of self-movement motor skills and physical activity. Some authors argues that the relationship among motor skills and moderate to vigorous physical activity is very important as, for example, children with the most limited engagement in moderate to vigorous physical activity also had the poorest performance in the motor skills assessment, and it is possible that limited engagement in moderate to vigorous physical activity might hinder motor development or that limited motor development might restrict participation in moderate to vigorous physical activity (Fisher et al., 2005).

Results of studies, which examine the relationship of motor competencies with the body composition, in particular, body mass index, are inconsistent. The literature review revealed that some studies found negative association among those factors and some others, in line with our study, did not find any. More recent studies have shown that motor skills have a negative link with the body mass index and body fat percentage (D'Hondt et al., 2013; Lopes et al., 2012; Vandendriessche et al., 2011). Our study obtained similar results. Body mass was not related to motor skills. However, motor skills are closely related to other physiological factor – physical fitness. Scientific literature shows that motor competence is especially related to muscular fitness and flexibility as well as composite fitness score (Lubans et al., 2010).

Conclusion

Neither object related nor self-movement related motor competence was associated with body composition.

Object related motor competence was associated, meanwhile self-movement related motor competence was not associated with physical activity.

References

1. Andersen, L.B., Harro, M., Sardinha, L.B. et al (2006) Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). *Lancet*, 368, 299-304.
2. Barnett, L.M., van Beurden, E., Morgan, P.J., Brooks, L.O., & Beard, J.R. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. The Journal of Adolescent Health, 44, 252-259. doi:10.1016/j.jadohealth.2008.07.004.
3. D'Hondt, E., Deforche, B., Gentier, I. et al. (2013) A longitudinal analysis of gross motor coordination in overweight and obese children versus normal-weight peers. *Int J Obes (Lond),* 37 (1), 61-67, doi: 10.1038/ijo.2012.55.
4. Fisher, A. B. I. G. A. I. L., Reilly, J. J., Kelly, L. A. et al. (2005). Fundamental movement skills and habitual physical activity in young children. *Med Sci Sports Exerc*, *37*(4), 684-688.
5. Gallahue DL, Ozmun JC. (2006) Understanding motor development: infants, children, adolescents, adults. 6th ed. Boston (MA): McGraw-Hill,
6. Herrmann, C., & Gerlach, E. (2014). Motorische Basiskompetenzen in der Grundschule. Pädagogische Zielentscheidung und Aufgabenentwicklung [Basic motor competencies in primary school. Pedagogical aim decisions and development of tasks]. Sportunterricht, 63 (11).
7. Linden, C., Alwis, G., Ahlborg, H. et al. (2007) Exercise, bone mass and bone size in prepubertal boys: one-year data from the pediatric osteoporosis prevention study. *Scand J Med Sci Sports,* 17, 340-347.
8. Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., & Okely, A. D. (2010). Fundamental movement skills in children and adolescents. Sports medicine, 40(12), 1019-1035.
9. McKenzie T, Sallis J, Broyles S, et al. (2002) Childhood movement skills: predictors of physical activity in Anglo American and Mexican American adolescents? Res Q Exerc Sport; 73 (3): 238-44
10. Payne VG, Isaacs LD. (1995) Human motor development: a lifespan approach. 3rd ed. Mountain View (CA): Mayfield,
11. Stodden, D.F., Goodway, J.D., Langendorfer, S.J. et al. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. Quest, 60, 290-306. doi:10.1080/00336297.2008. 10483582
12. Valdimarsson, Ö., Linden, C., Johnell, O., Gardsell, P., Karlsson, M.K. (2006) Daily physical education in the school curriculum in prepubertal girls during 1 year is followed by an increase in bone mineral accrual and bone width-data from the prospective controlled Malmo pediatric osteoporosis prevention study. *Calcif Tissue* Int 78, 65-71.
13. Vandendriessche, J.B., Vandorpe, B.F.R., Coelho e Silva, M. et al. (2011) Multivariate association among morphology, fitness, and motor coordination characteristics in boys age 7 to 11. *Pediatr Exerc Sci*, 23 (4), 504-520.

PE TEACHER'S PERCEPTION ON STEM INTEGRATION IN CURRENT HONG KONG PE CURRICULUM

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Purpose

With the latest developments in the disciplines of knowledge and learning theories, physical education (PE) teachers are encouraged to exercise their expertise to introduce and incorporate science, technology, engineering, and mathematics (STEM) in PE curriculum as appropriate to enhance the learning and teaching effectiveness and enrich students' horizons. This study explored three secondary schools and three primary school PE teachers' perceptions of STEM integration in current Hong Kong PE Curriculum through interviews. The approach was constructivist and data were analyzed according to the recommendation and strategies to promote STEM education in recent curriculum updated in Hong Kong (Curriculum Development Council, 2015).

Methods

Three secondary school and three primary school PE teachers were purposively invited to participate in this study. Each participant completed three interviews to investigate their past experiences, then present perceptions, and lastly reflections on how to integrate STEM in current PE curriculum. Constant comparison and analytic induction were used to organize and categorize the data.

Results

Teacher perceptions were outlined individually and then compared. The teachers shared similar perceptions related to time constraints, purpose of PE, the effects of STEM integration, concerns about collaboration with other subject teachers, rapport with students, and curricular resources. Perceptions aligned well with the recommendation and strategies to promote STEM in PE in Hong Kong. Besides, enrich learning activities could be designed for students to extend their learning experiences in PE. Misconceptions of STEM education included incomplete understanding of technology and engineer education, and viewing the use of instructional technology as STEM education.

Conclusions

The findings suggest that support from tertiary institution, sharing among PE teachers and resources in teaching, and professional developments are needed to better promote STEM in PE.

References

1. Curriculum Development Council. (2015). *Consultation Brief: Updating the Physical Education Key Learning Area Curriculum (Primary 1 to Secondary 6) Ongoing Renewal of the School Curriculum – Focusing, Deepening and Sustaining.* Retrieved February 6, 2017, from http://www.edb.gov.hk/attachment/en/curriculum-development/renewal/PE/brief_PE%20KLA_e.pdf

REVIEW OF A RESEARCH ON GAME-BASED APPROACHES IN SLOVAKIA

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Abstract

Although one of the first tactical models, Bunker and Thorpe's Teaching Games for Understaning approach emerged in Europe in early 1980s, the initial researches on game-based approaches in Slovakia arose only 30 years later. Tactical models of teaching ball games have appeared in scientfic journals since 2012. Majority of the researches have focused on a comparison of a traditional, technical approach to tactical inquiry approaches like TGfU at a primary and secondary school level. The authors have mostly compared game performance, game skills, and procedural and declarative knowledge in volleyball, basketball, minihandball, floorball, frisbee ultimate and badminton. In most cases the matches were video recorded to evaluate game performance precisely. Most often Gréhaigne's Game Performance Assessment Instrument was applied. In general, the results support findings from several foreign studies that game-based models do not neglect game skills acquisition, just the opposite, the skills are well acquired in game-like situations. Moreover, tactical approaches based on constructivism enhance game performance and tactical (critical) thinking of the students.

Key words: *Teaching Games for Understanding, Physical Education, technology*

The content of school physical education in the Slovak republic consists of fundamental (mandatory) and optional thematic units. Sport games such as basketball, football, handball and volleyball have had a strong tradition in Slovak physical education curriculum for many years and therefore belong to the group of fundamental thematic units. Similarly to many other countries in the past, sport games (Oslin & Mitchell, 2006) have been widely taught from the perspective that students need to be competent in their physical skills in order to play the game; specifically, the focus of games has traditionally been on skill development. According to Slovak State Education Programme (ŠPÚ, 2009) the output of teaching games should be that a student acquires such level of game skills that (s)he is eventually able to play a game. When teaching a game, teachers often have the students practice motor skills used in the game and then expect them to be able to play the game, what is reffered to as a technical approach to teaching games (Bell & Hopper, 2003). According to Bunker and Thorpe (1982) a focus on skill development only teaches skill in isolation, separately from the context in which it will be used. For this reason Bunker and Thorpe (1982) proposed Teaching Games for Understanding (TGfU) as an alternative approach to the technical approach. The TGfU phrase was first coined in the United Kingdom in the early 1980s. The ideas were spawned by Thorpe, Bunker & Almond (1986) and drew on the earlier work of Mauldon & Redfern (1981). Since then, TGfU has attracted widespread attention from physical education teachers. The TGfU focuses upon teaching students tactical understanding before dealing with the performance of skills, as such the TGfU offers a *tactical approach* to games teaching emphasizing game performance before skill performance (Griffin, Mitchell & Oslin, 1997).

The concept of TGfU has served as an inspiration for development of several alike approaches to teaching games all over the world. For instance, *Games Concept Approach* in Singapore (Wright et al., 2005; Tang & Wong, 2000; Tan et al., 2002) known also as a *Concept-Based Games* (Mandigo et al., 2007), *Tactical Games Approach* in US (Mandigo et al., 2007; Griffin et al., 1997; Mitchell et al., 2003; 2006) which spread to Korea in the late 1990s (Butler & Griffin, 2010), Hopper's (2003) *4R model*, *Tactical Decision Learning Model* (Gréhaigne, Richard & Griffin, 2005; Gréhaigne et al., 2001), *Tactical Games Model* (Mitchell et al., 2006; Bohler, 2011; Griffin & Sheehy, 2004), *Playsport* in UK (Butler & Griffin, 2010), *PlaySMART* (Bell & Penney, 2004), *Teamball* in Denmark (Halling, 2008), *Invasion Games Competence Model* in Belgium (Musch, 2002), *Didactic Model of the Action Games Competences* in Columbia (Arias et al., 2014), *Play Practice* (Launder, 2001), *Sport Education* (Siedentop, 2002; Bohler, 2011) that spread to New Zealand (Grant, 1992), Australia (Alexander et al., 1993) and US (Carlson & Hastie, 1997; Hastie, 1996; 1998; Hastie & Siedentop, 1999), *Cooperative Learning* (Antil et al., 1998; Putnam, 1998), *Game Sense* (Light, 2006; Den Duyn, 1997), *Playing for Life* (ASC, 2005), *Game Based Approach* (www.acecoach.com), *Integrated Game Practice* in the Czech republic (Dobrý et al., 2011), etc.

The TGfU approach has stimulated research comparing technical versus tactical approaches to games teaching, especially on game skills, game performance and tactical knowledge.

Comparative studies examined skill execution in motor tests (Allison & Thorpe, 1997; Dalton 2009; French et al., 1996a; b; Gabriele & Maxwell, 1995; Lawton, 1989; Turner & Martinek, 1992; 1999) and games or game-like situations (Gray & Sproule, 2011; Griffin et al., 1995; Chatzopoulos et al., 2006; Mitchell et al., 1995; 1997; Turner & Martinek, 1992; 1999; Harrison et al., 2004; 1999). In general the studies did not show any significant differences in game skills' level of students taught by tactical versus technical approach.

Studies investigated tactical (declarative and procedural) knowledge in written or video tests (Allison & Thorpe, 1997; French et al., 1996a; 1996b; Gabriele & Maxwell, 1995; Griffin et al., 1995; Lawton, 1989; Mitchell et al., 1997; Turner & Martinek, 1992; 1999), as well as in games or game-like situations (Gabriele & Maxwell, 1995; Griffin et al., 1995; Mitchell et al., 1995; Turner & Martinek, 1992; 1999), and in the interviews (French et al., 1996a; 1996b). Turner (1996) and Turner & Martinek (1999) in field hockey, Griffin et al. (1995) in volleyball and Mitchell et al. (1997) in football found better declarative knowledge in tactically taught groups. Other studies have not found any differences in tactical knowledge between the groups (Griffin et al., 1995; French et al., 1996a; 1996b; Mitchell et al., 1997; Turner & Martinek 1992). McPherson & French (1991) in tennis and Harrison et al. (2004) in volleyball found improvement in tactical knowledge in both groups. Blomqvist (2001) in badminton found significantly better declarative knowledge in written test and procedural knowledge in video-test in group taught by the tactical approach.

Decision-making as a part of a game performance was assessed in games or game-like situations as appropriate or inappropriate (French et al., 1996a; 1996b; Gabriele & Maxwell, 1995; Griffin et al., 1995; Mitchell et al., 1995; Turner & Martinek 1992; 1999). The studies did not show unequivocal results. Better decision-making achieved by a tactical group was shown in squash (Gabriele & Maxwell, 1995), football (Chatzopoulos et al., 2006; Arias et al., 2014) , in basketball (Gray & Sproule, 2011), and partially in field hockey in case of where to pass (Turner & Martinek, 1999). No differences in decision-making between the groups were found in football (Mitchell et al., 1995), field hockey (Turner & Martinek, 1992), badminton (French et al., 1996a) and volleyball (Harrison et al., 2004; 1999).

Though the results of these studies were inconclusive in many of them it was noted that children in a tactical approach indicated more enjoyment when learning and did not show any less significant skill improvement. Indeed, Strean & Holt's (2000) research highlight that children, coaches and parents all acknowledge that games and game-like situations were more fun than technically oriented drills. Teachers of the tactical groups stated that the students were more involved in the lesson, showed more enthusastic and positive attitudes to the content and Physical Education as a school subject (Allison & Thorpe, 1997; Almond, 1986; Burrows & Abbey, 1986; Doolittle, 1983; Gubacs, 2000; Mitchell et al., 1997; Turner, 1996).

A number of studies (e.g. Gray & Sproule, 2011; Psotta & Martin, 2011; Harvey, www.researchgate.net) used Game Performance Assessment Instrument (GPAI) to evaluate the game performance and its components such as skill execution, decision-making, support, guard, cover, base or adjust of the students. There are two ways of using the GPAI: 1-5 scoring system and Tally scoring system (Mitchell & Oslin, 1999). To increase the reliability and objectivity of the assessment it is recommended to use digital records.

Research in Slovakia

In the Slovak republic a very first comparative study related to TGfU and traditional approach appeared just 5 years ago when Popelka's (2012) doctoral study investigated the appllication of both approaches in secondary school (Grade 8) volleyball units. The results unambiguously suggest better efficiency of TGfU compared to the technical approach. The tactically taught group achieved better quality of the bump's technique, better procedural knowledge and decision-making in the game. No significant differences were found in students' declarative knowledge between the groups.

Žuffová (2012) compared the efficiency of TGfU and technical approach in secondary school (Grade 6 and 7) frisbee ultimate units. The technically oriented groups showed better improvement in game skills, but on the contrary, less game performance level.

Olosová (2012), Olosová & Zapletalová (2012) investigated the comparison of TGfU and traditional approach in primary school second graders' minibasketball units. The game performance of tactically taught group was significantly better compared to the technical group but there was no difference in acquired motor skills between the groups.

Argaj (2012a; b; 2013; 2014) carried out several single-group experiments in order to investigate TGfU' efficiency in basketballl and frisbee ultimate. He (2012b; 2013) confirmed significant improvement in layup of 11- to 12-year old basketball players. In addition, an upward tendency of their game performance based on shooting efficiency, number of conquered and lost balls was shown throughout the season. Similar results were confirmed in Physical Education Teacher Education (PETE) students' frisbee ultimate units (2012a; 2013). Argaj (2014) showed significant improvement in game skills of primary school Grade 4 students, specifically in under basket shot, pass for accuracy and dribling. Selected components of game performance (skill execution, decision-making, support and guide) were evaluated by the GPAI using digital records.

Kucharik (2014) compared the application of TGfU and technical approach in minihandball in primary school students of Grade 1 to Grade 5. The results confirmed better game performance in TGfU group compared to the technical group and there were no significant differences in game skills acquisition between the groups.

Zapletalová & Řezníčková (2016) indicated better game performance and tactical knowledge of 16- to 17-year old students in badminton of the tactically taught group in comparison to the group taught by the technical approach.

Zapletalová, Antala & Huntata (2016) implemented a comparative study in secondary (Grade 5-7) and high school students (Grade 1) in floorball units. The study results showed very similar effects of both approaches on game skills as well as game performance assessed by the GPAI.

Olosová’s (2016) doctoral study investigated immediate and follow-up effects of TGfU and technical approach on game skills, game performance and tactical knowledge in secondary school students’ (Grade 5 and 6) basketball units. Game performance was assessed by the GPAI using digital record. With regard to immediate efficiency of the teaching models, no difference in game skills (pass, shot, dribbling) were found between the groups. Secondly, the tactically taught group showed better skill execution and decision-making as well as overall game performance in 3-3 game. Thirdly, the same group showed better procedural and declarative basketball knowledge than the technically led group. From the follow-up point of view the results indicated very similar effects of both approaches to teaching basketball.

Žuffová (2016) in her doctoral study compared TGfU and technical approach to teaching 11- to 15-year old students in frisbee ultimate. Game performance was assessed by the GPAI using digital record. The tactically taught students showed better decision-making in the game and 11-year old students achieved better procedural knowledge in comparison to the technically taught groups. No differences in game skills in motor tests, skill-execution in the game and declarative knowledge in the written test were confirmed between the groups. In addition, a comparison of different age cathegories showed very similar effects of both methods on all measure variables.

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Compared to other countries the research on TGfU and alike approaches to teaching games in Slovakia is quite new and has been very limited so far. More rigorous evidence in this field is needed to support the integration of tactical approaches into practice.

References

1. Alexander, K., Taggart, A. & Medland, A., 1993. Sport education in physical education: Try before you buy. In: *ACHPER National Journal*, *40*(4), s. 16-23.
2. Allison, S. & Thorpe, R., 1997. A comparison of the effectiveness of two approaches to teaching games within physical education: A skills approach versus a games for understanding approach. In: *The British Journal of Physical Education, 28*(3), s. 9-13.
3. Antil, P. C., Jenkins, J. R., Wayne, S. K., & Vadasy, P. F., 1998. Cooperative learning: Prevalance, conceptualizations, and the relation between research and practice. In: *American Educational Research Journal,* 35, s. 419-454.
4. Argaj, G., 2012a. Efekty taktického prístupu pri vyučovaní športovej hry frisbee ultimate. In: *Aktuálne problémy telesnej výchovy a športu I* [CD]. Ružomberok: VERBUM - vydavateľstvo KU v Ružomberku, s. 14-20. ISBN 978-80-8084-822-4.
5. Argaj, G., 2012b. Efekty taktického prístupu pri vyučovaní basketbalu. In: *Hry 2012*. Plzeň: Západočeská univerzita, s. 34-48. ISBN 978-80-261-0160-4.
6. Argaj, G., 2013. Efekty taktického prístupu pri výučbe športových hier. In: *Aktuálne problémy telesnej výchovy a športu II*. Ružomberok: VERBUM - vydavateľstvo KU v Ružomberku, s. 12-22. ISBN 978-80-8084-984-9.
7. Argaj, G., 2014. Efekty herného prístupu pri výučbe basketbalu na základnej škole. In: *Hry 2014. Hra od kolébky do hrobu* [CD]. Plzeň: Západočeská univerzita, s. 48-59.
8. Arias, e., Valencia, w., Marín, h., & Arias, A., 2014. The construction of action knowledge learning competencies in sport games, a didactic model of the game action competences. In: *FIEP World Congress 2014* [online]. Vierumäki: University of Jyväskylä, s. 17. Dostupné z: http://www.vierumaki.fi/wp-content/uploads/2014/08/Abstract-Book.pdf
9. Australian Sports Commission (ASC), 2005. *Active after-school communities – Community coach training program*. Canberra: ASC.
10. Bell, T. & Penney, D., 2004. PlaySMART: developing thinking and problem-solving skills in context of the national curriculum for physical education in England. In: J. Wright, D. Macdonald A L. Burrows. *Critical inquiry and problem-solving in physical education*. London: Routledge, s. 49-61. ISBN 0-415-29163-1.
11. Blomqvist, M., 2001. *Game Understanding and Game Performance in Badminton: Development and validation of assessment instruments and their application to games teaching and coaching.* Jyväskylä. Master thesis. University of Jyväskylä.
12. Bohler, H. R., 2011. *Fifth-Grade Students’ Tactical Understanding, Decision-Making and Transfer of Knowledge in a Tactical Games Model Net/Wall Sampling Unit* [online]. Doctoral thesis. University of Massachusetts – Amherst. Dostupné z: http://scholarworks.umass.edu/open_access_dissertations
13. Butler, J. & Griffin, L., 2010. *More teaching games for understanding: Moving globally*. Champaign Illinois: Human Kinetics. ISBN-13: 978-0-7360-8334-8. ISBN-10: 0-7360-8334-0.
14. Carslon, T. & Hastie, P., 1997. The student social system within sport education. In: *Journal of Teaching in Physical Education,* 16, s. 176-195.

15. Dalton, W., 2009. *Teaching teachers to play and teach games* [online]. http://wiliandalton.blogspot.sk/2009/03/teaching-teachers-to-play-and-teach.html
16. Den Duyn, N., 1997. *Game Sense: Developing thinking players*. Belconnen: Australia Sports Commision.
17. Dobrý, L., Tomajko, D., Velenský, M., Tůma, M., Háp, P., Šafaříková, J., Šafařík, V. & Argaj, G., 2011. Integrovaná praxe ve sportovních hrách. In: Tělesná výchova a sport mládeže, 77(2), s. 7-17.
18. French, K. E., Werner, P. H., Taylor, K., Hussey, K., & Jones, J., 1996b. The effects of a 6-week unit of tactical, skill or combined tactical and skill instruction on badminton performance of ninth-grade students. In: *Journal of Teaching in Physical Education,* 15, s. 439-463.
19. French, K. E., Werner, P. H., Taylor, K., Hussey, K., & Jones, J., 1996b. The effects of a 6-week unit of tactical, skill or combined tactical and skill instruction on badminton performance of ninth-grade students. In: *Journal of Teaching in Physical Education,* 15, s. 439-463.
20. Gabriele, T. E. & Maxwell, T., 1995. Direct versus indirect methods of squash instruction. In: *Research Quarterly for Exercise and Sport,* 66, A-63.
21. Grant, B. C., 1992. Integrating sport into the physical education curriculum in New Zealand secondary schools. In: *Quest,* 44, s. 304-316.
22. Gray, S. & Sproule, J., 2011. Developing Pupils' Performance in Team Invasion Games. In: *Physical Education and Sport Pedagogy, 16*(1), s. 15-32.
23. Gréhaigne, J. F., Godbout, P., & Bouthier, D., 2001. The teaching and learning of decision making in team sports. In: *Quest,* 53, s. 59-76.
24. Gréhaigne, J. F., Richard, J. F., & Griffin, L., 2005. *Teaching and Learning Team Sports and Games*. USA: Tailor and Francis Group. ISBN 0-415-94639-5.
25. Griffin, L. & Sheehy, D., 2004. Using the tactical games model to develop problem-solvers in physical education. In: J. Wright, D. Macdonald a L. Burrows. *Critical inquiry and problem-solving in physical education*. London: Routledge, s. 33-48. ISBN 0-415-29163-1.
26. Griffin, L., Mitchell, S. & Oslin, J., 1997. *Teaching sport concepts and skills. A tactical game approach*. Champaign: Human Kinetics. ISBN 0-7360-5453-7.
27. Griffin, L., Oslin, J. & Mitchell, S., 1995. An analysis of two instructional approaches to teaching net games. In: *Reserch Quarterly for Exercise and Sport,* 66, A-64.
28. Halling, A., 2008. Teamball – a third generation of Teaching Games for Understanding. In: *AIESEP 2008 World Congress-Sport pedagogy research, policy and practice: International perspectives on physical education and sports coaching*. ID 483.
29. Harrison, J. M., Blakemore, C. L., Richards, R. P., Oliver, J., Wilkinson, C. & Fellingham, G., 2004. The Effects of Two Instructional Models—Tactical and Skill Teaching—on Skill Development and Game Play, Knowledge, Self-Efficacy, and Student Perceptions in Volleyball. In: *Physical Educator, 4*(61).
30. Harrison, J. M., Preece, L. A., Blakemore, C. L., Richards, R. P., Wilkinson, C. & Fellingham, G., 1999. Effects of two instructional models – skill teaching and mastery learning – on skill development, knowledge, self efficacy, and game play in volleyball. In: *Journal of Teaching in Physical Education,* 19, s. 34-57.
31. Hastie, P & Siedentop, D., 1999. An ecological perspective on physical education. In: *European Physical Education Review,* 5, s. 9-29.
32. Hastie, P., 1996. Student role involvement during a unit of sport education. In: *Journal of Teaching in Physical Education,* 16, s. 88-103.
33. Hastie, P., 1998. The participation and perceptions of girls within a unit of sport education. In: *Journal of Teaching in Physical Education,* 17, s. 157-171.
34. Hopper, T., 2003. Four Rs for Tactical Awareness: Aplying Game Performance Assessment in Net/Wall Games. In: *Teaching Elementary Physical Education, 14*(2), s. 16-21.
35. Chatzopoulos, D., Drakou, A., Kotzamanidou, M. & Tsorbatzoudis, H., 2006. Girls soccer performance and motivation: Games versus technique approach. In: *Perceptual and motor skills*, 103, s. 463-470.
36. Kucharik, I., 2014. *Efektivita taktického a technického didaktického prístupu pri výučbe minihádzanej 1. až 5. ročníka základných škôl*. Bratislava. Diplomová práca. FTVŠ UK.
37. Launder, A. G., 2001. *Play practice: The games approach to teaching and coaching sports*. Champaign, IL: Human Kinetics.
38. Lawton, D., 1989. *Education*. London: Hodder and Stoughton.
39. Light, R., 2006. Game Sense: Innovation or just good coaching? In: *Journal of Physical Education New Zealand, 39*(1), s. 8-19.
40. Mandigo, J., Butler, J. & Hopper, T., 2007. What is Teaching Games for Understanding? A canadian perspective. In: *Physical and Health Education,* summer.
41. Mcpherson, S. & French, K., 1991. Changes in cognitive strategy and motor skill in tenis. In: *Journal of Sport Exercise and Psychology,* 13, s. 29-41.
42. Mitchell, S., Griffin, L., & Oslin, J., 1997. An analysis of two instructional approaches to teaching invasion games. In: *Research Quarterly for Exercise and Sport,* 66 (Suppl.), A-65.

43. Mitchell, S., Oslin, J. & Griffin, L., 1995. The effects of two instructional approaches on game performance. In: *Pedagogy in Practice: Teaching and Coaching in Physical Education and Sports,* 1, s. 36-48.
44. Mitchell, S., Oslin, J., & Griffin, L., 2003. *Sport Foundations for Elementary Physical education: A tactical games approach.* USA: Human Kinetics. ISBN 0-7360-3851-5.
45. Mitchell, S., Oslin, J., & Griffin, L., 2006. *Teaching sport concepts and skills: A tactical games approach for ages 7 to 18.* 2nd ed. USA: Human Kinetics. ISBN-13: 978-1-4504-1122-6. ISBN-10: 1-4504-1122-3.
46. Musch, E. et al. 2002. *The invasion games competence model: An alternative approach to games instruction and learning* [CD]. Poster presented in AISEP congress of LaCoruna, Spain.
47. Olosová, G. & Zapletalová, L., 2012. Účinnosť taktického a technického prístupu k výučbe minibasketbalu. In: *Od výskumu k praxi v športe. Zborník vedeckých prác.* Bratislava: STU, s. 205-210. ISBN 978-80-227-3854-5.
48. Olosová, G., 2012. Účinnosť taktického a technického prístupu k výučbe minibasketbalu na rozvoj herného výkonu a pohybových schopností. Bratislava. Master thesis. FTVŠ UK.
49. Olosová, G., 2016. Účinnosť herne orientovaného modelu vyučovania basketbalu v telesnej a športovej výchove. Bratislava. Doctoral thesis. FTVŠ UK.
50. Popelka, J., 2012. *Vplyv špecifického programu na zmeny úrovne hernej výkonnosti žiakov vo vyučovaní volejbalu na 2. stupni základných škôl*. Banská Bystrica Doctoral thesis. UMB Fakulta Humanitných vied.
51. Siedentop, D., 2002. Content knowledge for physical education. In: *Journal of Teaching in Physical Education*, 21, s. 368-377.
52. Špú, 2009. Štátny vzdelávací program telesná a športová výchova (Vzdelávacia oblasť: Zdravie a pohyb): Príloha ISCED2. Bratislava. http://www.statpedu.sk/sites/default/files/dokumenty/statny-vzdelavaci-program/telesna_vychova_isced2.pdf
53. Tan, S., Wright, S., Mcneill, M., Fry, J., & Tan, C., 2002. Implementation of the games concept approach in Singapore schools. A pre liminary report. In: *Review of Educational Research and Advances for Classroom Teachers, 21*(1), s. 77-84.
54. Tang, S. K. S. & Wong, I. Y. E., 2000. Meeting the challenge within the physical education curriculum in the new millennium: Policies, possibilities and problems. In: *Journal of the International Council for Health, Physical Education, Recreation, Sport and Dance, 36*(2), s. 39-47.
55. Thorpe, R., Bunker D. & Almond. L., 1986. *Rethinking games teaching.* England: Louhgborough, University of Technology, Department of Physical Education and Sport Science.
56. Turner, A. P. & Martinek, T., 1992. A comparative analysis of two models for teaching games (technique approach and game-centered tactical approach). In: *International Journal of Physical Education*, 29, s. 131-152.
57. Turner, A. P. & Martinek, T., 1995. Teaching for understanding: A model for improving decision making during game play. In: *Quest*, 47, s. 44-63.
58. Turner, A. P. & Martinek, T., 1999. An investigation into TGFU: Effects on skill, knowledge and game play. In: *Research Quarterly for Exercise and Sport,* 70, s. 286-296.
59. Wright, S., Mcneill, L., Fry J. & Wang, J., 2005. Teaching teachers to play and teach games. In: *Physical Education and Sport Pedagogy, 10*(1), s. 61-82.
60. Zapletalová, L. & Řezníčková, Ľ., 2016. Účinnosť herne orientovaného modelu výučby bedmintonu v školskej telesnej a športovej výchove. In: *Telesná výchova a šport 1(26),* 8-12. ISSN 1335-2245.
61. Zapletalová, L., Antala, B., & Huntata, M., 2016. Integrovaná herná prax verzus neštruktúrovaný model výučby flórbalu. In: *Telesná výchova a šport 2(26),* 6-14. ISSN 1335-2245.
62. Žuffová, Z., 2012. *Efektivita rôznych prístupov k vyučovaniu frisbee ultimate*. Bratislava. Master thesis. FTVŠ UK.
63. Žuffová, Z., 2016. Efektivita herne orientovaného a tradičného modelu vyučovania frisbee ultimate v rôznych vekových skupinách dievčat. Bratislava. Doctoral thesis. FTVŠ UK.

THE USE OF MOTOR IMAGERY IN PHYSICAL EDUCATION AND SPORT

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Abstract

Objectives*:* The motor imagery is a cognitive process of mental simulation of actions in absence of movement. There are two methods to improve skills learning trough motor imagery: in first person and In third person. The biological basis on which the motor imagery theory is founded, is formed by: mirror neurons. The aim wants to evaluate the effects of motor imagery practice in training.

Methods: It is an experimental approach and it consists of two steps:

1) To administrate the questionnaire. The participants are asked to evaluate the sensation of their own motor act and then their mate's one in accordance with valuation methods of Italian federation of artistic gymnastics. 2) The means used in the second part of the study is the video recording. The participant are given the vision of their own motor gesture that will be stopped and the participant are asked a final forecast of the performance result.

Results: The results are based on the assumption neuro-scientific by the activity of mirror neurons that allow you to use the same nervous substrate for actions performed or observed, or thought. Interpretation of data concerning evaluation of others, namely evaluation of the athletes towards the companions emerged a more low outside awareness of the motor act that is looked. However, there are consistency and improvements for about 80% of the ratings that shows how the training of motor imagery in the first person may be accompanied by one in the third person. In order to contribute to improving the performance in training and the race since it the same neuronal synapses are activated for both actions you thought or observed both for themselves (ie in the first person), and other (ie in the third person).

Conclusions: In this study two basic aspects of the performance are examined: the motor execution and the motor imagine. Both share the same neuro-motor mechanism: the motor imagery. Concerning the woman artistic gymnastics, it can be useful during the training and the race. So providing the athletes and trainers of a means which uses the motor imagery as a possible application for the improvement of the performance. So in conclusion, the study aims to provide a standard training feasible on a large scale to train the cognitive and physical abilities of an athlete and provide a support tool in the race in order to improve performance, optimize time and to reduce the margin of error.

***Key words**: mirror neurons, VMIQ and MIQ-R, vividness, motor skills*

Introduction

The motor imagery is a cognitive process of mental simulation of an action in the absence of physical movement. (Jeannerod, 1995). MI was deeply investigated also by Marc Jeannerod. One of the most scientist about the neurological process.

He had lived between 1935 and 2011, its scientific life was entirely dedicated at neurology and neurophysiology, as well as other Scientifics about cognitive neuroscience and experimental psychology are interested. Specially, yhe mechanisms underpinning motor control, motor cognition are investigated by Decety in 1996, Driskell and Copper in 1994, Gallese and Rizzolatti between 1996-2012, Lafleur in 2002, Sanders in 2004. It also defined as a state of general activation during which a person feels himself to perform an action.

The motor imagery should be distinguished from mental practice, the first refers to the cognitive process while, the second refers to the process of mental training that takes advantage of the first process.

There are two types of motor imagery: in first-person and in third-person.

In first person mode, the subject imagines himself to perform an action but not in the sense of seeing himself as an external or reflected image, in the sense to see what he would see, if he performed a movement and at the same time feel emotions, excitation, stress and changes of arousal. In third person mode, the person sees himself or another person as an external image, as with the use of a camera. The most effective for learning is that first-person. Numerous studies have shown that the performance is optimized through the cognitive process of motor imagery. During the motor imagery the cerebral areas of the pre-motor cortex, the same which a muscular contraction would put in action, are activated.

The pre-motor cortex is responsible for complex sequences of movements and selects them in response to a stimulus. The pre-motor cortex is located in front of the primary motor cortex and laterally on the surface of the frontal lobe The execution and imagination activate the same regions of the cerebellum, basal ganglia and motor cortex. All this is possible thanks to mirror neurons which are the biological basis on which is based the motor imagery.

Mirror neurons are a class of neurons which are activated when we make a move and when we observe it, as if the observer did the movement (Rizzolatti, Sinigaglia, 2006). Mirror neurons were discovered in the 90's by a group of researchers in a macaque, group coordinator is Giacomo Rizzolatti. In 1995, the same group of researchers demonstrated the existence of a neuronal group, similar to that of macaques, also in man. Mirror neurons have been found in the pre-motor cortex and the parietal lobe, area to which deputed only motor function and not the cognitive function.

The activation of mirror neurons allows to map on the same nervous substrate actions performed and observed or imagined. In this way you create an internal image released from execution. (Jeannerod, 2002a). Mirror neurons are a particular class of visual-motor neurons which allows to learn and optimize a motor gesture without executing it. Mirror neurons represent the space of internal sharing that allows us to imitate, learn and understand the intentions of motor events.

The ability to create an inter-subjective space which is then shared with the world is connected to the role played by embodied simulation, neuro-scientifically based on mirror neurons. (Jeannerod, 2002b). The study aims to evaluate the potential benefits of motor imagery on a group of gymnasts practicing gymnastics, especially for the round off flick. (image 1).

The artistic gymnastics is a sport of precision and the movements are complex, then it use the abilities closed skills serial type, skills that are used in stable environments consist of a number of discrete skills are placed in sequence to form a more complex and protracted movement; as round off flick.

The round off is like the wheel but at half movement the legs join. The flick is often performed after the round off and consists of two times: the first time you push whit the legs and then you put your hands back to the ground, in the second time you push by the upper limbs and then return to the position departure. The artistic gymnastics uses the model of closed-loop control with the use of feedback (Schmdit, Wrisberg 2000). In sport activity the phenomenon of the influence of mental aspects run usually.

In the School of Sport, Health, and Exercise Sciences at Bangor University, the project proposal module is worth 10 credits and comprises of a verbal presentation and written proposal. Nichola Callow and Ross Roberts propose the module project is worth 10 credits and comprises of a verbal presentation and written proposal on sport activity.

In physical education and sport medicine was realized many studies about the mental function and the results show the preeminent position on imagination and its pattern in movement and performance (Astin et al. 2003). Curry, L. A and Maniar, S. D. researched in academic course combining psychological skills training and life skills education for university students and student-athletes (Curry et al. 2004). The aim of this study is to apply the tool of the evaluation by oneself, by others and by judge according to a specific standard tests. Two imagery measures (VMIQ and MIQ-R) were used to capture whether the self-modeling video would influence competitive divers' imagery vividness and ability.

Methods

The method used for this study is an experimental one and it consists of two steps: the first step is a direct experimental type while the second is an indirect experimental type. The means used in the first part of the study is the questionnaire (here attached) formed by three columns and different items. The first columns concerns the evaluation by oneself, the second one concerns the oneself evaluation of others and the third one the valuation by a judge/technician. The participants are asked to evaluate the sensation of their own motor act and then their mate's one in accordance with valuation methods of Italian federation of artistic gymnastics.

The data will be compared with those of judge/technician. The means used in the second part of the study is the video recording. The participants are given the vision of their own motor gesture and then the others' one, previously recorded, and the video will be stopped before the gesture ends.

The participants are asked a starting evaluation of external type, which will be compared with those of the judge/technician and at last a final forecast of the performance result will be asked.

The forecast will be compared with the final results (internal, external and judge/technician) and collective according to an appropriate statistical pattern. The sample that are part of the experiment consists of two athletes to medium-high level practicing gymnastics for not less than 5 years of age between 12 and 15 years.

The athletes before beginning the training, they will be educated on the modalities cognitive and practices that must be performed (MI in the first and third person) and the means by which they are evaluated.

The research hypothesis is to provide a standard training feasible on a large scale to train the cognitive and physical abilities of an athlete and provide a support tool in the race in order to improve performance, optimize time and to reduce the margin of error.

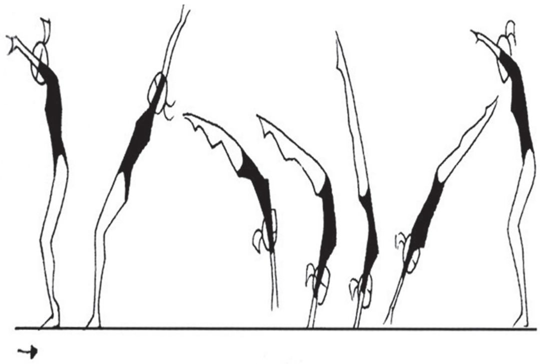


Image 1: Flick

Results

The results are based on the assumption neuro-scientific by the activity of mirror neurons that allow you to use the same nervous substrate for actions performed or observed, or thought. Interpretation of data concerning evaluation of others, namely evaluation of the athletes towards the companions emerged a more low outside awareness of the motor act that is looked.

However, there are consistency and improvements for about 80% of the ratings that shows how the training of motor imagery in the first person may be accompanied by one in the third person. In order to contribute to improving the performance in training and the race since it the same neuronal synapses are activated for both actions you thinked or observed both for themselves (ie in the first person), and other (i.e. in the third person).

In the table 1 and 2 there are evaluation of the athlete 1 and 2. In the table 3 there are evaluation by judge.

In the figure 1 there is the comparison between hetero-evaluations and evaluation of the judge. As can be seen from Figure 1, the evaluation by athletes have not assonance with those by the judge. However, we note an improvement of performance and of skill to evaluate in the second part of study (month 4 and 5).

First the athletes tend to underestimate the performance then there is more consistency.

As can be seen from Figure 2, there is a 80% improvement of the ‘assessment skills.

Table 1: Hetero-evaluation by the athlete 1

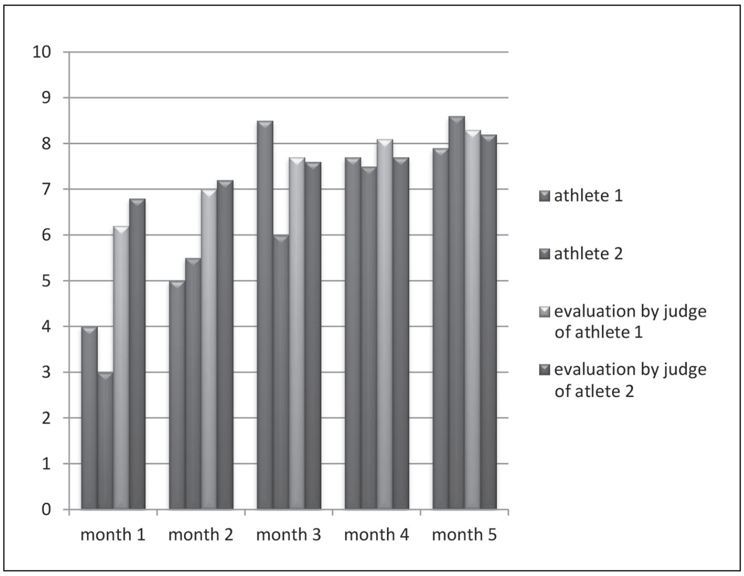
	Athlete 1	Athlete 2
1 ROND- OFF FLICK		3,5
2 ROND- OFF FLICK		3
3 ROND- OFF FLICK		4,5
4 ROND- OFF FLICK		4,5
5 ROND- OFF FLICK		5,5
6 ROND- OFF FLICK		8,6
7 ROND- OFF FLICK		8.5
8 ROND- OFF FLICK		7
9 ROND- OFF FLICK		8,2
10 ROND- OFF FLICK		7,9
11 ROND- OFF FLICK		8,2

Table 2: Hetero-evaluation by the athlete 2

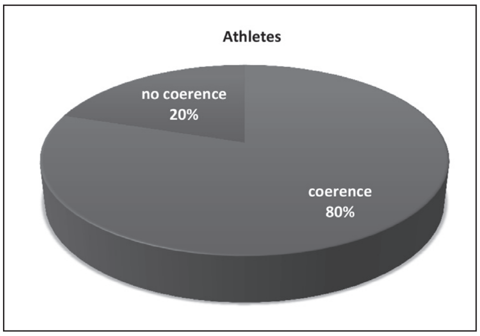
	Athlete 2	Athlete 1
1 ROND- OFF FLICK		3
2 ROND- OFF FLICK		4
3 ROND- OFF FLICK		3,5
4 ROND- OFF FLICK		4,5
5 ROND- OFF FLICK		6,5
6 ROND- OFF FLICK		6
7 ROND- OFF FLICK		6
8 ROND- OFF FLICK		7,5
9 ROND- OFF FLICK		7,5
10 ROND- OFF FLICK		8,2
11 ROND- OFF FLICK		9

Table 3: Evaluation by judge

	Athlete 1	Athlete 2
1 ROND- OFF FLICK	6.3	6,5
2 ROND- OFF FLICK	6.2	7,9
3 ROND- OFF FLICK	6.5	6
4 ROND- OFF FLICK	6,9	7.5
5 ROND- OFF FLICK	7	7
6 ROND- OFF FLICK	7,5	7,5
7 ROND- OFF FLICK	8	7.8
8 ROND- OFF FLICK	8,3	7,9
9 ROND- OFF FLICK	7,9	7,5
10 ROND- OFF FLICK	8	8
11 ROND- OFF FLICK	8,5	8.5



Graph 1: Comparison between hetero-evaluations and evaluation of the judge



Graph 2: assonance between judge's evaluation and athletes' evaluation

Discussions

The innovative aspect of this study is the use of hetero-evaluation tool. It is rarely used, but the data show improvements in the performance and ability to evaluate, after using for 5 months of this methodology. Another innovative aspect is the use of motor imagery in the third person. Also it is rarely used. These tools use the same nervous substrate used for movements executed, thought or observed. In this way stimulates neural connections and improving performance, racing and training. Awareness improves in young athletes too. Study provides a valuable tool for improving performance, minimally but it is a great starting point. In sport activity the phenomenon of the influence of mental aspects run usually. In the School of Sport, Health, and Exercise Sciences at Bangor University, the project proposal module is worth 10 credits and comprises of a verbal presentation and written proposal. Nichola Callow and Ross Roberts propose the module project is worth 10 credits and comprises of a verbal presentation and written proposal on sport activity. In physical education and sport medicine was realized many studies about the mental function and the results show the preeminent position on imagination and its pattern in movement and performance (Astin et al., 2003). Curry, L. A and Maniar, S. D. researched in academic course combining psychological skills training and life skills education for university students and student-athletes (Curry et al., 2004).

Conclusions

In this study two basic aspects of the sports performance are examined: the motor execution and the motor imagine. Both share the same neuro-motor mechanism: the motor imagery. Concerning the woman artistic gymnastics, it can be useful during the training and the race. It gives a pattern of action in first person which allow to concentrate all emotions, sensations and mood of a motor action without moving a muscle but putting all the neuro-motor proceeding in action. The motor imagery is a natural ability and so if trained, it is useful for the performance strengthening. So providing the athletes and trainers of a means which uses the motor imagery as a possible application for the improvement of the performance is very ambitions. So in conclusion, the study aims to provide a standard training feasible on a large scale to train the cognitive and physical abilities of an athlete and provide a support tool in the race in order to improve performance, optimize time and to reduce the margin of error. This tool aims to be refined with the use of notational video methods that will allow the analysis of quantitative aspects (such as the strength, the explosive strength, the resistance etc.) other than those quality of the internal and external evaluation, in relation to the effective role played by the motor imagery widely used for sports that use closed skills and therefore useful for artistic gymnastics. The study aims to use the motor imagery in first person (much used) and in the third person (less used) for the training of gymnasts practicing artistic gymnastics. The study also in some small way confirms the usefulness of using the tool of motor imagery in third person.

References

1. Astin, J. A., Shapiro, S. L., Eisemberg, D. M., & Foris, K. L.,. *Mind-body medicine: State of the science, implications for practice. Journal of the American Board of Family Practice, 16*, 131-147. 2003
2. Curry, L. A., & Maniar, S. D.,. *Academic course combining psychological skills training and life skills education for university students and student-athletes. Journal of Applied Sport Psychology, 15, 270-277.* 2003
3. Curry, L.A., & Maniar, S. D.,. *Academic course for enhancing student-athlete performance in sport. The sport Psychologist, 18*, 297- 316. 2004
4. Jeannrod, M., a. *Le Cerveau intime*. Paris: Editions Odile Jacob2002
5. Jeannrod, M.,. *La Nature de l'esprit*. Paris: Editions Odile Jacob2002b
6. Jeannrod, M., *Motor cognition*: What actions tell the Self. Oxford University Press. 2006.
7. Rymal A M, Ste-Marie M., *Does Self-Modeling Affect Imagery Ability or Vividness Journal of Imagery Research in Sport and Physical Activity.* 2009
8. Tursi D, Napolitano S., Raiola G. *Assessment the technical execution in archery through video analysis .Buletin Stiintific - Universitatea din Pitesti. Seria Educatie Fizica si Sport,* vol. 17; p. 41-43, ISSN:1453-1194, doi: 10.7752 2013
9. Napolitano S. *Cliff diving: water impact and video-analysis. Journal of Physical Education and Sport,* vol. 14; p. 93-97, ISSN: 2247-8051, doi:DOI:10.7752/jpes.2014.01015; © JPES 2014.
10. Tursi D, Napolitano S, Raiola G. *Assessment the technical execution in archery through video analysis . Buletin Stiintific - Universitatea din Pitesti. Seria Educatie Fizica si Sport, vol. 17,* p. 41-43, ISSN: 1453-1194, doi: 10.7752. 2013
11. Napolitano S, Tursi D *The evaluation of the tactic in women's water polo: the experience of a team in the Italian championship premier league. Buletin Stiintific - Universitatea din Pitesti. Seria Educatie Fizica si Sport*, vol. 17, p. 36-40, ISSN: 1453-1194, doi: 10.7752. 2013.

EFFECTS OF A FIVE-MINUTE CLASSROOM-BASED PHYSICAL ACTIVITY ON ON-TASK BEHAVIOR AND PHYSICAL ACTIVITY LEVELS

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Purpose: Opportunities for physical activity during the school day are steadily declining. Simultaneously, more time is allocated for improving pupils' academic achievements. Study aims to explore the effectiveness of a five-minute classroom-based physical activity (5min-Class-PA) to keep student behavior on task while increasing physical activity and energy expenditure during school days.

Methods: A sample of 126 elementary school pupils (6-10-year-old) was selected to participated in a 5-min PA daily in the middle of a 45-min academic lesson by imitating video animations (Brain Break by HOPSports®). Multiple baselines across subjects design was implemented for 12 weeks to assess on-task behavior during academic lessons by observing pupils in a classroom. A quasi-experimental design was implemented for 8 weeks to assess PA volume and energy expenditure using SenseWear Armband body monitor (BodyMedia Inc., Pittsburgh, PA, USA).

Results: When 5min-Class-PA was implemented, initially high on-task behavior during the first part of the lesson (91.42% and 94.8% for 6-8 and 8-10-year-old pupils, respectively) was not significantly changed after the 5min-Class-PA. In contrast, when 5min-Class-PA was not implemented, on-task behavior during the second part of the lesson decreased (by 3% and 4% for 6-8- and 8-10-year-old pupils, respectively). Additionally, after the 5min-Class-PA was systematically introduced, on-task behavior systematically improved. The results also indicate there is a significant increase or improvement in PA levels and energy expenditure during school days.

Conclusion: On-task behavior during academic lessons and daily in-school PA levels can be improved by implementing a 5min-Class-PA.

INFLUENCE OF HOME ENVIRONMENT SIZE ON MOTOR PROFICIENCY OF PRESCHOOL CHILDREN

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Abstract

Environmental influence is important to child motor development. It is well documented how early motor stimulation or deprivation affects motor and cognitive development of a child (Santrock, 2009). Recently, great number of research shows also that different environmental settings have impact to physical activity of children and adolescents. The purpose of this paper is to determine how home physical environment size is associated with children's motor proficiency. Sample of subjects consisted of 259 preschool children and their parents from three kindergarten institutions in Croatia's capital city. Testing was conducted in two parts. In first part parents filled out a socio-demographic questionnaire and in the second motor skills and abilities of children were tested. Main results of this research show that living area size (Mean value 92,11m^2) is significantly correlated to child's motor proficiency (r = 0.16), while yard area size (Mean value 343,58m^2) was not significantly correlated (r = 0.12). Values of both coefficients indicate, although for house area size significant, that the correlation is poor. The explanation for results in our study can be that most children are physically active and developing motor skills away from the home environment (parks, playgrounds, etc.). More studies of environment correlates of physical activity and motor skills in children and youth are needed.

Introduction

Process of development occurs according to the pattern that is established by the genetic potential and also by the influence of environmental factors. Environmental influence is important to child motor development. It is well documented how early motor stimulation or deprivation affects motor and cognitive development of a child (Santrock, 2009). Child's family plays a leading role in its development. Factors, such as the family's socioeconomic status, mother's educational level and the existence or the absence of siblings affect children's development (Venetsanou & Kambas, 2010). Permissive, accepting families, providing a healthy effective environment and plenty of opportunities for perceptual-motor experiences help their children's development. Preschool centers with adequate equipment and appropriate care, as well as a specific pedagogic methodology for the age group, provide more opportunities for an appropriate development of children's motor abilities. Apart from schooling, the society in which a child lives forms a specific cultural context that favors certain aspects of motor development (Venetsanou & Kambas, 2010). Recently, great number of research shows also that different environmental settings have impact to physical activity of children and adolescents. In children potential determinants of higher physical activity are father's physical activity habits, school physical activity related policies and time spent outdoors (Ferreira et al., 2007). In this review, the other variables association's with physical activity, like home and neighborhood physical environment, were inconsistent or not possible to infer from the limited number of existing studies (Ferreira et al., 2007). Cools and associates (2011) determined that environmental risk factors such as the prosperity index of the municipality, type of housing, and street traffic of the home environment were not directly associated with preschool children's fundamental motor skills.

The purpose of this paper is to determine how home physical environment size is associated with children's motor proficiency.

Methods

Subjects

Sample of subjects consisted of 259 preschool children and their parents from three kindergarten institutions in Croatia's capital city. Parent signed written informed consent for each child to participate in this study. Research was conducted in accordance with Declaration of Helsinki and was approved by Institutional Ethical Board.

Testing protocol

Testing was conducted in two parts. In first part parents filled out a socio-demographic questionnaire and in the second motor skills and abilities of children were tested. Questionnaire consisted information on physical living environment, parents determined living area size and yard area size in square meters. Prior to motor testing, verbal information and demonstration was given to a child and he/she had one non-recorded trial. We used Bruininks-Oseretsky Test of Motor Proficiency – Second Edition (BOT2) to measure motor skills and abilities of children. Test is suited for children from 4 up to 21 years of age and measures motor precision, motor integration, ambidexterity, manual coordination, balance, bilateral coordination, speed, agility and strength. The test result is standardized overall motor score, with very good reliability (0.86 do 0.89)(Cools et al., 2009).

Statistical procedures

Data was processed in Statistica 13.2. (Statsoft, Inc., Tulsa, OK, SAD). Correlation between variables of home environment and motor skills of children was determined using Pearson coefficient of correlation. Level of statistical significance was set to $p < 0.05$.

Results and discussion

Main results of this research show that living area size (Mean value 92,11m^2) is significantly correlated to child's motor proficiency (r = 0.16), while yard area size (Mean value 343,58m^2) was not significantly correlated (r = 0.12). Values of both coefficients indicate, although for house area size significant, that the correlation is poor. Mean values of overall standardized score (BOT2=52,19±8,24) show average motor proficiency of Croatian capital city preschool children. We presumed that children that live in larger houses or flats have more space for movement and greater level of motor skills. Furthermore, we presumed that having larger yard and outside area to play would potentiate greater motor proficiency. It seems that size of living space and outside yard area is not related to motor proficiency of preschool children. One previous study suggested that children who had limited physical environments at home demonstrated low levels of activity, with over 80% of time at home spent lying, sitting or standing (Johns and Ha, 1999). Given many parents' concerns about children playing outside due to safety reasons, the home environment may be an important setting in which to target physical activity behaviors, and development of basic motor skills (Hume et al., 2005). In parent's reports, availability of play spaces and frequency and time spent playing outside were very important correlates to child's physical activity (Sallis, 1993; Ferreira et al., 2007).

According to the distribution of movement of children in different environments by Dunton and associates (2012) most of children's physical activities is carried out in the open spaces away from home (42%), followed by children physical activity at home (indoors) (30%), in the yard at home (8%) or at somebody else yard (8%), in the gym and recreation centers (3%), and elsewhere (9%). Children's physical activity was pronounced while with more people (friends and the family) (39%), followed by family members (32%), independent (15%) and finally with friends (13%). All three kindergarten in our research are located in the City of Zagreb where some of children is living in small apartments and do not have a yard. It seems that having a yard or a flat of different size does not make a difference for a child's motor proficiency. In a study conducted in England with greater number of participants (6,497 children) no significant difference was found between the yard characteristics and physical activity (Pouliou et al., 2014). The explanation for this and results in our study can be that most children are physically active and developing motor skills away from the home environment (parks, playgrounds, etc.).

Several studies have identified aspects of the built environment that are related to adult physical activity (see Norman et al., 2006). The few studies examining this association in children have demonstrated that time spent outdoors was associated with observed physical activity and that preschool centers with larger indoor play areas (20.4 steps per minute) tended to have higher step counts than centers with smaller indoor play areas (18.2 steps per minute)(see Trost et al., 2010). Research of Sallis and associates (2001) indicated a possibility that school area size, equipment availability and adult supervision could affect child's physical activity. Their results implicate that making realistic improvements to school environments could increase the physical activity of children throughout the school day. When the school environment had high levels of physical improvements, the percentage of physically active boys and girls was 4-fold higher (Sallis et al., 2001). Based on previous studies it was reasonable to hypothesize that a child's immediate surroundings may play a role in influencing their physical activity and skills. Within the broader neighborhood, environmental factors such as living in an apartment block with a courtyard, living near a park and the age of the neighborhood were positively associated with children's independent mobility (Prezza et al., 2001). Furthermore, the number of play spaces near children's homes, and the amount of time children used those play spaces were positively associated with activity levels (Norman et al., 2006). In our research, majority of the parents (97%) indicated their satisfaction on playground area near to their house, so children had opportunity to be active. Although, the difference in living space conditions and backyard area did not reflect the children's motor proficiency. In our research, children who have availability and larger inside and outside play areas, do not have greater motor skills as a result of potential greater physical activity. In research of Norman and associates (2006) built environment variables explained only 2% to 3% of the variance in physical activity. More studies of environment correlates of physical activity and motor skills in children and youth are needed.

Conclusion

When consistent correlates are identified, it will be useful to estimate the number of youth exposed to environments in risk and to develop strategies to ensure that young people grow up in environments that make it easy and safe for them to be physically active (Norman et al., 2006). To increase children's physical activity it may be important to create child friendly communities, and provide skills to safely negotiate the environment (Timperio et al., 2006). The challenge for researchers and practitioners wishing to promote motor skills, physical activity and prevent obesity in preschool children is to identify which policies and what types of environments best promote regular physical activity in child care and home settings.

Acknowledgements

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References

1. Cools, W., de Martelaer, K., Samaey, C., Andries, C. (2009). Movement Skill Assessment of Typically Developing Preschool Children: A Review of Seven Movement Skill Assessment Tools. *Journal of Sports Science Medicine* 8(2): 154-168.
2. Cools, W, De Martelaer, K., Samaey, C., Andries, C. (2011). Fundamental movement skill performance of preschool children in relation to family context. *Journal of Sports Science* 29(7):649-660.
3. Cottrell, L., Zatezalo, J., Bonasso, A., Lattin, J., Shawley, S., Murphy, E., Lilly, C., Neal, W.A. (2015). The relationship between children's physical activity and family income in rural settings: A cross-sectional study. *Preventive Medicine Reports* 2: 99-104.
4. Dunton, G.F., Kawabata, K., Intille, S., Wolch, J., Pentz, M.A. (2012). Assessing the social and physical contexts of children's leisure-time physical activity: an ecological momentary assessment study. *American Journal of Health Promotion* 26(3):135-142.
5. Ferreira, I., van der Horst, K., Wendel-Vos, W., Kremers, S., van Lenthe, F.J., Brug, J. (2007). Environmental correlates of physical activity in youth - a review and update. *Obesity Reviews* 8(2):129-154.
6. Hume, C., Salmon, J., Ball, K. (2005). Opportunities for physical activity in the neighborhood maps. *Health and Education Research* 20(1): 1-13.
7. Johns, D.P., Ha, A.S. (1999). Home and recess physical activity of Hong Kong children. *Research Quarterly in Exercise and Sport* 70(3):319-323.
8. Norman, G., Nutter, S.K., Ryan, S., Sallis, J.F., Calfas, K.J., Patrick, K. (2006). Community Design and Access to Recreational Facilities as Correlates of Adolescent Physical Activity and Body-Mass Index. *Journal of Physical Activity and Health* 3(S1): S118-S128.
9. Pouliou, C., Sera, F., Griffiths, L., Joshi, H., Geraci, M., Cortina-Borja, M., Law, C. (2015). Environmental influences on children's physical activity. *Journal of Epidemiology and Community Health* 69(1): 77-85.
10. Prezza, M., Pilloni, S., Morabito, C. (2001). The influence of psychosocial and environmental factors on children's independent mobility and relationship to peer frequentation. *Journal of Community and Applied Social Psychology* 11: 435–450.
11. Sallis, J.F., Conway, T.L., Prochaska, J.J., McKenzie, T.L., Marshall, S.J., Brown, M. (2001). The association of school environments with youth physical activity. *American Journal of Public Health* 91(4):618-620.
12. Santrock, J.W. (2009). Child development. New York City, NY: McGraw-Hill Companies.
13. Timperio, A., Ball, K., Salmon, J., Roberts, R., Giles-Corti, B., Simmons, D., Baur, L.A., Crawford, D. (2006). Personal, family, social, and environmental correlates of active commuting to school. *American Journal of Preventive Medicine* 30(1):45-51.
14. Trost, S.G., Ward, D.S., Senso, M. (2010). Effects of child care policy and environment on physical activity. *Medicine and Science in Sport and Exercise* 42(3): 520-525.
15. Venetsanou, F., Kambas, A. (2010). Environmental Factors Affecting Preschoolers' Motor Development. *Early Childhood Education Journal* 37: 319-327.

PHYSICAL EDUCATION AND NEW TECHNOLOGIES IN OPINIONS OF PUPILS AND PRIMARY SCHOOLS TEACHERS

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Abstract

The aim of this study was to find out the opinions of pupils and teachers, which are currently confronting with sedentary lifestyle and physical inactivity related to health, economic and social consequences. This part of study was oriented to selected indicators and their relationship to Physical Education – popularity of subject, importance of subject, and demandingness of subject. The results of scientific research (n=817 pupils from 17 primary schools in Slovakia) was focused on indicators that showed very positive evaluation in popularity of subject and just positive in significance of subject, but there are significant differences between boys and girls assessments mostly in popularity of subject (very popular: 52.8% - 28.8%) and significance of subject (very significant: 33.8% - 14.3%).

The second part of this study was aimed at opinions of general teachers at primary schools in Slovakia (n=756 general teachers) using new technologies in educational process in Physical Education and in teaching preparation. General teachers mostly use YouTube videos (75.7%) and articles from the Internet (69%) to prepare physical education lessons. Most physical education teachers realized their teaching process using outdoor sport facilities (86.6%), as well as gymnasium (80.7%) and doing activities in nature (69%).

Key words: *physical education, indicators, usage technologies, sport facilities*

Introduction

The results of scientific researches in many countries show declining levels of motor development of children and youth, their fitness and coordination abilities (Sedláček, Antala, Šelingerová, Šelinger & Adamčák, 2008; Zapletalová, 2011; Bendíková, 2014), decreasing interest of children and youth to physical and sport activities, expanding sedentary lifestyle (Šimonek, 2010; Antala, 2012), resulting to decreasing quality of children and youth health, increasing obesity and overweight and other health problems. They also point to the problems with quality of Physical Education (PE), especially in primary schools (Šimonek, 2010). This period is considered by most of PE and sport professionals and educators as a key in shaping children's positive attitude to lifelong physical activity and to the subject. In many countries, in primary school PE is taught by general teachers (Klein & Hardman, 2009). They have lack of sufficient new knowledge, their skills are often of older character. Surveys of teachers indicate the need for lifelong learning in relationship with school PE practice.

This study was focused on getting information about basic condition on PE process in primary school according to pupils and teachers points of view. We would like to present results of our two researches. The aim of this research was to find out:

1. popularity, demandingness and significance of PE as a school subject in primary schools (2nd grade);
2. opinions of general teachers teaching PE in primary schools (1st grade) which were focused on selected questions using new technologies in Physical Education.

Methods

The first sample consisted of 817 pupils of the second grade form 17 primary schools in Slovakia (boys = 417; 51%, girls = 400; 49%). The average age of the pupils was 12.82 years. Collection of data, statistic processing and elaboration of outputs were carried out in the period 2012 – 2014.

The second sample consisted of 756 general teachers teaching PE at primary schools in Slovakia (male = 151; 20%, female = 605; 80%). Collection of data, statistic processing and elaboration of outputs were carried out in the period 2015 – 2016.

In both researches the main research method of data mining was a questionnaire. The questionnaire was compiled so that the research problem was grasped and at the same time the results could be compared with the similar research carried out in the past. Another method which we used was a non-standardized dialogues with pupils and a non-standardized dialogues with general teachers by means of which researchers completed their findings of the issues observed. The questionnaire for pupils consisted of 5-grade scale of evaluation (figure 1-3) from very popular (1) up to very unpopular

(5), very demanding (1) up to very easy (5), very significant (1) up to non-significant (5). The questionnaire which was prepared for the teachers involved selected questions with multiple choices (figure 4 and 5).

The data were processed by using basic statistic methods and interpreted by using logical methods. When assessing the statistical significance of differences between individual variables in the selected groups of pupils, as well as upon finding the relations between the selected indicators, correlation analysis was used along with Chi-square test. For identification of differences in frequency of evaluations (1-5) we used Chi-square test (figure 1-3). Acquired results we evaluated on 0,05 (*) and 0,01 (**) significance levels.

Results and Discussion

1. Popularity, demandingness and significance of Physical Education as a school subject

In order to find out the way pupils perceive the school subject PE from their point of view according to selected indicators, such as popularity, demandingness and significance. The results are analyzed below as to the observed parameters.

Popularity of subject

Results of our research show that PE is very popular or popular school subject with majority of the boys at primary schools. Only a small percentage of boys consider it to be unpopular or they do not like it at all. In girls, popularity of subject is on a lower level than in boys. Comparison of this indicator by gender (figure 1) showed statistically significant difference.

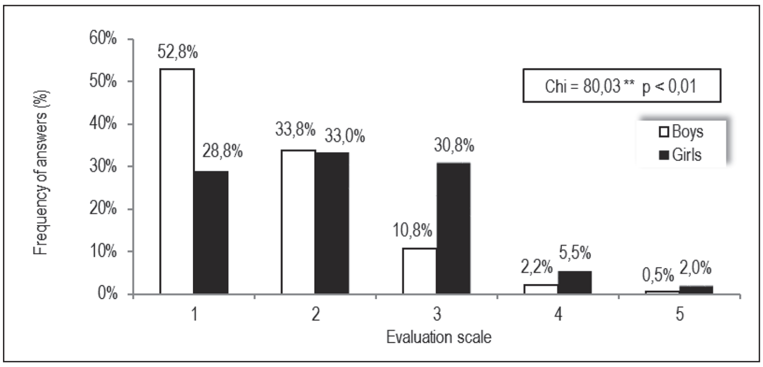

Figure 1: Popularity of Physical Education by gender – in 2nd grade of primary school

Demandingness of subject

The results show that Physical Education is considered to be an undemanding subject with majority of pupils at primary schools. Girls consider it to be more demanding than boys do. Only a small part of pupils considers it a very demanding or demanding subject. Comparison of this indicator by gender (figure 2) showed statistically significant difference.

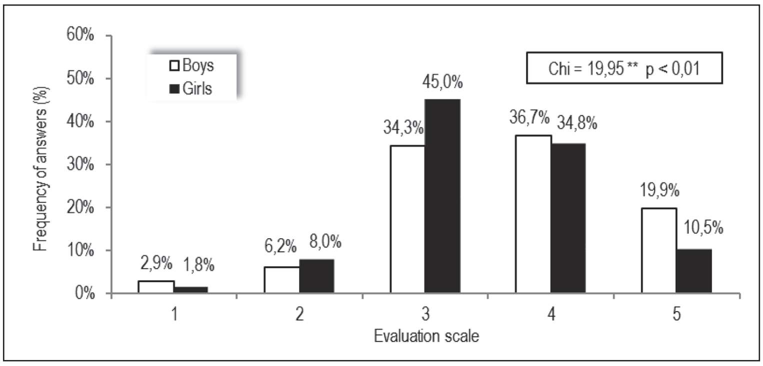

Figure 2: Demandingness of Physical Education by gender – in 2nd grade of primary school

Significance of subject

Results show that PE is perceived with majority of the boys and girls as the subject of medium importance. Greater significance is attached by boys than girls. Only a small part of boys and girls consider it to be non-significant, mainly girls. On the contrary, boys at primary schools consider it very significant. Comparison of this indicator by gender (figure 3) showed statistically significant difference.

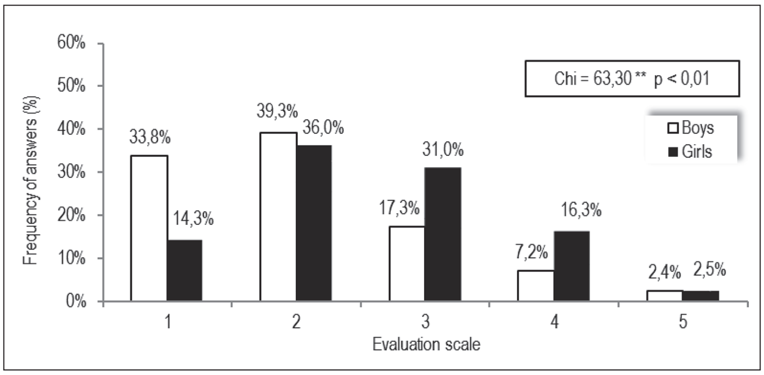

Figure 3: Significance of Physical Education by gender – in 2nd grade of primary school

2. Opinions of general teachers teaching PE on selected questions related to using of new technologies and sport facilities in PE teaching.

The highest number of answers in the first question related to using new technologies indicated to YouTube video clips and the Internet articles (figure 4). These two types of technologies are used by more than 65% general teachers. Minimum number of teachers uses social networks and mobile phones or smart phones. Taking into account specificity of PE, especially PE environment, where using various mobile devices are limited.

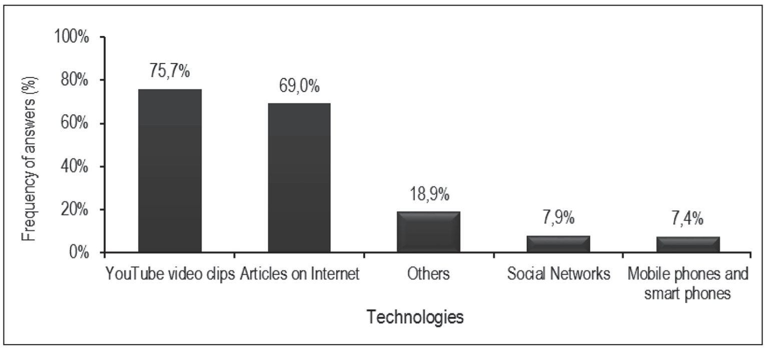

Figure 4: Using of new technologies by general teachers in primary schools in preparation on PE lessons

The second question is related to using facilities. The highest number of answers achieved outdoor facilities, gymnasium and exercising in nature (figure 5). Nearly 20% of teachers did not have any opportunity to use gymnasium. During PE lessons teachers used swimming pools, fitness gym, and corridor in school, classroom and adapted classroom on similar level (app. 15-24%). These answers showed relatively satisfactory situation in facilities used in primary schools.

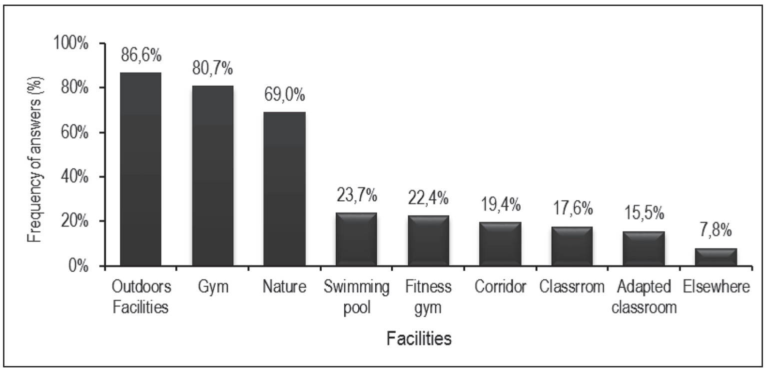

Figure 5: The use of facilities by general teachers in primary schools in PE teaching

Conclusions

The results of our research show that PE is very popular or popular school subject for majority of boys attending primary schools. In girls, popularity of the subject is on a lower level than in boys. Results also show that PE is considered to be an undemanding subject by number of pupils and that PE is perceived in the majority of boys and girls as the subject of medium importance.

General teachers mostly use YouTube videos and articles from the Internet (65%) to prepare Physical Education lessons. Only some of them use social networks, mobile phones and smartphones. For PE teaching process, they use especially outdoor sport facilities, gymnasiums and different activities in nature.

Based on the researches which were carried out we can formulate the following recommendations:

– Focus our attention on improving quality of teaching process by means of getting better knowledge and application of new PE curricula, training of PE teachers within the framework of life-long education, as well as by means of improving the quality of conditions and more effective motivation of pupils;
– PE of girls seems to be more problematic and demanding than PE of boys. It is inevitable to look for the ways of making education more attractive, mainly for girls;
– Increase attractiveness of the contents of education through implementing new physical activities preferred by pupils and through using of new technologies in teaching (Villalba, & Gonzales-Rivera, 2016);
– Regularly diagnose opinions of pupils on selected issues of PE;
– In terms of potential reserves in PE teaching at 1st grade of primary school to reflect on employing specially qualified (Bc.) assistants of teachers at PE lessons;
– New technologies should not be teacher's enemies but they should help teachers increase quality of PE teaching (Knjaz, Rupčić & Antekolović, 2016). PETE should be more oriented to this area.

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References

1. Antala, B. (2012). School Physical Education and its changes during last two decades. In M. Dopsaj, (Ed.), *Proceedings of the Thematic Conference, 2012, "Effects of Physical Activity Application to Anthropological Status with Children, Youth and Adults"* (pp. 309–319). Belgrade: Faculty of Sport and Physical Education of University of Belgrade.
2. Bendíková, E. (2014). Lifestyle, Physical and Sports Education and health benefits of physical activity. *European Researcher: International Multidisciplinary Journal*. *69*(2-2), 343-348.
3. Klein, G. & Hardman, K. (2008). *Physical Education and Sport Education in European Union*. Paris: Editions Revues EPS.
4. Knjaz, D., Rupčić, & T., Antekolović, L. (2016). Application of Modern Technology in Teaching and Training with Special Emphasis on Basketball Contents. In D. Novak, B. Antala, D. Knjaz (Eds.), *Physical Education* and *New Technologies* (pp. 112-122). Zagreb: Croatian Kinesiology Association.
5. Sedláček, J., Antala, B., Šelingerová, M., Šelinger, & Adamčák, Š. (2008). *Hodnotenie telesného rozvoja a motorickej výkonnosti žiakov v procese kurikulárnej transformácie výchovy a vzdelávania*. Bratislava: ICM AGENCY.
6. Šimonek, J. (2010). Materiálno-technické a personálne zabezpečenie vyučovania telesnej a športovej výchovy na slovenských základných školách. *Telesná výchova a šport*, *20*(4), 21-27.
7. Villalba, A., & Gonzales-Rivera, M.D. (2016). Teachers' Perceptions of the Benefits of ICT in Physical Education. In D. Novak, B. Antala, D. Knjaz (Eds.), *Physical Education* and *New Technologies* (pp. 217-227). Zagreb: Croatian Kinesiology Association.
8. Zapletalová, Ľ. (2011). Changes in somatic parameters and motor performance of children and youth of Slovakia across the period of last 20 years. In J. Labudová & B. Antala (Eds.), *Healthy active life style and physical education* (pp. 110-115). Topoľčianky: END.

DETERMINING THE LEVEL OF DIAGNOSTIC COMPETENCE IN UNDERGRADUATE PHYSICAL EDUCATION TEACHERS

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Abstract

One of the goals of teacher education lies in the development of pedagogical competences in undergraduate physical education teachers. The aim of this research was to determine the level of diagnostic competence in undergraduate physical education (PE) teachers studying to teach at secondary level at the Faculty of Sports Studies Masaryk University (FSpS MU). To determine the level of diagnostic competence we developed an electronic learning and research instrument called Videoweb for physical education (Videoweb PE), which is based on analysis of video recording. Qualitative analysis of the data obtained from Videoweb PE showed that the level of diagnostic competence of undergraduate teachers is lower to intermediate. Based on the findings of the study we outline recommendations for the development of pedagogical competences of undergraduate physical education teachers and their further application in teaching practice.

Key words: *professionalization of teacher, system of categories, electronic learning environment, coding, Videoweb PE*

Introduction

The modern civilisation places increasingly higher demands on professionalization of (undergraduate) teachers. The process of professional development of a teacher should take place as early as in undergraduate training. There have been previous attempts to identify the essence of teacher professionalism by means of determining the key competences (Dytrtová & Krhutová, 2009). There are calls for a change and development of the key competences of a teacher. PE teachers are constantly facing new situations that they need to be able to adequately diagnose and subsequently solve. Therefore it seems necessary to develop and improve their *diagnostic competence.* The topic of diagnosing in teaching and the term diagnostic competence is conceived rather generally both by Czech and foreign authors. For the purposes of this study we define the concept of diagnostic competence of PE teacher as an ability to *identify, describe, interpret, explain, evaluate and predict teaching situations and offer alternative ways of solving problems* (cp. Edelenbos & Kubanek-German, 2004; Janík et al., 2009; Mojžíšek, 1986; Radtke, 2000; Seidel et al., 2009; Sherin, 2007; Sherin & van Es, 2008; Schwindt, 2008).

In order to develop and raise the level of teacher´s diagnostic competence the Institute for Research in School Education at the Faculty of Education Masaryk University (IVŠV PdF MU, the former Centre of Educational Research CPV PdF MU) designed an electronic learning environment for (undergraduate) teachers called the CPV Videoweb (Janík et al., 2011). This instrument was designed to diagnose the competences of teachers of physics, chemistry, science, physical education and in lessons of pedagogical communication and interaction. Alongside the CPV videoweb, Videoweb for physical education (Videoweb PE), an electronic learning and research environment was designed for the purposes of physical education. Videoweb PE is based on analysis of video recording of teaching. It has two main functions. Firstly it serves as a diagnostic instrument to determine the level of diagnostic competence in undergraduate teachers. They answer various open questions and complete tasks in Videoweb PE and at the same time provide data for research. Secondly, Videoweb PE is used as an instrument to develop diagnostic competence in undergraduate teachers who, based on directed exploration, develop their abilities to *describe, interpret, evaluate, predict and alter* the observed phenomena in teaching (Janíková et al., 2008). The main motivation for the creation of Videoweb PE is not to replace teaching practice but to prepare future teachers for it (Janík et al., 2011, p. 105).

Research methodology

The aim of this research was to determine the level of diagnostic competence in undergraduate physical education teachers studying to teach at secondary level using a learning and research environment Videoweb PE. The study was conducted within a project of the Faculty of Sports Studies registered as ROZV/20/FSpS/07/2015.

Our study was divided into five stages. In the first stage of the study the aim was to define the theoretical concept of diagnostic competence in PE teachers and a system of categories for coding the data obtained from Videoweb. Based on a literature review and drawing on an analytic-synthetic method we created a field-specific – general concept of diagnostic competence developed in cooperation with the IVŠV PdF MU (for more see Minaříková, 2011). The concept was subsequently adjusted for physical education (tab 1). The system of categories of diagnostic competence builds on the defined concept of diagnostic competence, organised in a hierarchical manner. The categories at the bottom of the system are *description + identification*, while at the top of the system there is *alteration.* Table 1 summarises literary sources of individual components.

Table 1: The concept of diagnostic competence

Diagnostic competence is the ability to:	Similar components identified in texts of these authors:
describe + identify	Janík, 2009; Mojžíšek, 1986; Seidel, 2009; Sherin, 2007; Schwindt, 2008
interpret + explain	Edelenbos & Kubanek-German, 2004; Janík, 2009; Seidel, 2009; Sherin 2007; Sherin & van Es, 2008; Schwindt, 2008
evaluate	Janík, 2009; Seidel, 2009; Schwindt, 2008; Radtke, 2000
predict	Janík, 2009; Seidel, 2009; Schwindt, 2008
suggest alterations (of teaching situations)	Mojžíšek, 1986; Schwindt, 2008

The aim of the second stage of the study was to analyse video recordings made within the project of CPV video studies of PE (Janíková et al. 2008). The analysis of individual parts of video recordings resulted in short movie sequences from teaching (lasting approx. 1-2 min.). Afterwards, in cooperation with experts on field-specific methodology we formulated questions and tasks accompanying these sequences. The third stage of the research involved the design of an electronic learning and research tool Videoweb PE and the following pilot study. The aim of stage four was making Videoweb PE accessible online, training students and coders and subsequent work of undergraduate teachers of FSpS MU on Videoweb PE. The students underwent training in seminars of the course School pedagogy taught at FSpS in full-time and combined form. To decode the generated data it was necessary to write a coding manual and train coders. The training was given in software MAXQDA 11, which was then used also for coding the data from the complete sample. In coding one must make sure that different coders will code the observed phenomena identically or at least similarly. The training was aimed at achieving an acceptable rate of inter-rater-reliability (IRR), i.e. agreement between coders (for more detail see Viera & Garrett, 2005). The last stage of the study included content analysis of the qualitative data from the complete sample. Based on the evaluated results we formulated conclusions and recommendations.

Research sample

The investigated sample was composed of the students of FSpS MU of master programme, both full-time and combined form, enrolled on the course School pedagogy. In total 83 students participated in the study, 61 full-time and 22 combined. There were 39 women and 22 men in the full-time group. In combined form there were 7 women and 15 men. Table 2 shows the representation of respondents in terms of gender and age. Concerning previous teaching practice in PE 28 full-time students responded they had had some practice, 23 had had no practice and 10 students had had practice as a part of their studies at FSpS MU. In combined students, 14 had had practice, 5 no practice and 3 had had practice as a part of their studies. Regarding video analysis, 45 full-time students responded they had had experience, 16 had had no experience while 11 combined students had had experience and 11 no experience.

Table 2: Numbers and age of respondents

Form of study	Total number of students	Female	Male	Average age	Age males		Age females	
					Min.	Max.	Min.	Max.
Full-time	61	39	22	21	22	26	21	26
Combined	22	7	15	27	23	38	22	36
Total	83	46	37					

Results

The pilot study data were not included in the evaluation of the data. The final sample thus included 75 students, 55 in full-time and 20 in combined form. The first research question was focused on the proportional representation of individual categories of diagnostic competence in undergraduate teachers of PE in full-time and combined form (diag. 1). The total number in the whole sample included 7 284 codes. The most common category was Interpretation + explanation comprising 44.1% and 3 214 codes. The second most common category was alteration with 17.4% and 1 267 codes. The third was Evaluation with 1 103 codes (15.1%), followed by Description + identification with 14.3% and the total of 1 042 codes. The one before the last was category Prediction with 8.5% and 621 codes. Finally the category of Unprocessed questions comprised 0.5% with 37 codes.

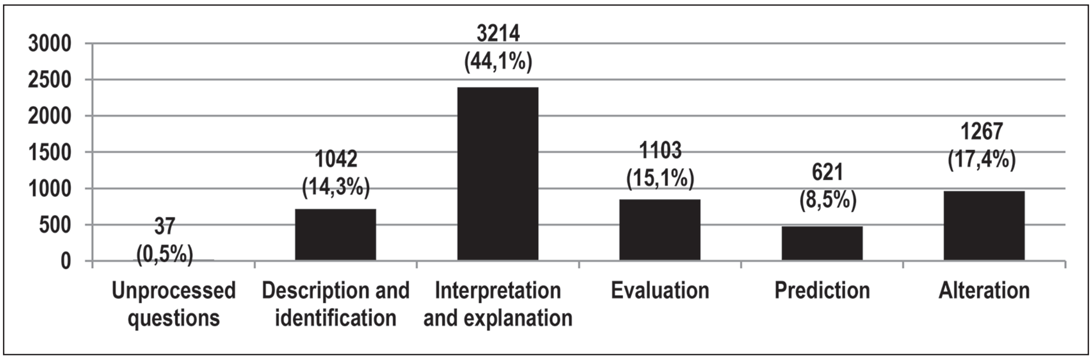

Diagram 1: The proportional representation of individual categories from all the respondents

The second research question focused on the proportional representation of individual categories of diagnostic competence in undergraduate PE teachers both in full-time and combined form. Overall there were 5414 codes from full-time students in all categories. As demonstrated in graph (diag. 2) the most common category was Interpretation and explanation with 44.2% and the total number of codes 2395, followed by Alteration with 17.8% and 961 codes. The third most common category was Evaluation with 15.7% and 849 codes. Next there was Description and identification with 13.2% and 714 codes. The one before the last was Prediction with 8.8% and 479 codes. The least common was the category Unprocessed questions with 0.3% and 16 codes. In combined students there were in total 1870 codes. The most common category was Interpretation and explanation with 43.8% with total 819 codes. The second most common category was Description and identification with 17.5% and 328 codes. The third category was Alteration with 16.4% and 306 codes. The fourth category was Evaluation with 13.6% and 254 codes followed by Prediction with 7.6% and 142 codes. The least common category was Unprocessed questions comprising 1.1% with 21 codes.

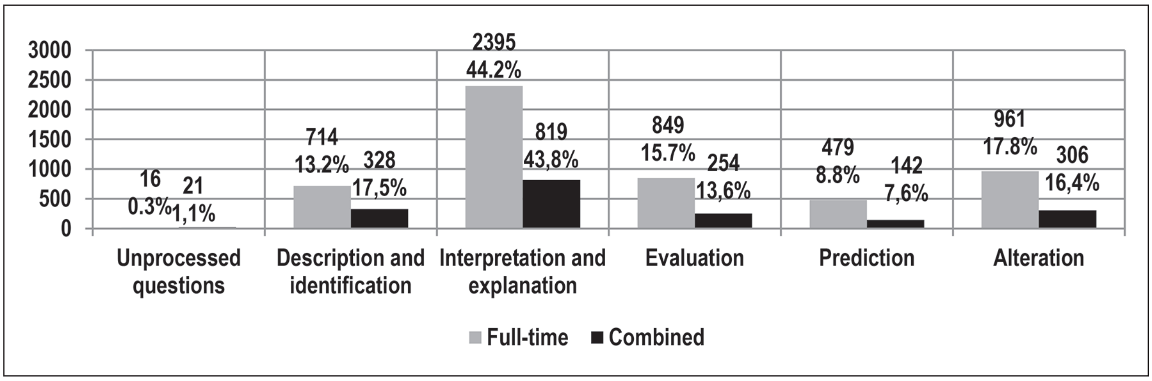

Diagram 2: The proportional representation of individual categories in full-time and combined students

Discussion

As mentioned earlier in the introduction, the concept of diagnostic competence was developed in a hierarchical manner, starting with the lowest category Description + identification to the highest category Alteration (the category Unprocessed results is not included in the discussion of results). We expected that in respondents with a lower level of diagnostic competence the most common categories will be the lower categories and vice versa. Also, we expected that the students of combined form will achieve a higher level of diagnostic competence as in most cases these students have already had many years´ practice as teachers. On the contrary, full-time students are typically students who enrolled on university immediately after graduating from high school and so they are much less likely to have had years of teaching practice.

To gain a better insight into the proportional representation of individual categories we conducted an in-depth analysis of the results of the subcategories for individual categories. After generalisation of the results of the analysis of individual subcategories we found out that that the level of diagnostic competence in the examined sample was on lower to intermediate level. The students are able to interpret the observed situations into events and draw on theory when formulating their statements or comment on them, however mostly using colloquial language. They are able to describe and link the observed situations, however, they are not able to relate the situations described in formal language to context. Also, they are able to evaluate the observed situations but it seems to be more difficult for them to refer to an explanation using formal language. The students are able to use the higher categories, such as Prediction and Alteration only when they are directed to use that category by a question related to a movie sequence. The students use the higher categories very rarely unless there is a clue. Once they use the higher levels, it is most frequently the intermediate subcategories of the given categories, which signifies that there were students with higher diagnostic competence among the respondents.

If we compare the percentage representation of individual categories and their subcategories between full-time and combined students the results are almost identical. Based on the analysis of the results shown in the graph (diag. 2) it is apparent that the level of diagnostic competence in PE teachers in not determined by the form of study. Many years´ practice thus may not be the determining factor in the level of diagnostic competence. A student enters the practice after graduation with a certain level of diagnostic competence which is then in practice impacted minimally. The determining stage for the development of diagnostic competence in PE teacher is not the length of practice, but rather the preparation for the future career, e.g. undergraduate study.

Conclusion and recommendations

The aim of the study was to determine the level of diagnostic competence in undergraduate PE teachers studying to teach at secondary level at FSpS MU. The aim was achieved by means of qualitative analysis of the data obtained in an electronic learning and research environment we created called Videoweb PE. We found out that students most often describe, interpret, explain, evaluate, predict or alter phenomena using colloquial language. They are able to relate the observed situations to context, however, they are rarely able to use technical language when doing so. The most common were answers belonging to the lower and intermediate categories, where the lower levels of individual subcategories prevailed. The level of diagnostic competence of PE teacher is, based on our findings, not influenced by the form of study (full-time or combined), nor by the length of practice.

The determining factor for achieving a certain level of diagnostic competence in PE teacher is probably university study. It is namely the undergraduate study that can have an impact on the development of pedagogical competences of teachers while using various learning tools (e.g. the above mentioned Videoweb PE) and thereby develop and achieve higher level of pedagogical competences. The contribution of Videoweb PE lies in the enhancement of teacher training in PE via the development of their pedagogical competences within the lessons at FSpS MU. The undergraduate teachers can further apply the acquired competences in their teaching practice.

References

1. Dytrtová, R., & Krhutová, M. (2009). Učitel: příprava na profesi. Praha, Česko: Grada.
2. Edelenbos, P., & Kubanek-German, A. (2004). Teacher Assessment: The concept of "diagnostic competence". Language Testing, 21(3), 259-283.
3. Janík, T., Janíková, M., Knecht, P., Kubiatko, M., Najvar, P., Najvarová, V., & Šebestová, S. (2009). Exploring different ways of using video in teacher education: Examples from CPV Video Web. In T. Janík & T. Seidel (Eds.), The power of video studies in investigating teaching and learning in classroom (pp. 207-224). Münster, Germany: Waxmann Verlag. ISBN 978-3-8309-2208-7.
4. Janík, T., Minaříková, E., Haláková, Z., Kostková, K., Kubiatko, M., Píšová, M., Slavík, J., Stehlíková, N., Šmerdová N., Švecová, Z., Vaculová, I., & Valkounová, E. (2011). Video v učitelském vzdělávání: teoretická východiska – aplikace – výzkum. Brno, Česko: Paido.
5. Janíková, M., Janík, T., Knecht, P., Kubiatko, M., & Sebera, M. (2008). CPV videoweb: tvorba elektronického učebního prostředí pro didaktickou přípravu budoucích učitelů. In J. Havel, O. Šimoník, & J. Šťáva (Eds.), Pedagogická praxe a oborové didaktiky (pp. 151-156). Brno, Česko: MSD.
6. Minaříková, E. (2011). Nástroj pro zkoumání diagnostické kompetence (budoucích) učitelů. In
7. T. Janík, P. Najvar, & M. Kubiatko (Eds.), Kvalita kurikula a výuky: výzkumné přístupy a nástroje (pp. 147-159). Brno, Česko: Paido.
8. Mojžíšek, L. (1986). Základy pedagogické diagnostiky. Praha, Česko: SPN.
9. Radtke, F.–O. (2000). Professionalisierung der Lehrerbildung durch Autonomisierung, Entstaatlichung, Modularisierung. Sowi On-line Journal, pp. 1-8.
10. Seidel, T., Prenzel, M., Schwindt, K., Stürmer, K., Blomberg, G., & Kobarg, M. (2009). LUV and Observe – Two projects using video to diagnose teacher competence. In T. Janík, & T. Seidel (Eds.), The power of video studies in investigatin teaching and learning in the classroom (pp. 243-258). Münster, Germany: Waxmann.
11. Sherin, M. G. (2007). The development of teachers' professional vision in video clubs. In R. Goldman, R. Pea, B. Barron, & S. Derry (Eds.), Video research in the learning sciences. New York, NY: Routledge.
12. Sherin, M. G., & van Es, E. A. (2008). Mathematics teachers' "learning to notice" in the context of a video club. Journal of Teaching and teacher education, 2008(24), 244-276.
13. Schwindt, K. (2008). Lehrpersonen betrachten Unterricht. Münster, Germany: Waxmann.
14. Viera, A. J. & Garrett, J. M. (2005). Understanding Interobserver Agreement: The Kappa Statistic. Family Medicine, 37(5), 360-363.

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Science in Dance

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UNIVERSITY OF ZAGREB
FACULTY OF KINESIOLOGY

DANCE – CONTINUITY IN CHANGE

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Dance is a body activity, often defined as rhythmical human movements. But not all movements are considered dance, the borders to other movement systems differ between cultures. Dance is also strongly connected to music, even if it is no not always easy to say how flow of movement we call dance and the flow of sound we call music interact. My interest is mainly popular and folk dance, genres that also have boarders between each other ant towards other genres, boarders that change over time and space.

Dance is both *contemporary* and *traditional*, because any dance used today is contemporary, and all dancing has its traditions. Over a period of around 100 years of time it is also possible to see a change from *communities that dance* to dancing *communities*. However we define dance there are interesting differences and similarities over time and space

In this presentation I will give some examples how popular and folk dance is used for fun, competition and stage performances. I will also discuss what happens to old dances from the countryside in the urban cities of our time.

ANALYSIS OF ADJUDICATORS' OBJECTIVITY AT A DANCESPORT COMPETITION IN LATIN DANCES

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Abstract

The aim of the paper has been to determine the objectivity of the judges - adjudicators, correlations between them and how objectively they evaluate the dancing couples in elimination rounds of a competition, as well as how they influence the final outcome of the competition. The research has been conducted on the dancesport competition in Latin dances with the dancing couples from 17 countries, organized by the World DanceSport Federation that took place in Russia (Moscow) and was named Grand Prix Dynamo 2012. The judging objectivity of thirteen dancesport adjudicators, in three preliminary rounds of the competition, the sixteenth-finals, the eighth-finals and the quarterfinals, has been analysed. The analysis results suggest biased judging of four out of thirteen adjudicators in all three rounds. In order to avoid the subjectivity of the dancesport adjudicators' evaluation in future, it is necessary to elaborate the judging system in more detail, define the criteria more clearly and evaluate these, increase the panel of adjudicators and improve the supervision of the adjudicators at the competitions. Objectivising of judging in dancesport would contribute to including dancesport in Olympic programme.

Key words: *dancesport, judges, Latin, objectivity, dancing couple*

Intoduction

Dancesport belongs to a group of conventional dances, aesthetically formed and choreographically arranged acyclic moving structures (Adzo Banini & Despot, 2003). There are many disputes whether dancesport is art or sport, and whether a dancer is an athlete or an artist. (Zagorc, Zaletel, Škofic-Novak, Tušak & Golja, 1999). Dancesport has been normed, in the sense that there are special rules regarding competitions, dance technique, costumes and judges. Dancesport is one of the most beautiful indoor sports in which art, sport and fun can all be found. There are two basic categories of dances performed - Latin (Samba, Cha-cha-cha, Rumba, Paso doble and Jive) and standard dances (English Waltz, Tango, Viennese Waltz, Slow-fox and Quickstep). The couples choose the category they want to compete in and whether they will participate in one, or both categories. A thesis that dancesport is a fusion of sport and art (Zagorc, et al., 1999) greatly influences the performance quality evaluation and it is related indirectly to the competent judges' subjective assessment, that is made in line with the *Skating System* (HŠPŠ 2011). In accordance with the thesis, when evaluating, adjudicators pay special attention to rhythm, posture, body lines, hold, balance, partnering skills, music interpretation, presentation, foot action, moving across the dance floor and the overall impression the couple makes (Clippinger, 2007). Then again, dance requires high level of strength and energy, balance, movements' amplitude, neuromuscular coordination and kinesthetic sensitivity (Welsh 2009). A body trained in this way is a top instrument for a dancing expression (Despot & Jeličić, 2010). Opinion of judges about a dancesport couple should aim at increasing objectivity. However, errors occur that might be accidental, but might be on purpose as well, which is the matter that concerns judging in many sports in which the quality of performance is being subjectively evaluated (Leskošel, Ćuk, Karacsony, Pajek & Bučar 2010). In order to avoid a tie in the result, there is an odd number of adjudicators who judge at a competition, with the minimum of 3 and the maximum of 13 dancesport adjudicators. When it comes to top dancesport couples competing for the medals, details are crucial for the final rank and great judging errors may cause great differences among the competitors. To become a dancesport adjudicator in Croatia, one has to attain at least one of the two dance licences: ISTD (Imperial Society of Teachers of Dancing) or IDTA (International Dance Teachers Association) and must comply with the criteria defined by a national dancesport federation (HŠPS, 2010). Since the final result of a dancesprot couple depends solely on the adjudicators' evaluation, so is the whish for objective judging really strong among the dancing couples and the judges' evaluations are the major issue, not only at the competition, but at the dancesport trainings weeks after the competitions. Numerous other aesthetic sports, such as rhythmic gymnastics and gymnastics, have found a model to a more objective judging, by awarding additional points for certain technical element, as well as penalty points if the element is not performed well, a special mark for technical and special for artistic impression, etc. (FIG 2011). With respect to judging, dancesport still does not offer such possibilities - a judges 'eye' evaluates couples who advance from one preliminary round to another, in the way that each judge marks the couples who in their opinion should advance to a next round of the competition, and in the final round only do the couples get marks from 1-6, or 7, depending on the number of couples in the finals, so that the couple who they consider the best gets the mark 1, meaning the first place, and so on for all the other couples in the finals. There is numerous research on metric characteristics of the judges in gymnastics (Zhao, Sun & Dong 2008; Sun & Wu, 2003; Leskošek, et al., 2010), aerobics (Xue & Li, 2007; Xue, Li, Lin & Liang, 2007), cheerleading (Zhue 2009), figure skating (Seltzer, Glass, 1991; Marilyn, 2012; Bruine de Bruin, 2006), rhythmic gymnastics (Popović, 2000; Božanić, 2011; Bučar, Čuk, Pajek, Karacsony &Leskošek, 2012), social and folk dances (Miletić, Maleš, Sekulić, 2000; Stettum, 1998), but only a few on dancesport (Zhaolong, 2007; Xu, 2008) and they have all been conducted in China which has experienced an unbelievable expansion of dance sport over the last decade.

The aim of the research is to determine the objectivity of judges - adjudicators, correlation between them and how objectively they evaluate dancesport couples from one competition round to another, as well as what their influence on the final outcome of the competition is. The competition on which the research has been conducted included senior dancesport couples from 17 countries, competing in Latin dances in organisation of World Dancesport Federation, held in Russia (Moscow) and called Grand Prix Dynamo 2012. The reasons why this competition has been chosen for analysis of the judging objectivity are: great number and high quality of participating dancing couples and a large panel of experienced judges.

Methods

The research has included 96 senior amateur Latin dancesport couples from 17 European countries that have advanced to the sixteenth-finals of the competition, after elimination rounds (there are couples who directly participate in finals and these are the best ranked couples at the world ranking list, as well as couples that advance to a next round by re-dancing of an extra qualification group). The couples competed in the category of Latin dances which includes five dances: Samba, Cha-cha-cha, Rumba, Paso-doble and Jive. Adjudicators' assessment was made for the sixteenth-finals (96 dancing couples), the eighth-finals (48 dancing couples) and finally in a quarterfinal round (24 dancing couples). All thirteen adjudicators evaluated all dancing couples and they marked couples in their mark sheets, i.e. their pocket PCs - if the couple met all the criteria for a given dance, they got a mark. Maximum of marks was 13, that is, a couple was marked by every adjudicator to advance to another round of the competition in the given category of dance. The rule applies to all dances. The couples with the highest number of marks progress to a next elimination round. Basic descriptive parameters: arithmetic mean, standard deviation and variance have been calculated for the results of 16th-finals, 8th-finals and quarterfinals, according to adjudicators' evaluation. From the calculated arithmetic mean, a fairly unanimous overall criterion of all the adjudicators appears, however, the standard deviance and variance results show a different variability among adjudicators. Adjudicators with a greater variance have directly a stronger influence on a final mark. A total mark has been calculated by applying a real results' simple summation method (Dizdar, 2006), presuming that the adjudicators judge equally objectively, in other words, the overall adjudicators' mark has been achieved by applying simple linear combination of the original marks (Pedišić and Dizdar, 2010), that is, by summing up all adjudicators' marks for all five Latin dances. By applying this method, statistic measures and Cronbach reliance coefficient have been determined for each adjudicator separately and these two measures have been observed in all three rounds (Table 1, Table 2, Table 3). Analysis has been made by SPSS 7.0 statistical software system.

Results

Table 1: Analysis of adjudicators' objectivity in the16th-finals, 96 dance couples

1/16	Var. if	StDv. if	Itm-Totl	Alpha if
S1	240,94	15,52	0,68	0,89
S2	264,21	16,25	0,31	0,90
S3	255,44	15,98	0,49	0,90
S4	226,69	15,06	0,76	0,88
S5	242,48	15,57	0,59	0,89
S6	232,67	15,25	0,78	0,88
S7	228,46	15,11	0,74	0,88
S8	252,31	15,88	0,50	0,90
S9	260,56	16,14	0,38	0,90
S10	238,19	15,43	0,65	0,89
S11	250,73	15,83	0,58	0,89
S12	239,92	15,49	0,70	0,89
S13	234,33	15,31	0,63	0,89

Table 2: Analysis of the adjudicators' objectivity in the 8th-finals, 48 dance couples

1/8	Var. if	StDv. if	Itm-Totl	Alpha if
S1	180,17	13,42	0,54	0,79
S2	189,25	13,76	0,33	0,81
S3	187,79	13,70	0,38	0,80
S4	170,79	13,07	0,54	0,79
S5	182,71	13,52	0,41	0,80
S6	173,25	13,16	0,61	0,79
S7	174,00	13,19	0,58	0,79
S8	182,13	13,50	0,40	0,80
S9	198,79	14,10	0,15	0,82
S10	174,50	13,21	0,58	0,79
S11	190,21	13,79	0,33	0,81
S12	179,04	13,38	0,62	0,79
S13	178,67	13,37	0,39	0,81

Table 3: Analysis of adjudicators' objectivity the quarterfinals, 24 dance couples

1/4	Var. if	StDv. if	Itm-Totl	Alpha if
S1	159,50	12,63	0,53	0,75
S2	174,50	13,21	0,18	0,79
S3	168,25	12,97	0,36	0,77
S4	159,50	12,63	0,46	0,76
S5	151,33	12,30	0,63	0,74
S6	157,17	12,54	0,64	0,74
S7	156,75	12,52	0,58	0,75
S8	179,58	13,40	0,10	0,79
S9	174,17	13,20	0,25	0,78
S10	157,33	12,54	0,50	0,75
S11	162,67	12,75	0,42	0,76
S12	168,50	12,98	0,40	0,77
S13	166,75	12,91	0,29	0,78

The results of correlating each adjudicator with the total mark, excluding the adjudicator in question (Alph if-deleted), (Dizdar and Maršić, 2000), in the first elimination round indicate high correlation percentage of all the adjudicators apart from adjudicators S2, S3, S8 and S9, the correlations of who are not significant. Regarding the correlation values in the second and third competition round, results show that the same adjudicators, including adjudicator S13, correlate low with the total mark. Cronbach's alpha reliability coefficient, that monitors objectivity fluctuations when a particular adjudicator is excluded, points to a very high objectivity of previously mentioned adjudicators S2, S3, S8 and S9, which indicates that the adjudicators' involvement in the judging process harms the objectivity itself when evaluating the quality of the dance couples. Consecutively, the average Cronbach's reliability coefficient decreases from 16th-finals to the quarterfinals, and the objectivity drop follows subsequently, as the contest progresses to semi-finals and finals.

Discussion

The objectivity coefficient decrease and the consequential correlation of the adjudicators from the panel of adjudicators indicates that the same adjudicators (S2, S3, S8, S9) do not judge objectively, as opposed to others, who do, which questions the end ranking of the dance couples in the finals of the competition. Besides, it is questionable as well what the final result would be in the case that some adjudicators did not *aim at* the same couples from round to round. The term *aim at* refers to adjudicator's judging bias, his/her quality and competence, as well as how much she or he complies with the judging rules when evaluating dance quality. The results gained by this analysis question the very quality of the competition and indicate the need for detailed analysis of the other world competitions with the great number of participants. Another question of why there is a biased judging emerges as well. Many dance judges coach the couples that are competing. Additionally, the evaluation system has not got clearly specified assessment criteria – one mark unites more criteria and some adjudicators take into account all the criteria when giving the final mark to the couple they observe performing on the dance floor, the others on the other hand, consider only one or two. Judging experience contributes to objectivity, too.

Conclusion

In order to avoid subjectivity of a judging evaluation in dancesport, it is necessary to work out more detailed adjudication system, define criteria precisely and award points for them, increase the panel of adjudicators and improve adjudicators' supervision at the competitions. In addition, the adjudicators themselves believe that the changes in the current judging system should be made and they would include (Teodorescu & Nicora, 2016): introduction of quantified sub-criteria; each major criterion in the system should be judged separately by an adjudicator, a smaller number of couples should perform simultaneously on the dancing floor, the technical skills should be assessed separately from the artistic ones, and some bonus points should be awarded for more difficult elements. Increasing judging objectivity would definitely contribute to including dancesport in the Olympic programme.

References

1. Adzo- Banini, I. S. & Despot, T. (2003). Kondicijski trening u sportskom plesu. U D. Milanović & I. Jukić (ur.), Zbornik radova međunarodnog znanstveno-stručnog skupa ‚Zagreb, 2003, "Kondicijska priprema sportaša" (str. 466-472). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu; Zagrebački športski savez.
2. Božanić, A. (2011). Vrednovanje i analiza razvoja motoričkih znanja u ritmičkoj gimnastici. Doktorska disertacija, Sveučilište u Splitu. Split: Kineziološki fakultet Sveučilišta u Splitu.
3. Bruine de Bruine, W. (2006). Save the last dance II: Unwanted serial position effects in figure skating judgments. Acta Psychologica, 123, 299-311.
4. Bučar, M., Čuk, I., Pajek,J., Karacsony & Leskošek, B. (2012). Reliability and validity of judging in women's artistic gymnastics at University Games 2009. European Journal of Sport and Science, 12 (3), 207-215.
5. Clippinger, K. (2007). Dance anatomy and kinesiology. Champaign, IL: Human Kinetics.
6. Despot, T. & Jeličić, A. (2010). Pliometrijski trening kao pomoćna metoda u funkciji razvoja skočnosti baletnih plesača. Kondicijski trening, 8 (1), 43-50.
7. Dizdar, D. (2006). Kvantitativne metode. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu
8. Dizdar, D. & Maršić, T. (2000). Priručnik za korištenje programskog sustava Statistica. 20. Zagreb: Dizidor d.o.o.
9. FIG (2011). 2009 FIG General Judges' Rules. FIG. Retrieved April 3, 2011, from http://figdocs.lx2.sportcentric.com/external/serve.php?document=658.
10. HŠPS (2011). Pravilnik natjecanja. Retrived May 5, 2011, from http://www.hsps.hr/index.php?option=com_contetn&view=article&id=2&Itemid=8.html
11. Leskošek, B., Čuk, I., Karácsony, I., Pajek, J., & Bučar M. (2010). Reliability and validity of judging in men's artistic gymnastics at the 2009 University Games. Science of Gymnastics Journal, 2, 25-34.
12. Marilyn, A. L. (2012) Judging Anomalies at the 2010 Olympics in Men's Figure Skating. Measurement in Physical Education and Exercise Science, 16 (1) 55-68.
13. Miletić. Đ., Maleš. B., & Sekulić, D. (2000). Dance steps: Differentiating between more and less successful 7-year old girls. Facta Universitatis (Series: Physical Education and Sport), 1(7) 49-55.
14. Popović, R. (2000). International Bias Detected in Judging Rhythmic Gymnastics Competition at Sydney 2000 Olympic Games. Facta Universitatis (Series: Physical Education and Sport), 1 (7), 1–13.
15. Seltzer, R., & Glass, W. (1991). International politics and judging in Olympic skating events: 1968 – 1988. Journal of Sport Behavior, 14 (3) 189 – 200.
16. Stettum, B. S. (1998). Validity and reliability of a folk dance performance checklist for children. Master's thesis. Northern: Illinois University.
17. Sun, J. & Wu, S.B. (2003). Analysis of referees's objectivity in gymnastics contest of the 10th Anhui provincial games. Journal of Anhui Norma University, 9 (7), 85-94.
18. Teodorescu, S. & Nicora, A. A. (2016). Study regarding the need to objectify evaluation in latin – american dances. Science, Movement and Health, 16(2) supplement, 706-710.
19. Welsh, T. (2009). Conditioining for dancers. Gainesville, FL: University press of Florida
20. Xu, Li. (2008). Syntetic evaluation of sport dance teaching effects in colleges and universities. Journal of Shandong Institute of Physical Education and Sports, 22 (1), 22-31.
21. Xue, M. & Li, X. (2007). Objective Analysis of Artistic and Exection Scoring at the Ninth World Aerobics Championship. Journal of Jilin Institute of Physical Education, 22 (03), 70
22. Zagorc, M., Zaletel, P.,Škofic- Novak, D., Tušak, M. & Golja, A. (1999). Vsestranska priprava plesalcev. Ljubljana: Fakulteta za šport, Inštitut za šport: Združenje plesnih vaditeljev, učiteljev in trenerjev Slovenije: Plesna zveza Slovenije.
23. Zaletel, P., Vučković, G., Dimitrou, L., James, Nic., Rebula, A. & Zagorc M. (2011). Analysis of dance postures in Latin-american dances using annotation and sagit tracking. In D. Milanović & G. Sporiš (Eds.), Proceeding Book of 6th International Scientific Conference on Kinesiology, Opatija, 2011, "Integrative power of kinesiology" (pp.577-578). Zagreb: Faculty of Kinesiology, University of Zagreb.
24. Zhao, M., Sun, Y. & Dong W. (2008). Objective Analysis on Judge Scoring in the 39th World Gymnastics Championships. Bulletin of Sport Science and Technology. 12 (10), 124

EVALUATION OF THE NUTRITIONAL STATUS OF YOUNG ELITE DANCERS BY ANTHROPOMETRIC MEASUREMENTS

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Abstract

The foundation of sustainable health, optimal growth and biological development in children and adolescent is a balanced nutritional intake. It's essential to put emphasis on qualitative and quantitative nutritional aspects of young athletes. The adequate nutritional intake is also necessary to be ensured. Apart from the growth the intake is required to be such that it as well prevents injuries, enables the athletes to withstand the training, give appropriate performance, minimalize exhaustion and develop their cognitive functions. There is a lack of dietary recommendations for young competitive athletes which hinders the nutritional analysis. As a base we use regular standards for children and we expect that their needs grow by 20-30% above the given recommendation. However, there is no specific norm. The only clear assessment criteria is to track the child's development on percentile graphs, to carry out the anthropometric and biochemical exams more often, by and large to observe the child's social, cognitive, biological and athletic development. Any deviation in behavior is a possible indicator of insufficient nutrition. In cooperation with the Ballroom and Latin-American Dance National Team we have examined 20 juvenile dancers using bioelectric impedance. We have used a calibrated device Inbody 230, which measures the body composition, assesses the ratio of the fat tissue to the lean mass using the bioelectric impedance.The body composition of the majority of these young athletes corresponds with their biological age and training load. Body lean mass and fat tissue are rather below the average population standard. Given the sport discipline such results are probably desirable and in the norm but regarding the biological development it would be appropriate to monitor the dietary habits and adequate energy intake in accordance with the training volume and additional physical, cognitive, biological and mental load. In particular the low weight and low body fat mass can be a warning sign for possible delayed menstruation onset, delayed biological development, etc.

Key words: *child athletes, dance, body composition, training load*

Introduction

Specifics of children's nutrition and child growth

Nutritional intake affects children some basic factors. It is not only the biological development, but also the training load. Age 10-12 years is a specific pre-pubertal maturation, increased load and starting the growth spurt. Subsequently adolescence, 13-15 years, which is different biological changes, hormonal changes, and further increased the intensity of training, which is also becoming more specific and drifting away from the general training.In adolescence there are described more frequent occurrences of eating disorders among girls (more anorexia), but also among boys frequently occurs eating disorders, e.g. bigorexia. At puberty accelerates development of bone density, with an average of 80 – 90% of the peak of bone density in this period. Eating disorders occur in adolescence on the ground that the distribution of fat and muscle component in the prepubertal period is very similar for boys and girls. They differ just in a subsequent period, to which some girls respond by limiting food intake and the effort to prevent the sexual development. Consequences of eating disorders can be totally irreversible and damaging some of the parameters of the girl's body. Growth spurt among girls occurs earlier than among boys, about 2 years earlier, ie. around the 13th year of life. The optimal development of a child's growth can be measured under the standardized percentile graphs, where the average child moves from 25 percentile up to 75. It is necessary to evaluate the movement of percentile in time, not based on a single measurement. The aim of monitoring is to prevent high volatility motion percentile on the curve as downwards as well as upwards.

Requirements for energy intake in the nutrition of children athletes

Considering high variability between individuals, the energy requirements are defined according to several parameters. This includes age, height, weight and level of physical activity. It is proven, that children have higher metabolic rate than adults, about 30% more for the same activity. Thus, recommendations for adults can be undervalued in comparison to the children's needs. Unfortunately, there are not enough researches that can demonstrate the ability of the management of supply and energy intake among the participating children. In practice, we see rather undervalued energy intake among children. For example, during monitoring of nutritional standards between 15 subjects of 13-17 years old sports gymnasts in the Czech Republic, it was found that their caloric intake is on the level of about 50-60% of the actual needs corresponding to the training load and other circumstances appropriate to their lifestyle. We conclude that energy intake in young, nationally ranked gymnasts (14,5 y +-2,2) is insufficient. The reported intake (7028 ± 1702 kJ) was even lower then resting metabolic rate (7152,9 ± 996,5) measured by indirect calorimetry.(Kumstat, Hrncirikova, Berankova,2011). The risk of long-term inadequate intake among children are deficient growth, delayed adolescence, amenorrhea, or irregular menstruation, low bone density, increased incidence of injury. Inadequate food intake also results from a child's busy day mode.The average reported values for energy intakes of male football players are adequate, but many individual atlhetes, particularly gymnasts, dancers, and wrestlers, report inadequate energy intakes. (Thompson, Janice L. 1998). Consequences of chronic negative energy balance wil be reviewed in detail:Short stature a and delay puberty, nutritent deficiences, menstrual irregularities, poor bone health, increased incidence of injuries, increased risk for developing eating disorders. (Thompson, Janice L. 1998).Poor carbohydrate intakes can result in inadequate glycogen sotres and premature fatigue, in addition to increasing the use of body protein stores for energy. Adequate calcium intakes are critical to maitain bony mass. Low iron intakes can impair oxygen carrying capacity and inhibit training and performanceif iron defficiency anemie results.Deficiences of vitamin B6 can limit amino acids sythesis and red blood cell production.

In order to decrease the incidence of eatingdisorders and use of dangerous weight controll techniques, young athletes need to be better educated regarding healthy food choices and adequate energy intake.(Thompson, 1998)Sports that emphasize low body weight for optimal performance are often associated with an increased prevalence of female athlete triad. Low energy availability with or without disorderdered eating, menstrual irregularity, or amenorrhea and bone loss or osteoporosis are the three interrelated conditions that comprise atlhete triad.Ballet dancers consistently weigh 10% to 12% below ideal body weight, and these low weight ranges are commonly achieved vy low energy intakes.It has beev observed that student and professional ballet danceres, specifiacally females, consume 70% to 80% or below of the recommended daile allowance of calories for total energy. (Lucas, 2010)

Physical strain in dance sport

Dance sport belongs to the interval kind of sports. The most important factors, which affect the strain in dance sport, are duration of sport performance, intensity of sport performance, length of rest between sport performances and movement on the dance floor. These factors are affected by many variable factors. Dance sport is still very underestimated in terms of physical strain. Comparing the mean gross energy expenditures between ballroom dancing and other sports, it is evident that competitive dancing is equally as demanding in comparison to other sporting activities such as basketball or cross-country running.

The purpose of this research was to monitor basic anthropometric indicators - height, weight, body composition among a group of young dancers aged 11-18 years, belonging to the group. Their training load is 20 hours per week. This research was taking a part of a comprehensive evaluation of the organism in terms of physiotherapists.

Methods

To evaluate body composition was used method of bioelectrical impedance (device InBody 230, which is validated method with wide application in practice for the measurement of the general population. Body height was measured at Tanita device (Chumley & Baumgartner, 1990) and active athletes (Moon, 2013). Bioelectrical impedance is a method of determining lean body mass. It is based on measuring resistance of body tissues against alternating electric current. The resistance depends inversely on the amount of body water.

Results

Table 1: Summary of results

Number	Age	Height (cm)	BMI	Weight (kg)	Lean mass (kg)	Body fat (kg)	PBF (%)	Percentil weight	Percentil height
1	14	165	20,1	55,4 kg	28,0 kg	5,0 kg	9%	50.-75.	50.-75.
2	16	178	20,2	63,5 kg	33,7 kg	4,2 kg	6,7%	50.-75.	50.-75.
3	**13**	**163**	**14,1**	**37,2 kg**	**19,4 kg**	**1,1 kg**	**3,0%**	**0.-10.**	**50.-75.**
4	**11**	**153**	**13,3**	**31,2 kg**	**15,2 kg**	**2,0 kg**	**6,4%**	**10.-25.**	**75.-90.**
5	**14**	**165**	**17,7**	**48,4 kg**	**25,9 kg**	**1,7 kg**	**3,5%**	**25.-50.**	**50.-75.**
6	18	175	20,4	62,5 kg	30,5 kg	8,4 kg	13,5%		
7	14	164	18,9	50,3 kg	23,9 kg	6,8 kg	13,5%	50.-75.	50.-75.
8	14	173	17,5	51,8kg	26,2 kg	3,9 kg	7,6%	25.-50.	75.-90.
9	**16**	**167**	**20,3**	**56,5 kg**	**28,58 kg**	**5,0 kg**	**8,8%**	**10.-25.**	**10.-25.**
10	17	183	21,0	70,4 kg	35,1 kg	8,3 kg	11,7%		
11	17	187,5	21,2	74,6 kg	38,7 kg	6,4 kg	8,6%		
12	13	160	19,3	49,3 kg	21,2 kg	10,0 kg	20,2%	50.-75.	50.-75.
13	16	166	19,0	52,7 kg	2 4,6 kg	7,7 kg	14,7%	25.-50.	50.-75.
14	**14**	**154**	**17,1**	**41,7 kg**	**19,0 kg**	**6,3 kg**	**15,2%**	**10.-25.**	**10.-25.**
15	13	155	17,4	42,6 kg	20,4 kg	4,8 kg	11,2%	10.-25.	25.-50.
16	16	162	21,7	57,0 kg	24,7 kg	12,2 kg	21,4%	50.-75.	25.-50.
17	**16**	**167**	**19,6**	**48,7 kg**	**20,7 kg**	**10,3 kg**	**21,2%**	**10.-25.**	**10.-25.**
18	12	155	18,5	44,7 kg	20,2 kg	6,8 kg	15,2%	50.-75.	25.-50.
19	15	172	19,4	57,4 kg	29,5 kg	4,4 kg	7,6%	25.-50.	50.-75.

Quantity of muscle tissue and fat mass proportion is therefore rather low. Due to the competitive discipline of body composition in the majority of younger athletes corresponds to biological age and the training load. it is desirable and apparently normal, but due to the biological development it would be appropriate to monitor the eating habits and ensure regularity in eating and intake of adequate quantity of energy due to training load and school activities. We especially note the occurrence of very low weight and percentage of body fat among girls, these parameters may cause delayed start of menarche, slow biological evolution. It is important to ensure energy intake with regard to the training load and due to the age and continued growth it is necessary to pay attention to adequate energy intake and sources of important nutrients - carbohydrates, proteins and fats, but also on the intake of vitamins - especially vitamin D, group B and minerals such as calcium, iron, magnesium.

BMI among the evaluated competitors is ranked at the lower limit of standard. Another drastic weight reduction in these cases is not desirable. Risk low percentile of body mass by proband no.3 is on the border of healthy development. In this case, it is necessary to consult weight with doctor, perform additional testing, or pause training load for necessary time. A similar case is that of the probands no. 4, 9, 14, 15, 17. Proband no. 12 follows a normal weight, but very low percentage of muscle mass (a limiting factor for performance and training tolerance) and a high proportion of body fat. Low proportion of muscle tissue may be associated with long-term low energy intake and low intake of protein. At the age of probands, it is necessary to consult such a condition with the doctor, and consistently monitor the quality of food. Risk of further reduction of muscle tissue are deficient growth, weakening of cognitive function, immune system weakening and more.

Discussion

Nutritional requirements among pediatric athletes are very high. It is expected that it will ensure both the actual development of a child's body, and also cover the increased energy needs associated with the load. Insufficiency, both in qualitative or quantitative level, is admissible only in the short term, not longer. In such cases can be expected health problems reflected in disorders of the immune system, lack of bone mineral density, increased fatigue, lack of hematopoiesis, cognitive impairment, increased accident rates, etc. These are complications, which not only do not enable to continue in the training process, but the effect is significant within the body, while ensuring the basic physiological functions.

Risk for low bone density is high. Low bone density for age has been found in female athletes who suffer form amnerrhoea or have eating disrordes. Cacading events pf diordered eating, amenotthoea and osteoporosis have bee termed the female athlete triad. Low bone mass has also been associated as a contributinf factor for stress fractures among athletes.For example ballet danceres are in high rates with stress fractures (22-45%) (Pelly, Mexer, 2011) we are expeting the same with dancers.

Conclusion

Securing adequate nutrients both in qualitative and quantitative terms, it is necessary to ensure optimal biological development, cognitive development of muscle and bone system and the ability to load during physical activity, which will gradually increase. Nutrition is an integral part of the training process, and each child must be under the control of the collateral. Conversely, inadequate nutrition in children can lead very quickly to damage the body with irreversible consequences.

References

1. American Academy of Pediatrics 2005. Use of performance – enhancing substances. Pediatrics 2005,115. 1103-1106.
2. Bass, Inge k. Nutrition for special populations: children and young athletes. In: Clinical sports Nutiriton, 4th edn (Burke L, Deakin V, eds). Sydney: McGraw- Hill, 2010, pp 508-546
3. Boisseau N, Delamarche P. Metabolic and hormonal responses to exercise in children and adolescents. Sport Med 2000, 30: 405-422.
4. Calfee R, Fadale P. popular ergogenic drugs and supplements in young atlhetes. J Sch Nurs 2005, 21: 323-328
5. Dougherty KA, Baker LB, Chow M, Kenney WL. Two percent dehydratation impairs and six percent CHO drink improves boys basketball skills. Med Sci Sports Exer 2006, 38: 1650-1658
6. F.Doyle-Lucas Ashley,. Askers Jeremy D, M.Davy Brenda : Energetic Efficiency, Menstural Irregularity and Bone Mineral Density i Elite professional Female Ballet Dancers. Journal Of Dance Medicine and Science, 2010, Vol 14: 4
7. Kumstát, Michal, Hrnčiříková, Iva a Beránková, Lenka. Nutritional Status and Body Composition of Czech Elite Female Gymnasts. *Studia Sportiva*, Brno (CZ): Masarykova univerzita, 2011, roč. 5, č. 3, s. 17-24. ISSN 1802-7679.
8. Pelly Fiona, Mexer Nanna L, and Hunking Penny J, In Sport and exercise nutiriton, 1.edition, 2011 The NUtiriton society, Published 2011 by Blacwell Publishing Ltd.
9. Sanborn Charlotte (Barney) , Nichols David L and DiMarco Nancy M, In Sport and exercise nutiriton, 1.edition, 2011 The NUtiriton society, Published 2011 by Blacwell Publishing Ltd.
10. Thompson, Janice L. Energy Balance In Young Athletes. Interantional Journal of Sport Nutrition, 1998, 8:160-174
11. Volpe SL. Micronutirent requiremens for atheltes. Clin Sports Med 2007, 26: 119-130.

DANCE AS MOVEMENT AND OBJECT OF RESEARCH

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Under the excuse of the untraslatability of dance, its non-verbal presentation, misunderstanding or disinterestedness of the society and often the academic community, dance can appear as a neglected object and area of scientific interest, despite the ongoing research. Namely, dance is a specific and partly abstract area of research. It is not tangible, provable or permanent. Dance is attributed with elusive presence, its mobile trace appears irretrievable, its movements are never completely translated. Partly, the reason dance research seems questionalbe lies in the presentational elusivenes and transience of dance, as well as in the lack of an adequatly translatable language to describe dance. However, dance leaves a trace. Different than a material trace. It is in impression, thoughts and memory, and the manifestations of dance lie in wider contexts of its performativity, on local and global levels, and within the phenomenologies of diverse dance forms. This presentation will aim at explaining the tenability and need of dance research from an anthropological perspective.

Key words: *dance, research, ephemeral, elusive*

Introduction

Despite intense academic research, dance can appear as a neglected subject of scientific interest. We can consider research of dance as part of a wider area of behavior and movement research, taken into consideration that dance is movement, although movement is not always dance. There is a range of more or less related academic disciplines that focus on dance as the research subject (dance ethnography, anthropology of dance, ethnocoreology…). They operate with different terminology, differ in approaches, methods and historical development. Due to the limited framework of this text, I cannot analyze these disciplines in more depth, although it is the disciplinary considerations, such as the methods of research, that often determine the perspectives of dance research. Here I will focus on several characteristics of dance that, apart from revealing something about the specificities of the research subject, can also be perceived as problems in research. These are also the characteristics that are singled out in discussions about reasons (real or potential) dance is an underrepresented or insufficiently acknowledged subject of research. Although I do not agree with the thesis that dance research is underrepresented, or that there is a justified reason for its neglect, in this paper I will analyze the characteristics of dance as a narrow subject of research, that are frequently cited as problems in dance research, after which I will discuss whether these doubts are justified.

The transient and untranslatable quality of dance

Unlike the written text or a work of visual art, such as a painting or sculpture that has a material presence and can be revisited (in order to see it again, observe, or analyze), dance can be perceived as transient, ephemeral, and immaterial. Since the "text" of dance exists primarily in the moment of watching, Jane C. Desmond qualifies dance as the most ephemeral among all arts (1997:51, note 3). A material object created by a physical being, such as writing or a painting, is tangible and therefore, more understandable and acceptable. In a dance performance presented by a material, embodied, living being, the result is opposite – the product is immaterial. In the act of materialization, dance disappears. The presence of dance even during its performance is not material; what is material, or embodied, is its medium, the dancing body. The absence of the materiality of dance presents itself as the elusiveness of the result of dance, and is contributed by the transience and invisibility attributed to dance. Without a tangible result, what is recorded is the value and aesthetics of dance. Writing about dance is actually translation, or interpretation, of dance from the temporal dance experience to written materiality, although "movement knows nothing of the dimensional categories of time and the linear perceptions we create about it" (Louppe, 2009:159). However, even though the result of dance is not material or tangible, dance does leave a trace, a trace different and never identical, but ones that partly form the basis of its existence. These traces are left in the impressions, thoughts and memories. Of course, memory is subject to censorship and forgetting. It is deceptive, selective and subjective. Impression is deceptive as well. However, interpretations are not constant either. They are questioned and remade in the interpretations of the material and immaterial.

Also, one of the basic premises of the analyses of dance is the definition of dance as constantly directed towards history, which results in discussions of the presence/absence of dance. Thoinot Arbeau (the famous 16th-century theorist and historian of dance, whose book *Orchésographie* contains detailed descriptions of 16th-century and older dance forms, cf. Arbeau, 1967 [1588-1589]), discusses, as early as the 16th century, the scarceness of the knowledge of dance due to its temporariness and short duration (Lepecki, 2004a:125), and the structure of forgetting attributed to dance. While Elizabeth Dempster writes about “an unspeakable presence” of the dancer (1995:22), for Peggy Phelan (1993) performance indicates the possibility of a reevaluation of emptiness, researching something which is not there, which has disappeared, which takes place in the present only to exist in the past (Boyd, 2014:494). Susan L. Foster writes that “text is assigned the ability to interpret and theorize about the ephemeral yet magnetizing presence of the dance” (1995:234). Mark Franko and Annette Richards claim that dance, due to its momentariness and elusiveness, is essentially ephemeral (Lepecki, 2004b:4), that is, always in the past, absent. André Lepecki reads the presence of the body as introductory, that which always precedes the field of absence, lack, non-presence (Lepecki, 2004b:3).

Dance is therefore attributed with fleeting presence, its movable trace appears irretrievable, its movements are never fully translated. Namely, through dancing, the subject is “directly in its own movement. It does not possess a means of substitution for its presence, such as language does” (Louppe, 2009:18). The script can be understood as the means of substitution in language. However, dances, or more precisely – choreographies, can be recorded with a series of dance scripts, that is – dance notes. Dance notes, which allow for the freezing of dances, or a series of movements that should represent a dance unit, are the most direct evidence of dance structure. When we look at dance as a system of structured movements that can be transcribed and analyzed, we look at the formal dimension of dance. Dance script in the hands of a researcher represents a functional tool for analyzing specific dance performances. However, dance notes do not contain the meanings of dance, which this system cannot translate. Therefore, as was noted by Jonathan Saul Marion, the lack of an adequately translatable language to describe dance is one of the reasons dance research is undervalued (2006:85). However, the untranslatability of dance, apart from being a challenge for dance scholars, can also be a value of a different kind. Betty Redfern notes that what can be expressed through dance cannot be expressed in literature, what is expressible through music is not expressible through sculpture, etc. (1998:132). Other art forms cannot give the viewer (the receiver) sensory stimuli dance can, regardless of the uniqueness of experience or the duration of the phenomena (Louppe, 2009:9). Understanding of the world is enhanced through sensory channels to a same, if not a greater, degree than through discursive paths of denotative communication, resulting in a raised critical awareness (ibid. 2009:27). Susan L. Foster thinks that “[w]ords can translate directly into movements, as the scenarios for the story ballets demonstrate, yet movement’s message appeals to heart and soul in a way that words cannot” (1995:234). Janet Adshead therefore holds that “[t]o watch a dance and see and hear its complex interweaving of rhythms and patterns and to perceive the way in which these contribute to the imaginative significance of the whole construction is, similarly, both the excitement of, and justification for, engaging in analysis” (1998:165).

Concluding remarks

As can be seen, dance is a specific research area. It is not tangible, probable or lasting. The diverse manifestations of dance and its elusiveness make it an enigmatic and somewhat abstract area of academic interest. However, “’[a]bstraction does not have the status of a ‘category’”, and “[d]ance abstraction is a process, not an element in a fixed aesthetic typology” (Louppe, 2009:284). Regardless of this, analyses of dance are obliged to continue, as “the halt in the theoretical production on dance (...) could lead to the exhaustion of resources or the standardization of theoretical tools if they are not renewed, but only used” (ibid. 2009:23).

Therefore, it has been acknowledged that dance is “surely the most bodily of cultural productions” (Dempster, 1995:23) and should be viewed as an embodied and cultural practice (Boyd, 2014:491), but also considered in a wider perspective. What is less prominent in dance research is its breadth, dance being the platform for addressing many other related topics. In frequent perceptions of dance as the “art of movement” or a mode of communication analogous to language, what is overlooked is the potential of dance research that does focus of dance, but not necessarily as its sole subject. It is not my intention to neglect the value of texts oriented exclusively on movement, but to point to more complex, and underrepresented, content of dance research.

The analysis of dance that does not have to be based on dance notes, represents an additional dimension of describing dance. Dance scholars today are not focused solely on the structure of dance movements and the whole dance unit (the technical aspect of dance), but they also try to interpret and analyze dance symbolism or dance context. Social, cultural, historical and political circumstances can be reflected in dance, and they, in turn, generate different gender, racial, class perspectives. Dance can be viewed only as a practice of movement, this is its most visible element. However, it is not *only* that. Dance has a story, tradition, history, contexts, systems of values, philosophies, influences, and finally, a trace.

Somewhere between the emphasis on specificities of dance as a subject of research and reducing these specificities partly on problems in dance research, there occurred a transfer of certain specificities from the subject (dance) to the disciplines (that analyze dance). In other words, it appears that there is no clear boundary between the characteristics and values of the subject of research, and the disciplines dealing with it, the result being that some characteristics of the subject become attributed to the discipline. Namely, research (of any subject) is not (specifically) ephemeral and elusive, although there is a potential for it to be so. Research can be difficult due to the elusiveness of the subject, however, in this case it would be impossible to analyze the majority of movements or, for example, emotions (phenomenology). The specificity of dance (as a subject of research) has to pertain exclusively to the subject, without questioning the methods or disciplines that focus on it. In this way, the subject in itself becomes especially challenging and valuable, and there is no room for undervaluing the disciplines that focus on dance.

References

1. Adshead, J. (1998). An Introduction to Dance Analysis. In A. Carter (Ed.), *The Routledge Dance Studies Reader* (pp. 163-170). London and New York: Taylor & Francis e-Library and Routledge.
2. Arbeau, T. (1967 [1588-1589]). *Orchésographie et traicte en forme de dialogve, par leqvel tovtes personnes pevvent facilement apprendre & practiquer l'honneste exercice des dances.* Langres. New York: Dover publications.
3. Boyd, J. (2014). I go to dance, right?: representation/sensation on the gendered dance floor. *Leisure Studies*, 33(5), 491-507.
4. Dempster, E. (1995). Woman Writing the Body: Let's Watch a Little How She Dances. In E. W. Goellner & J. Shea Murphy (Eds.), *Bodies of the Text* (pp. 21-38). New Brunswick, New Jersey: Rutgers University Press.
5. Desmond, J. C. (1997). Embodying Difference: Issues in Dance and Cultural Studies. In J. C. Desmond (Ed.), *Meaning in Motion, New Cultural Studies of Dance* (pp. 29-54). Durham and London: Duke University Press.
6. Gore, G., Grau, A. (2014). Dance, cultural heritage, and the training of future heritage "managers": Anthropological reflections. In A.M. Fiskvik & M. Stranden (Eds.), *(Re)Serarching the Field. Festschrift in Honour of Egil Bakka* (pp. 117-138). Bergen: Fagbokforlaget.
7. Green, J. & Stinson, S. W. (1999). Postpositivist Research in Dance. In S. Horton Fraleigh & P. Hanstein (Eds.), *Researching Dance, Evolving Modes of Inquiry* (pp. 91-123). Pittsburgh: University of Pittsburgh Press.
8. Foster, S. L. (1995). Textual Evidances. In E. W. Goellner & J. Shea Murphy (Eds.), *Bodies of the Text* (pp. 231-246). New Brunswick, New Jersey: Rutgers University Press.
9. Lepecki, A. (2004a). Inscribing Dance. In A. Lepecki (Ed.), *Of the Presence of the Body, Essays on Dance and Performance Theory* (pp. 124-139). Middletown, Connecticut: Wesleyan University Press.
10. Lepecki, A. (2004b). Introduction: Presence and Body in Dance and Performance Theory. In A. Lepecki (Ed.), *Of the Presence of the Body: Essays on Dance and Performance Theory.* (pp. 1-9). Middletown, Connecticut: Wesleyan University Press.
11. Louppe, L. (2009). *Poetika suvremenog plesa*. [Poetics of contemporary dance] Zagreb: Hrvatski centar ITI. (Prevela: Jelena Rajak).
12. Marion, J. Sl. (2006). *Dance as Self, Culture, and Community: The Construction of Personal amd Collective Meaning and Identity in Competitive Ballroom and Salsa Dancing.* (Unpublished doctoral dissertation, University of California) San Diego: University of California. UMI Microform 3213856.
13. Redfern, B. (1998). What is art?. In A. Carter (Ed.), *The Routledge Dance Studies Reader.* (pp. 125-134). London & New York: Taylor & Francis e-Library and Routledge.

LONG-TERM EFFECTS OF DANCING ON BRAIN STRUCTURE AND FUNCTION IN THE ELDERLY

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Physical activity and cognitive training have proved to be encouraging methods to affect positively age-related structural and functional brain changes. A combination of physical and cognitive strains seems to be the most effective method. Dancing conforms to this method because it combines conditional and coordinative strains. The aim of the long-term study is to compare the effects of long-term dance training with long-term endurance or strength training and with long physically inactive behavior according to motor abilities, neuropsychological and neurophysiological parameters of healthy older adults. Another purpose is to analyze the development of motor, neuropsychological and neurophysiological parameters in a temporal progress of 5 years regarding the dancers and endurance or strength athletes. Using a cross-sectional and longitudinal study design, we compare long-term dancers with long-term endurance or strength athletes (active control group) and inactive older adults (passive control group) at a specific point of time. Moreover we evaluate the development of long-term dancers and active controls before training, after 6 months, 18 months and 5 years of training and compare the development of both groups. Each group includes 30 older adults (m/w), what makes 90 subjects altogether. At first we examine cognitive healthiness using the MMST, continuing with the Balance Master test, following the PWC-Test 130. Moreover each subject will pass a structural and functional MRI-measurement, blood analysis, questionnaires for evaluation of life style factors and leisure activities, several orientation tasks, a clinical balance test (GGT) and various neuropsychological tests (e.g. VLMT, ZVT, TAP, d2-R, BIS-4). Pretest, posttest 1 and 2 are already finished. The third posttest will be probably absolved in 2017. The present long-term study which bases on a RCT starting in 2012 (Rehfeld et al., 2014) is the first and single study that deals with long-term effects of dancing including active and passive controls, knowing that only long-term effects are important for prevention of dementia.

References

1. Rehfeld, K.; Hökelmann, A.; Lehmann, W.; Blaser, P. (2014). Auswirkungen einer Tanz- und Kraft-Ausdauer-Intervention auf kognitive Fähigkeiten älterer Menschen. *Zeitschrift für Neuropsychologie*. Bern: Huber, Bd. 25.2014, 2, S. 99-108.

EFFECT OF PROPRIOCEPTIVE TRAINING ON DANCE SPORT PERFORMANCE

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Abstract

The aim of research is analyzing the effects of proprioceptive training on the quality of Dance Sport performance. Proprioceptive training was conducted through tasks that required establishing and maintaining balanced position for balancing panels of various dimensions, work surfaces and support sizes. The task performance difficulty for the mentioned props was determined by the duration of the exercises and the body posture changes during the exercises. Thirty-eight Dance Sport competitors of both sexes participated in the conducted research, divided into an experimental and a control group. The experimental group conducted the proprioceptive training program in duration of twelve weeks (3 times a week for 30 min). The control group (simultaneously with the experimental) only conducted regular Dance Sport training. Dance performance quality was separately assessed for Standard and Latin American dances. The applied proprioceptive training model effects were determined by Multivariate (MANCOVA) and Univariate (ANCOVA) Analysis of Covariance. Statistically significant differences between the groups at the final measurement (p=.00) demonstrated positive effects in applying proprioceptive training program to the Dance Sport performance. Discovering the positive effects in developmental preparation of dancers will redirect perception of proprioceptive training as a model exclusively used in preventive and rehabilitation training programs of dancers.

Key words: *proprioceptive training, ballroom dances, technique skills, effects*

Introduction

Over the last years, the proprioceptive training has taken a more important role in sport preparation. Proprioception is an inborn “talent” for body awareness and knowing just where the body is positioned in space. Dancers might be more accustomed to related terms to define this, such as “kinesthesia”, muscle sense or simply sense of movement. This body sense is intimately tied to our feeling of muscle tone, and perceptions of effort and balance. The proprioceptive system, in general, enables correct functioning of the loco-motor apparatus during movement and sport activities, maintains muscle tonus and helps us precisely to differentiate isolated body moves that are particularly attractive in sports dance choreographies. An improvement of motor abilities using proprioceptive training is noticed in some research with uninjured and untrained individuals (Šimek, 2006; Myer, Ford, McLean & Hewett, 2006; Šebić-Zuhrić, 2007). What is especially interesting for dance performance are the studies in the field of balance (Kollmitzer et al., 2000; Elis & Roesnbaum, 2001; Heitkamp et al., 2001; Ziegler, Gibson, & Mc Bride 2002; Hrysomallis, 2007) where proprioceptive training has proved its role in development. There are but few studies on the effects of this training model made with active and healthy athletes (Simmons, 2005; Šebić, Rađo and Bonacin, 2007; Ljubojević et al., 2012; Srdić et al., 2013, Hutt & Redding, 2014). Dance profession emphasizes advantages of proprioceptive training (Batson, 2009; Ljubojević and Bijelić, 2014), however, scientific research of its application in dancers has been scarce. The results of dancers’ proprioceptive training effects in improving certain forms of coordination (Lukić, 2010) indicate statistically important positive effects on agility, but not to other forms of coordination. Ljubojević et al. (2014) confirmed the effects of proprioceptive training on improving balance of Dance Sport performers. The research results conducted by Srdić et al. (2013) on dancers proved the efficiency of proprioceptive training with jumping rope in making positive changes in motor, morphologic and functional indicators (predictor variable) in correlation with the mastery of dance movement and dance structures. Hutt and Reeding (2014) researched the effects of eyes-closed dance-specific training program on dynamic balance in elite pre-professional ballet dancers. Results indicate that dancers can be trained to adopt proprioceptive strategies to maintain dynamic balance, which consequently improves their balance performance. Athletes in Dance Sport have to demonstrate the perfect synthesis between technique, artistic skills and athleticism in order to demonstrate the best performance. The prescribed technique together with rhythmic interpretation is not sufficient to evaluate all requested dance skills, yet represent the basis for further dance development. The aim of this work is to analyze the proprioceptive training effects on improving the dance performance quality. The obtained results will enrich previous awareness of the training approach in Dance Sport and proprioceptive training application would mark new guidelines in individual, as well as group preparation of Dance Sport performers.

Methods

Examinees Sample

Examinees sample was made of 38 sport dance dancers, male and female, age 15-19 years, divided in two groups: experimental E (n = 19) and control C (n = 19). Experimental group was subjected to proprioceptive program in duration of three months, while the control group trained in accordance with their standard dance program. Only those subjects who regularly adhered to the proprioceptive program were considered (12 weeks in total). Examinees are active competitors of Dance Sport Association of Bosnia and Herzegovina. They are involved in training process for at least 5 years with minimum of three (3) trainings per week. They compete in higher dance levels (level B), who allow them to perform more complex dance choreographies.

Variables sample

Criteria variable consisted of the selected technique elements from Latin American (LA) and Standard dances (ST) which are mutually different in movement structure, rhythm and tempo. For assessing performance efficiency of basic technique elements, the selected ones for the Latin American dances were Samba, Rumba and Jive, and for the Standard ones English Waltz, Tango and Quickstep. Each dance contains choreography comprised of figures with complex dance technique elements used in higher dance levels. Used dance figures are standardized movements prescribed by the World Dance Sport Federation.

Table 1: Scale for assessing performance quality in Latin American and Standard Dances

Grade	Criteria
0	None of the elements were successfully performed
1	One element was correctly performed, but out of rhythm
2	One element was performed in rhythm, but others were performed incorrectly and out of rhythm
3	One element was performed in rhythm, others were performed in incorrect sequence and out of rhythm
4	Two elements were correctly performed, but out of rhythm
5	Two elements were correctly performed in rhythm, but others were out of rhythm
6	Elements were performed in correct sequence, but out of rhythm
7	Elements were performed in correct sequence, but only two were in rhythm
8	Elements were performed in correct sequence, but occasionally out of rhythm
9	Elements were performed with fluid technique in rhythm, but without presenting movement character
10	Elements were performed in rhythm, fluid technique and with good presentation of movement character

Method of forming criteria variable

Dance technique performance quality was assessed in accordance with the formed scale. Panel of judges consisted of three members, all licensed judges of the Dance Sport Association of Bosnia and Herzegovina. They assessed the performance quality of given technical elements in the scale of 0 to 10. The scale satisfied the discriminative criterion allowing the judges a precise leveling of examinees' performance quality. The judges separately graded each dance from Latin American and Standard dances. Score of each dance per examinee is formed on the basis of mean value of the received marks from the judicial trio. The mean value of Samba, Rumba and Jive represents variable of Latin American dances, and mean value of English Waltz, Tango and Quickstep represents variable of Standard dances.

The proprioceptive experimental program model

Proprioceptive experimental program model was conducted in three-month period (twelve weeks). Experimental group had three proprioceptive trainings per week with different duration, depending on the level of difficulty. Maximal duration of proprioceptive training (performance, pause between tasks, change of balance boards etc.) did not exceed 30 minutes. Experimental program was conducted before dance training, but after specific warm-up of dancers. During that training, balance boards of various dimensions, working surfaces and sizes of backbone were used: moving roller, T-board, semi-roller, semi-ball, asymmetrical cone, "Bosu" ball, Pilates ball, soft mat and unstable polygons. The duration and number of repetitions were determined by the difficulty of tasks. On the other hand, difficulty was determined by the body position during exercising, jumps on balance plate, distractions during exercising, and use of different additional props, which made the performance harder in particular body positions (tennis balls, balls for rhythmic gymnastics, medical balls). Certain tasks were made with eyes closed. Examinees were organized in several unstable polygons where they worked out in pairs on one balance plate. The total time of one proprioceptive training (its realization) per examinee did not exceed 10 minutes, in order to avoid nerve-muscular fatigue. While experimental group had both proprioceptive and dance trainings, control group had only regular dance trainings, three times a week.

Data analysis

Data gathered during this research were analyzed using statistic programs for personal computers SPSS 11.0 and statistic package STATISTIKA 7.0 for Windows. For analysis of basic statistic data and distribution of results on initial and final measurement for experimental and control group, basic descriptive parameters have been calculated. The Multivariate and Univariate Analysis of Variance (MANOVA, ANOVA) are used as the quantitative indicators for testing the significance of group differences in the final measurement. The Multivariate Analysis of Covariance (MANCOVA) and Univariate Analysis of Covariance (ANCOVA) were used to determine the existing effects of proprioceptive training which came as a consequence of its influence at the final measuring. The significance of conclusion is based on the $p < .05$ level.

Results

Table 2: The results of descriptive parameters of the initial and final measuring of the experimental (E) and control (C) group and differences between the initial and final measuring within a group (Anova)

	Variables	Mean	StdDev	Mean	StdDev	Anova*	
Group		INITIAL		FINAL		F	P
E	LA	5.00	0.70	9.05	.74	409.54	.00
	ST	3.88	0.85	9.05	.82	394.59	.00
C	LA	4.88	1.53	5.00	1.62	.23	.63
	ST	4.11	.99	4.64	1.57	2.52	.13

* Significance level from the one-way analysis of variance between the initial and final measuring within a group. Legend: Mean – means; StdDev. (Standard Deviation) – average deviation of gained results from their arithmetic mean

Table 2a: The differences between the experimental and control group achieved in initial and final measurement – Anova

	Variable	Mean E group	Mean C group	MS effect	MS error	F	P
INITIAL	LA	5.00	4.88	.11	1.43	.08	.77
	ST	3.88	4.11	.47	.86	.54	.46
FINAL	LA	9.05	5.00	140.02	1.59	87.96	.00
	ST	9.05	4.64	165.44	1.58	104.16	.00

Legend: Mean - value of arithmetic mean; MS effect – middle sum of arithmetic means squares between groups; MS error - middle sum of arithmetic means squares inside groups; F - value of F test coefficient for significance of Wilk's Lambda; p – coefficient of centroid difference significance

Table 2 offers information on average value of experimental (E) and control (C) group obtained at the initial and final measurement, as well as the results of Univariate Analysis Of Variance for repeated measurement testing the difference between the results of initial and final measurement within E and C group, especially for Latin American (LA) and Standard (ST) dances. The mean value results of the experimental group indicate result increase in final measurement, and the tested difference between the initial and final measurement for both dance disciplines showed statistically significant difference (LA .00; ST .00). However, it is evident that an increase in results achieved at the final measurement of the control group has not been statistically significant at the evaluated dance disciplines. Table 2a shows tested univariate differences between the groups achieved at the initial and final measurement. The results showed a statistically important difference at the final measurement between the experimental and control group in both dance disciplines (LA .00; ST .00). Following these data, the indicated importance of effects of proprioceptive program was also tested, conducted by the experimental group.

Table 3: Testing the significance of the effects of proprioceptive training on the dance performance by using the multivariate analysis MANCOVA model

Wilks Lambda	F	df 1	df 2	p
0.04	301.12	2	29	0.00

Legend: Wilk's Lambda – the value of Wilk's test for equality of centroid groups; F – value of F test coefficient for significance of Wilk's Lambda; df1 & df2 – degrees of freedom; p – coefficient of centroid difference significance

Table 3 shows the results of Multivariate Analysis of Covariance for the quality of dance performance among the examinees of experimental and control groups achieved at the final measurement. The results show statistically important difference (p=.00) between these groups, therefore it can be concluded that the applied twelve-week proprioceptive program showed a positive effect on improving the quality of dance performance. Considering the dance performance quality evaluation in two dance disciplines, it is interesting further to analyze the achieved effects of proprioceptive program on each of them.

Table 3a: Testing the significance of the effects of proprioceptive training on the dance performance by using a univariate analysis – ANCOVA model

Variables	Adjusted Mean Inicial	Adjusted Mean Final	MS effect	MS error	F	P
LA	5.05	9.00	130.03	.79	163.67	.00
ST	4.58	9.12	172.01	1.41	121.36	.00

Legend: Adjusted mean – adjusted value of arithmetic mean; MS effect – middle sum of arithmetic means squares between groups; MS error - middle sum of arithmetic means squares inside groups; F – value of F test coefficient for significance of Wilk's Lambda; p – coefficient of centroid difference significance

The results of Univariate Analysis of Covariance in Table 3a show statistically important effects of the applied proprioceptive training program to the quality of performance in Latin American dances (p=.00) as well as the performance quality in Standard dances (p=.00). Based on the F test, a slightly higher contribution of statistically important positive effects of proprioceptive program is shown in the values of Latin American dances (F=163.67).

Discussion

Considering the characteristics of performing Latin American and Standard dances, one can conclude that in general, due to the proprioceptive training application, a better kinesthetic feeling was created. Such achieved kinesthesia in this training model resulted in more coordinated, more precise, smoother, more efficient and better movement on the dance floor, which, certainly reflected on demonstrating better dance performance quality. It is assumed that practicing on unstable polygons, with soft and hard support surfaces, on one leg or both, rising etc., influenced better understanding of using tension in all muscles, especially caudal body part, which is a result of better coordination of agonists and antagonists. Functional synchronization of contraction and relaxation of agonist and antagonist muscles due to the application of proprioceptive training has surely brought a more optimal muscle strain, thus exerting less energy in dance choreography performance. A more economic movement has also produced a more elegant dance presentation. Economic movement, among else, is also a result of faster nerve reaction to information on changing body position or its parts. Nerve reaction speed is conditioned by muscle adaptation due to proprioceptive training while optimizing agonist-antagonist relation (activation of muscle fiber in charge of movement) i.e. their inhibition. Better intermuscular and intramuscular coordination has led to a more efficient dosage of muscle tension while transferring body weight from one leg to another, thus influencing finer toning of movement dynamic. All these aspects define dance performance quality. Moreover, Latin American and Standard dance choreographies are abound in elements that expressing static and dynamic balance. As stated earlier, proprioceptive training can improve dancers' balance abilities (Lukić, 2010; Srdić et al., 2013; Ljubojević et al., 2014), and as proven, these abilities contribute to a quality dance presentation (Uzunović, 2004; Lukić, 2006; Vlašić and as., 2009,). It is believed that strengthening joint and muscles with proprioceptive training has made an effect on achieving faster and a more precise body weight transfer at sudden changes of movement direction. Proper body part positioning while executing certain dance figures (due to the improved movement abilities) contributed to a more efficient and quality presentation of a chosen dance technique. In performing quality dance movement, it is of extreme importance to dosage muscular tension in caudal body part in order to maintain balance in multiple direction movements. This is particularly important while demonstrating slow dance techniques (English Waltz, Rumba). Supposedly, proprioceptive training due to its continuous effect on muscles of ankle joint (movement is mediolateral, anterior–posterior and their variation) effected their strengthening. It improved better sense of tension dosage for movement in various tempos and character (depending on dance types) thus enabling more stable and prettier movement and better control of movement direction, especially with more progressive dances (Samba, Tango). Considering the reduced support of body weight because constant lifts on the frontal part of the feet in Standard dances technique, we might conclude that proprioceptive training also made its contribution to better understanding the tension dosage in all muscles of the caudal body part stemming from the better coordination of agonist and antagonist muscles. The postural stability control in choreographic transition is one of the key requirements for presenting quality dance performance (Lukić i Bijelić, 2009). Moreover, apparently the proprioceptive training program has improved the kinesthetic feeling (Wolf-Cvitak and as., 2002) thus ensuring the safer movement of dancers in progressive choreographies, as well as more precision in music interpretation. Characteristic staccato and legato Tango actions have better expression and provide better characterization of movement due to better intermuscular contraction and relaxation control. Better kinesthetic sense contributes to achieving better body control in space (maintaining proper posture). Numerous papers (Hoffman and Payne, 1995, Paterno et al., 2004) emphasize the positive effects of proprioceptive training on postural stability, as well as to a better and a more economic movement. Samba and Jive are dances whose choreographies, besides establishing and maintaining balance, are also characterized by sudden changes in movement direction, and due to a quicker tempo dictated by music. Body agility is especially emphasized this way, and as it is previously mentioned, proprioceptive training has shown its positive influence on certain agility tests (Malliou et al., 2004; Šimek, 2006, Lukić, 2010).

Conclusion

The aim of this paper was to examine the effects of proprioceptive program on the quality of dance. The results conducted on Dance Sport examinees showed positive effects of proprioceptive exercise on improving the quality of Latin American and Standard dance performance. Changes were seen in achieving better control of muscle tension in changes of dynamic movement direction, better presentation of movement character in various dance techniques, better intermuscular coordination allowing more accurate and rhythmically precise dance expression, body posture control in progressive movements and in general, a more economical dance expression. Discovering positive effects of proprioceptive training model can innovate the approach to planning and programming the Dance Sport training process and significantly influence the quality of systematization of the training effects. The affirmation of the proprioceptive training as model for the development of dance performance will redirect the traditional comprehension, in a sense that this type of training belongs only to preventive, maintaining and rehabilitation dance fitness programs. The fact that this training concept could be applied in other sport fields with similar conventional structural movements (skating, synchronized swimming, rhythmic gymnastics, etc.) is one of the practical benefits of this research.

References

1. Batson, G. (2009). Update on proprioception: considerations for dance education. Journal of Dance Medicine Science. 13(2):35-41.
2. Elis, E. & Rosenbaum, D. (2001). A multi-station proprioceptive exercise program in patients with ankle instability. Medicine & Science in Sport & Exercise 33(12), 1991-1998.
3. Hutt, K. & Redding, E. (2014). The Effect of an Eyes-closed Dance-specific Training Program on Dynamic Balance in Elite Pre-professional Ballet Dancers: A Randomized Controlled Pilot Study Journal of dance medicine & science: official publication of the International Association for Dance Medicine & Science 18(1):3-11.
4. Heitkamp, H.C., Horstmann, T., Mayer, F., Weller, J., & Dickhuth, H.H. (2001). Gain in strength and muscular balance after balance training. International Journal of Sports Medicine 22(4), 285-290.
5. Hoffman, M. & Payne, V.G. (1995). The effects of proprioceptive ankle disk training on healthy subjects. Journal of Orthopedic and Sports Physical Therapy 21(2), 90-93.
6. Hrysomallis, C. (2007). Relationship between balance ability, training and sports injury risk. Sports Med.37(6), 547-556.
7. Jukić, I., Milanović, L., Šimek, S., Nakić, J., & Komes, Z. (2003). Metodika proprioceptivnog treninga na balans pločama (Methodology of proprioceptive training on the balance boards). Kondicijski trening 1(1), pp 55-59.
8. Lukić, A. (2006). Relacije nekih motoričkih sposobnosti i efikasnosti izvođenja osnovnih elemenata tehnike u sportskom plesu. (Relations between some motor skills and efficiency of performing the basic elements of technology in sport dance). Master´s thesis. Faculty of Physical education and Sports. University in Banjaluka.
9. Lukić, A. & Bijelić, S. (2009). Predikcija uspješnosti u latinoameričkim plesovima na osnovu motoričke sposobnosti koordinacije (Prediction of success in the Latin American dances based on coordination of motor skills). III International symposium "Nove tehnologije u sportu" (pp 123-127). Faculty of Sport and Physical education. University in Sarajevo.
10. Lukić, A. (2010). Efekti proprioceptivnog treninga na razvijanje ravnoteže i poboljšanje tehnike izvođenja u sportskom plesu. Neobjavljena doktorska disertacija. Fakultet fizičkog vaspitanja i sporta. Univerzitet u Banjoj Luci. (Effects of proprioceptive training on developing balance and improving performance technique in Dance Sport. Unpublished doctor dissertation. Faculty of Physical education and Sports. University in Banjaluka.)
11. Ljubojević, A. & Bijelić, S. (2014). Trenažni modeli u sportskom plesu. Univerzitetski udžbenik. Fakultet fitzičkog vaspitanja i sporta. Univerzitet u Banjoj Luci. (Training models in Dance Sport. Faculty of Physical education and Sports. University in Banjaluka)
12. Ljubojević, A., Bijelić, S., Zagorc, M., Radisavljević, L., Uzunović, S., Pantelić, K. (2012). Effect of proprioceptive training on balance skills among sport dance dancers. Facta Universitatis. Physical Education and Sport. University of Niš. Vol. 10. No3. Pp.257-266.
13. Myer, G.D., Ford, K.R., McLean, S.G., & Hewett, T.E. (2006). The effects of plyometric Versus Dynamic Stabilization and Balance Training on Lower Extremity Biomechanics. American Journal of Sports Medicine, 34(3), pp 445-455.
14. Malliou, P., Amoutzas, K., Theodosiou, A., Gioftsidou, A., Mantis, K., Pylianidis, T. & Kioiumourtzoglou, E. (2004). Proprioceptive training for learning downhill skiing. Perceptual and motor skills, 99(1), 149-154.
15. Paterno, M.V., Myer, G.D., Ford, K.R. i Hewet, T.E. (2004): Neuromuscular training improves single-limb stability in young female athletes. Journal of Orthopedic &Sports Physical Therapy, 34(6), 305-316.
16. Perrin, P.P., Deviterne, D., Hugel, F., & Perrot, C. (2002). Judo, better than dance, develops sensor-motor adaptabilities involved in balance control. Gait and Posture, 15 (2), 187-194.

17. Simmons RW. (2005). Sensory organization determinants of postural stability in trained ballet dancers. Intl J Neurosci.115:87-97.
18. Srdić, V., Bajrić, O., Oreb, G., Lolić, V. Zagorc, M. (2013). Regression analysis of cennection between morphological, motor and funcional abilities with the success of performance of tehnical elements in dance. Acta Kinesiologica 7. Faculty of Science and Education. University in Mostar. 1:60-65.
19. Šebić,L., Rađo, I. & Bonacin, D. (2007).The effects of propriceptive training on the results of specific movements in rhytmic gymnastics.Acta Kinesiologica, 1(1), 30-37.
20. Šimek, S. (2006). Promjene u rezultatima testova za procjenu motoričkih sposobnosti pod uticajem proprioceptivnog treninga (Changes in the results of tests for assessing motor skills under the influence of proprioceptive training). Master´s thesis. Zagreb: Faculty of Kinesiology.
21. Šebić-Zuhrić, L. (2007). Trasforamcioni procesi baz̆ičnomotoričkih sposobnosti i stilizovanih kretnih struktura u ritmičkoj gimnastici pod uticajem proprioceptivnog treninga (Transformational processes of basic motor skills and stylized kinesis structures in rhythmic gymnastics under the influence of proprioceptive training). Doctoral dissertation. Faculty of Sport and Physical education. University in Sarajevo.
22. Uzunović, S. (2004). Uticaj antropomotoričkih sposobnosti na uspješnost u sportskom plesu (Influence of motor skills to success in sport dance). Master´s thesis. Faculty of Physical culture. University of Niš.
23. Ziegler, L.P., Gibson, M.H., & Mc Bride, J.M (2002). Proprioceptive training improves vertical jump performance in untrained woman. NSCA Coference Las Vegas, July 10-13.
24. Wolf-Cvitak, J., Grčić-Zubčević, N., & Dolančić, A.(2002). Kinesthetic perception in rhythmic gymanstic-open vs. Closed –eye performance. U. D. Milanović & F. Prot (Eds.). Kinesiology – New Perspectives, Proceedings Book, 3rd International Scientific Conference. Opatija, 25-29 September, pp 253-256. Zagreb: Faculty of Kinesiology.

RELATION BETWEEN SEX AND AESTHETIC ASSESSMENT OF DANCESPORT

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Abstract

Dancesport is a very attractive sports discipline, which is a unique combination of art and sports, and includes competition in standard and Latin American dances. The movements of the dancers in each individual dance represent the primary means of their artistic expression and communication. Aspiration of every dancer during the dance is to perform the movements with high aesthetic criteria and as perfectly as possible. For the purpose of this paper a research was conducted using the semantic differential technique, with the use of an aesthetic experience assessment scale (Pejic, 2007). The research was conducted on a sample of 40 students (20 females and 20 males) in the third year of the Faculty of Sport and Physical Education in Belgrade. The aim of the research is a relation between the sex of the respondents and aesthetic assessment of dancesport regarding its aesthetic dimensions of harmony, semantic depth, evaluation, activity and decorations. After processing the data, considering the impact of sex of the respondents on the aesthetic experience of dancesport, and neglecting the influence of the type of dancesport, the research results indicate that female respondents assess dancesport more than male respondents only on the dimension of activity. If we ignore the role of the sex of the respondents and consider only the assessment of the type of dancesport, the differences in the aesthetic evaluation of standard and Latin American dances were observed in all tested aesthetic dimensions. Interaction between the sex of the respondents and the types of dancesport was present only regarding the dimension of activity.

Key words: *sex (gender), dancesport, aesthetic assessment*

Introduction

Dancing is an art, which is like any other art, created from the life itself. Today, dances can be discussed about as a unique combination of art and sports. Dances can equally be classified in artistic, as well as sports events, taking thus place in art, but also in the theory and practice of sport. Sports features of dances are mostly reflected in competitive dance events, one of which is the dancesport.

Dancesport is a sports event, created by extraction of certain dances from the original context, with targeted revision of dance steps and performance techniques (Katarinčić, 2012), their equalization by introducing rules and elements of holding partners in couples, or paths of movement of dancers in space (Kostić & Uzunović, 2012). In the official world competition program of the dancesport there are four competition events, namely: standard (ST) dances, Latin American (LA) dances, a combination (ten dances) and formations.

The main feature of standard dances is restraint of movements, which are light, harmonized and fluid, a feature of "cold-blooded" English temperament, while movement of the dancers must have a line, form and aesthetic expression. Standard dances include: Waltz, Tango, Viennese Waltz, Slowfox and Quickstep. Competitive Latin American dances, although called Latin American, have their origin in African dances, and represent a combination of African rhythms (which were brought to Latin America by African slaves), ritual customs of the natives, their folklore, as well as European style of dancing. Unlike standard dances, Latin American dances are by their nature lively, faster, more temperamental, which corresponds to the characteristics of the place of their origin. The Latin American dances include: Cha-cha-cha, Samba, Rumba, Paso Doble and Jive. The third competitive event is the competition in all ten dances (standard and Latin American), and the fourth is a competition of formations, teams of eight dance couples, dancing all five standard or Latin American dances.

In the dancesport, competition on stage is the ultimate goal of each dancing couple, or a place where they show their dance skills acquired. Success of performing dance skills depends on the aesthetically shaped movement, motor skills, specific traits (sense of rhythm, orientation in space, ability of coordination in space), musical interpretation and teamwork. In each dance, derived movements are in the function of aesthetics. The aesthetic dimension is one of the most important because dance represents a source of aesthetic impulses and feelings. Through dance a man gets the opportunity to aesthetically shape himself and to enjoy in other aesthetic forms and harmony. The means of aesthetics represent the ultimate form of dance expression (Kostić & Uzunović, 2012). Aesthetically shaped movement means nicely performed movement. However, the concept of "nicely"' cannot be precisely defined because it is conditioned by many factors. It often happens that two people do not have the same experience of some piece of art.

In psychology of art and experimental aesthetics, there are numerous studies that have examined various characteristics of aesthetic stimulus, assuming that some of them affect the aesthetic evaluation. Research in the field of aesthetic assessment and dance experience are relatively new and the results of the research have indicated different aesthetic experiences dances by spectators (Vukadinović, 2011). Spectators' aesthetic experience of dance may be observed from the perspective of somaesthetic studies (Arnold, 2005), from the perspective of neuroaesthetic studies (Calvo-Merino, et al., 2005; Cross et al., 2006; Calvo-Merino, 2009; Hagendoorn, 2011; Sevdalis & Keller, 2011), and from the perspective of cognitive-oriented research on dance and aesthetic experience of dance (Grove, et al., 2005; Pflug, 2011; Pflug & Mandarić, 2012; Mandarić & Pflug, 2012; Ristić, et al., 2013).

Conducting research in this area proved that the respondents make the difference in the aesthetic assessment of different types of dance. In the research by Mandarić and Pflug (2012), the results of the research on aesthetic assessment of social dances suggest that the Latin American dances are assessed as more dynamic, rhythmic, powerful, diverse than the standard dances, while the standard dances are assessed as shyer and more compelling than Latin American dances.

The research in the field of visual arts on the impact of sex on the aesthetic assessment of a piece of art, showed no consent among the results obtained. Previous research suggests that females have greater aesthetic sensitivity and a greater inclination towards the art (Eysenck & Castle, 1970; Chan, Eysenck & Götz, 1980; Frois & Eysenck, 1995). Research in the field of dance showed that sex of the respondents affected aesthetic assessment of the dances. Pflug (2011) reported that sex of the performer influences the aesthetic assessment of the ballet. Performance of a female ballet dancer in classical ballet is characterized by tenderness and likeability, while performance of a male ballet dancer is characterized by diversity, complexity, mystery and strength. Assessments of modern ballet are contrary. Performance of female ballet dancers is characterized by mystery and strength, while performance of a male ballet dancer is characterized by harmony, precision, gentleness and likeability. As in the aesthetic assessment of ballet, in the aesthetic assessment of social dances it is also observed that sex of the respondents influences their aesthetic assessment. Female sex assesses social dances as harmonized, precise, powerful, mysterious, dynamic, rhythmic, flaunting, diverse and rich, more than male respondents (Pflug & Mandarić, 2012).

Based on the above mentioned, the **subject matter** of this study was to determine the relation between the sex of the respondents and aesthetic assessment of dancesport. The **aim** of the research was to examine the connection between the sex of the respondents and aesthetic assessment of dancesport regarding the aesthetic dimensions of harmony, semantic depth, evaluation, activity and decorations.

Methods

The research was conducted on a sample of 40 students (20 females and 20 males), in the third year of the Faculty of Sport and Physical Education in Belgrade, who had acquired general knowledge about dancesport after completing theoretical and practical studies within the Theory and Methodology of Dances subject. The research used the Aesthetic Experience Assessment Scale (Pejić, 2007), which consisted of 15 seven-point scales in the form of the semantic differential. The scale measured 5 dimensions: harmony (scales: linked, precise, harmonious and their opposites), semantic depth (scales: strange, powerful, mysterious and their opposites), evaluation (scales: likable, shy, gentle and their opposites), activity (scales: dynamic, rhythmic, flauntingly and their opposites) and decoration (scales: rich, diverse, complex and their opposites). The sample of variables was composed of: independent variables – respondents' sex and type of dancesport, and dependent variables – dimensions of harmony, semantic depth, evaluation, activity and decorations.

Research protocol and statistical processing of data

At the beginning of the experiment, the subjects were given scales for assessing aesthetic impression, after which they were given instructions on videos and how to grade scales. The subjects had 10 1,5-minute videos of dancesport, namely 5 videos of standard and 5 videos of Latin American dances, played to them on an LCD projector. Respondents assessed each stimulus immediately after watching each video clip, on all 15 scales. Time for assessment was not limited.

Using the technique of analysis of variance for repeated measurements, it was examined how each of the independent variables (sex of respondents and type of dancesport) affect each of the five dependent variables (dimensions of harmony, semantic depth, evaluation, activity and decorations) and whether there was an interaction between mentioned independent variables.

Results

The research results, presented in Table 1, indicate the influence of the independent variables and their interactions on the dependent variables.

Table 1: Analysis of variance for repeated measurements shows the effect of the independent variables and their interactions on the dependent variables

Dep. variab.	*Sex of the respondents*			*Type of dance*			*Sex – type interaction*		
	DF	F	Sig	DF	F	Sig	DF	F	Sig
Harmony	1,38	2,427	0,128	1,38	6,342	0,016	1,38	0,075	0,786
Semantic depth	1,38	1,167	0,287	1,38	55,638	0,000	1,38	0,055	0,816
Evaluation	1,38	0,026	0,872	1,38	67,883	0,000	1,38	0,334	0,567
Activity	1,38	5,636	0,023	1,38	90,434	0,000	1,38	4,179	0,048
Decoration	1,38	0,567	0,456	1,38	72,503	0,000	1,38	0,000	0,990

Analysis of variance for repeated measurements (Table 1) indicates that *on the dimension of harmony*, the effect of the sex of respondents is not statistically significant: $F (1.38) = 2.427$, $p>.05$, while statistical significance was observed in the basic effect of the type of dancesport: $F (1.38) = 6.342$, $p <.05$, in relation to Latin American dances. The interaction respondents' sex *and* type of dancesport is not statistically significant: $F (1.38) = 0.075$, $p>.05$. The research results presented in Table 1 indicate that for *the dimension of semantic depth*, the effect of the sex of respondents is not statistically significant: $F (1.38) = 1.167$, $p>.05$. Statistical significance is observed in the basic effect of the type of dancesport: $F (1.38) = 55.638$, $p<.05$, in relation to Latin American dances. Analyzing the results of research on the interaction respondents' sex and type of dancesport, showed no statistical significance: $F (1.38) = 0.055$, $p>.05$. Analysis of variance for repeated measurements (Table 1) indicates that for *the dimension of evaluation*, the effect of the sex of respondents is not statistically significant: $F (1.38) = 0.026$, $p <.05$, while statistical significance was observed in the basic effect of the type of dancesport: $F (1.38) = 67.883$, $p<.05$, in relation to standard dances. The results indicate that the interaction respondents' sex *and* type of dancesport is not statistically significant: $F (1.38) = 0.334$, $p>.05$. The research results presented in Table 1 indicate that for *the dimension of activity*, there is a statistical significance of the base effect of the sex of respondents: $F (1.38) = 5.636$, $p<.05$, of the base effect of the type of dance: $F (1.38) = 90.434$, $p<.05$, and of the interaction respondents' sex *and* type of dancesport: $F (1.38) = 4.179$, $p<.05$. Analysis of variance for repeated measurements (Table 1) indicates that for *the dimension of decorations*, the effect of the sex of respondents is not statistically significant: $F (1.38) = 0.567$, $p>.05$, and the statistical significance is only observed in the base effect of the type of dancesport: $F (1.38) = 72.503$, $p<.05$, in relation to Latin American dances. The result of the research, which is related to the interaction respondent's sex *and* type of dancesport, and the effect of the sex of respondents, is not statistically significant: $F (1.38) = 0.000$, $p>.05$.

Discusion

The main effect of the type of dancesport indicates that, regardless of the sex of the respondents, there are systematic differences in the assessment of standard and Latin American dance regarding the *dimension of harmony*. Latin American dances are assessed on the dimension of harmony more than standard dances, in other words, respondents experienced Latin American dances as continuous, precise and harmonious, while the standard dances seemed interrupted, imprecise and discordant to them. As with *the dimension of harmony*, for *the dimension of semantic depth*, regardless of the sex of respondents, there is statistically significant difference in the assessment of standard and Latin American dances. Latin American dances were significantly more assessed by the respondents as strange, powerful and mysterious, which is consistent with the results obtained by Mandarić and Pflug (2012). Based on the results in Table 1, it can be seen that, regardless of the sex of the respondents, the main effect of the type of dancesport indicates the existence of systematic differences in the assessment of standard and Latin American dance on *the dimension of evaluation*. Contrary to the assessment on the *dimension of harmony* and *dimension of semantic depth*, standard dances are assessed on the *dimension of evaluation* substantially more than Latin American dances, in other words, male respondents experienced standard dances as likable, shy and gentle.

The base effect of sex of the respondents indicates that, regardless of the type of dancesport, there are systematic differences in the assessment for *the dimension of activity,* between male and female respondents. Female respondents estimated dancesport more compared to the male respondents. The results obtained are consistent with previous results from the dance research (Pflug, 2011; Pflug & Mandarić, 2012). The base effect of the type of dancesport, regardless of the sex of the respondents, indicates that there is a statistically significant difference between the Latin American and standard dances for *the dimension of activity*. Respondents assessed Latin American dances as more dynamic, rhythmic and flaunting, which is the characteristic of the place of their origin. The statistical significance of interaction respondents' sex *and* type of dancesport for *the dimension of activity* indicates that female respondents assess Latin American dances more than standard dances, and in that assessment, Latin American dances are more dynamic, rhythmic and flaunting to them. Male respondents, on *the dimension of activity*, just like female respondents assessed Latin American dances more than the standard dances. At the same time, in terms of the *dimension of activity*, compared to male respondents, female respondents assessed both Latin American and standard dances more.

The base effect of the type of dancesport on *the dimension of decorations* indicates that, regardless of the sex of the respondents, there are systematic differences in the assessment of Latin American and standard dances. Male respondents assess Latin American dances on *the dimension of decorations* more than standard dances. Male respondents assess Latin American dances more as luscious, diverse and complex than standard dances. Obtained results are in line with the "story" which depicts the life and temperament of the place of origin of Latin American dances, but also the sensuality and the passion of each individual dance.

Conclusion

Generally, it can be concluded that, based on the research conducted with the aim of finding a connection between sex of the respondents and aesthetic assessment of dancesport, the sex of the respondents does not affect the aesthetic assessment of dancesport regarding its aesthetic dimensions of harmony, semantic depth, evaluation and ornaments, and that the only effect is seen on the dimension of activity. The obtained results are not in consistence with previous research showing that women generally express a preference for art and greater aesthetic sensitivity (Eysenick & Castle, 1970; Chan, Eysenick & Götz, 1980; Frois & Eysenick, 1995), and bigger tendency to evaluate artistic dances (Pflug, 2011; Mandarić, Pflug 2012, Ristić et al., 2013).

The types of dancesport, standard and Latin American dances, were differently assessed for all aesthetic dimensions. Latin American dances are evaluated as more graceful, precise, powerful, playful, diverse, luxurious compared to the standard dances, which can be explained by Latin American dances being faster, more temperament and more lively. Standard dances are assessed as more gentle, shy and appealing than Latin American dances, which justifies their classification as classy dances, characterized by elegant, spontaneous, balanced, determined and convincing movements. Latin American dances are characterized by mystery, passion, magical attraction, the music of diverse and syncopated rhythm. The interaction between sex of the respondents and the type of dancesport is determined solely on the dimension of activity. From the above it can be seen that the results are partially consistent with the results of previous studies. In other words, aesthetic assessment of dances, as well as assessment of other works of art, depends on who assesses a work of art, the culture that person belongs to, previous experience, and other factors.

References

1. Arnold, P. J. (2005). Somaesthetics, education and the Art of Dance. *Journal of Aesthetic education,* 39(1), 48-64.
2. Calvo - Merino, B. (2009). Neural Signatures of the Aesthetic of Dance /on-line/. Retrieved January 23, 2017 from: http://ausdance.org.au/articles/details/neural-signatures-of-the-aesthetic-of-dance
3. Calvo – Merino, B., Glaser, D.E., Grezes, J., Passingham, R.E., and Haggard, P. (2005). Action Observation and Acquired Motor Skills: An fMRI Study with Expert Dancers. *Cerebral Cortex,* 15(8), 1243-1249.
4. Camuri, A., Lagerlöf, I., and Volpe, G. (2003). Recognizing emotion from dance movement: Comparison of spectator recognition and automated techniques. *International Journal of Human-Computer Studies*, 59, 213-225.
5. Chan, J., Eysenick H. J. & Götz, K. O. (1980). A new visual aesthetic sensitivity test: III Cross-cultural comparison between Hong Kong children and adults, and English and Japanese samples. *Perceptual and Motor Skills*, 50, 1325-1326.
6. Cross, E. S., Hamilton, A.F., and Grafton, S. T. (2006). Building a motor simulation de novo: observation of dance by dancers. *Neuroimage,* 31(3), 1257-1267.
7. Eysenick, H. J. & Castle, M. (1970). Training in arts as a factor in the determination of preference judgments for polygons. *British Journal of Psychology*, 69, 65-81.
8. Frois, J. P. & Eysenick, H. J. (1995). The visual aesthetic sensitivity test applied to Portuguese children and fine art students. Creativity Research Journal, 1995; 8: pp. 277-284.
9. Grove, R., Stevens, C. & McKechnie, S. (2005). *Thinking in four dimensions: creativity and cognition in contemporary dance*. Melbourne: Melbourne University Press.
10. Hangendoorn, I. (2011). Dance, Choreography and the Brain. In D. Melcher & F. Bacci (Eds.), *Art and the Senses* (pp. 499-514). Oxford: Oxford University Press.
11. Katarinčić, I. (2012). Paradoksi sportskog plesa. *Etnološka tribina 35*, 42, 207-224.
12. Kostić, R., Uzunović, S. (2012). *Ples*. [Dance. In Serbian.] Nis: Faculty of Sport and Physical Education University of Nis.
13. Mandarić, S., Pflug, A. (2012). Razlike u estetskoj proceni latino-američkih i standardnih plesova. *Book of abstracts the Symposium "Empirijska istraživanja u psihologiji"* (p. 17). Beograd: Institut za psihologiju i laboratorija za eksperimentalnu psihologiju.

14. Pejić, B. (2007). Skala procene estetskog doživljaja. *Book of abstracts the Symposium "Empirijska istraživanja u psihologiji"* (p. 23). Beograd: Institut za psihologiju i laboratorija za eksperimentalnu psihologiju.
15. Pflug, A. (2011). *Relacija pola i estetske procene baleta*. [Relation between sex and aesthetic assessment of ballet. In Serbian.] (Unpublished Master's thesis, University of Beograd). Beograd: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.
16. Pflug, A., Mandarić, S. (2012). Uloga pola ispitanika u estetskoj proceni društvenih plesova. *Book of abstracts the Symposium "Empirijska istraživanja u psihologiji"* (p. 18). Beograd: Institut za psihologiju i laboratorija za eksperimentalnu psihologiju.
17. Ristić, N., Mandarić, S., Jocić, D. & Lazarević, D. (2013). Aesthetic assessment of Folk Dances. *Facta Universitatis, Series: Physical Education and Sport*, 11(3), 255-265.
18. Sevdalis, V. & Keller, P.E. (2011). Captured by motion: Dance, action understanding and social cognition. *Brain and Cognition,* 77, 231-236.
19. Vukadinović, M. (2011). Aesthetic experience and emotional identification in the performances of different types of artistic dance. In J. Alcaraz, M. Carrasco & S. Rubio (Eds.), *Proceedings of the 5th Mediterranean Congress of Aesthetics, "Art, Emotion and Value"* (pp. 393-408). Cartagena: Universidad de Murcia.

FROM TRAINEES TO PROFESSIONAL DANCERS – THE CASE OF THE *CROATIAN NATIONAL FOLK DANCE ENSEMBLE LADO*

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This presentation is a continuation of research on professional dancers' practices of involving *Lado, The National Folk Dance Ensemble of Croatia* that focuses on the formal education and training of the present and potential members of the ensemble.

Unlike other countries in the region, Croatia has only one high school program where students can acquire a diploma as a folk dancer. *The Department of Folk Dance* was founded in the 1980s as a department of the *School for Classical Ballet of Zagreb*. The curriculum of the Department, as it stands on the official website of the school, is based on the ensemble *Lado*'s program and focuses on a Croatian, national dance expression. Although the program proclaims strong relations to *Lado* artistic policy, the diploma is not a precondition for becoming a member of the ensemble. In actuality, there are more active dancers who pass the audition that come from an amateur folk societies performing background than graduates from the *Department of Folk Dance*.

The change is also apparent within the ensemble's system of teaching and rehearsing. Dance training and technical rehearsals are led by assistant art directors who are concurrently active dancers and have emerged from within the ensemble. Conversely, vocal rehearsals are run by trained professionals (conductors and vocal singing specialists) hired from the outside, along with a full-time director of singing who is also the conductor.

The study is based on in-depth interviews with experienced and trainee dancers with different pre-ensemble experience. The position of the researcher is that of insiders (Professor at the *Department of Folk Dance* at the *School for Classical Ballet of Zagreb* and a one-year volunteer work in the Lado ensemble as a dancer) and outsiders (the loyal audience that follows Lado's theistic performances).

INJURY OCCURRENCE IN THE CROATIAN NATIONAL BALLET - A PRELIMINARY RETROSPECTIVE STUDY

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Abstract

The purpose of this preliminary retrospective study was to determine the injury occurrence in the classical ballet dancers of the Zagreb Croatian National Theatre ensemble during a one year period. Twenty dancers (13 females) participated in this study. The data on injuries during the past year were collected via questionnaire and used to investigate the relationship between gender and injury occurrence and between the position in the ensemble and injury occurrence. Five out of 13 female dancers experienced an injury (including one female dancer who experienced 2 injuries), as well as three out of 7 male dancers. The study showed higher rate of injuries among the corps de ballet members compared to the soloists. The injuries occurred at the beginning of the season (September, October), at the end of the season (May, June), and during December. The most common injuries were acute foot injuries.

Key words: *classical ballet, musculoskeletal injury, professional injury*

Introduction

Classical ballet is one of the most challenging and most physically demanding dance forms based on a very strict and precise technique which requires a high level of technical skills. In order to achieve the required technical proficiency, ballet dancers are exposed to extremely high training volume. They can, therefore, be considered not only as artists, but also athletes (Costa, Ferreira, Orsini, Silva, & Felicio, 2016). A high training volume and a large number of shows throughout the theatre season result in an elevated risk of injuries in these artists. The incidence of injuries, expressed as a number of injuries per 1000 hours of dance, ranges from 0.6 to 4.4 (Nilsson, Leanderson, Wykman, & Strender, 2001; Allen, Nevill, Brooks, Koutedakis, & Wyon, 2012).

The lower extremity and spine are the most commonly injured anatomical regions in ballet dancers. While lower extremity injuries constitute 66% to 91% of all injuries (with foot and ankle injuries being the most common), the prevalence of low back pain is 62% (Smith, et al., 2015). Overuse injuries are usually reported as more prevalent compared to acute ones (Smith, et al., 2015).

Many risk factors have been put forward in attempts to elucidate the injury occurrence in classical ballet. These include intrinsic factors, such as anatomical and biomechanical characteristics, age, body mass index, characteristics of menstrual cycle in female dancers, previous injuries, nutritional status, muscle imbalance, physical fitness, and extrinsic factors, such as training regime, and environmental factors (Peer & Dubois, 2005; Twitchett, et al., 2010a). Due to the multifactorial nature of injuries, comprehensive surveillance programs are recommended to gain further insight into the causes of injuries and provide a basis for interventions to reduce their occurrence (Allen, et al., 2012; Bronner, Ojofeitimi, & Mayers, 2006; Liederbach, Hagins, Gamboa, & Welsh, 2012).

The aim of our study was to determine the injury occurrence in the dancers of the classical ballet ensemble of the Zagreb Croatian National Theatre during a one year period.

Methods

This preliminary study was carried out during January and February 2017. The participants were members of the classical ballet ensemble of the Croatian National Theatre in Zagreb (n=20, 13 females). The participants' characteristics are presented in Table 1. In order to obtain the data on their professional injuries during the past year, the dancers filled out a questionnaire on their working and personal health history. The questions regarding injuries were based on the injury reporting forms suggested by Allen, et al. (2012) and Bronner, et al. (2006). The participants gave their written informed consent and the study was approved by the Institutional Review Board.

The participants' data are presented as mean (SD). T-test for independent samples was used to test the differences between the characteristics of female and male dancers. A Chi-square test for independence was used to explore the relationship between gender and injury occurrence and between the position in the ensemble and injury occurrence. The significance level was set at $p=0.05$. Data analysis was performed using STATISTICA 12 (StatSoft, Inc., Tulsa, OK, USA).

Table 1: Sample characteristics (mean (SD))

Variable	Females (n=13)	Males (n=7)	p-value*
Age (years)	28.9 (5.7)	25.1 (2.5)	0.12
Height (cm)	166.9 (3.8)	177.2 (4.3)	<0.001
Weight (kg)	51.9 (4.5)	66.5 (4.8)	<0.001
Body mass index (kg/m^2)	18.6 (1.3)	21.1 (0.9)	<0.001
Soloist/corps de ballet	6/7	2/5	

* T-test

Results

The results on musculoskeletal injuries during the past year are presented in Table 2.

Eight out of 20 dancers reported experiencing an injury, with only one female dancer reporting 2 different injuries during the past year.

Table 2: Characteristics of injuries in 1-year period and factors related to injuries per gender

Variable	Females	Males
Number of injuries (n)	6	3
Dancers with >1 injury [n of dancers (n of injuries)]	1(2)	0
Period of the season when the injury occurred:		
May	0	1
June	1	1
September	2	0
October	2	0
December	1	1
Onset of injury:		
Acute	4	3
Overuse	2	
Activity when the acute injuries occurred/the place where the acute injuries occurred:		
Class or rehearsal/studio	2	2
Show/stage	2	1
Injuries by anatomical region:		
Shoulder	1 (overuse)	
Low back		1
Thigh/hamstring	1 (overuse)	
Ankle		1
Foot/toe	3	1
Non-reported	1	
Exact dance movement or position when the injury occurred:		
Arabesque		1
Pointe	2	
Small jumps		1
Middle jumps		1
Cannot recall	3	
Non-dance related	1	
Footwear at the time of injury:		
Soft ballet shoes	1	3
Pointe	2	
Cannot recall	2	
Non-reported	1	
How many days absent from work because of injury during the last year:		
0	3	
2	1	
3		1
7	1	1
14		1
21	1	
Recurring injury:		
Yes	3	
Non-reported		1

Injury-related questions based on Bronner, et al. (2006) and Allen, et al. (2012)

The injuries occurred during the beginning (September, October) and end (May, June) of the theatre season, and in December, either in class/rehearsal or during shows. Most of the injuries were acute foot injuries that occurred during pointe work and jumps.

According to the classification of injury severity, proposed by Bronner, et al. (2006), half of the injured dancers had moderate injuries, resulting in 1-4 weeks absence from work. Two dancers (including the female dancer who experienced 2 injuries) did not leave work, so their injuries can be classified as either 'slight', or just as musculoskeletal complaints, rather than injuries.

A Chi-square test for independence—used to explore the relationship between gender and injury occurrence and between the position in the ensemble and injury occurrence—showed no significant association between gender and injury occurrence (Pearson Chi-square=0.04, p=0.85). On the other hand, it showed a significant association between position in the ensemble and injury occurrence (Pearson Chi-square=4.20, p=0.04), with a higher injury occurrence in the corps de ballet members as compared to the soloists.

Discussion

This preliminary retrospective study on injury occurrence in the Zagreb Croatian National Theatre ballet ensemble showed that two fifths of the surveyed dancers experienced injuries during the past year.

The injuries occurred during three distinct periods of the theatre season - the beginning (September, October), end (May, June), and during December. At the beginning of the season the dancers can be more prone to injuries (Byhring & Bø, 2002), since they are starting with rehearsals after the summer break, while at the end of the season the injuries might be affected by possible overtraining and burnout (Liederbach, Schanfein, & Kremenic, 2013). December is also a very busy period in which numerous performances of the 'Nutcracker' can lead to increased risk of injuries.

Most of the injuries were acute foot injuries that happened during pointe work and jumps. The predominance of foot injuries complies with the results of previous studies, such as the 10-year retrospective study by Ramkumar, et al. (2016), in which foot and ankle injuries were reported as the most prevalent in a professional ballet company, accounting for 40% of total injuries. On the other hand, our finding of a larger number of acute injuries differs from the results of previous studies that reported overuse injuries as more prevalent (Nilsson, et al., 2001; Smith, et al., 2015).

In this study, injury severity was classified by time loss, i.e. dancer's absence from professional activities. Half of the reported injuries were moderate injuries, causing 1-4 weeks of absence. These results are in line with the results of previous injury surveillance studies (Allen, et al., 2012; Byhring & Bø, 2002; Nilsson, et al., 2001).

Although some studies reported gender differences in injury occurrence (Wanke, Arendt, Helmgard, & Groneberg, 2013), in our study there was no significant relationship between gender and injury occurrence. This result partly conforms with the one of Nilsson et al. (2001), who reported no difference in the frequency of injuries between female and male dancers in a 5-year period, except for one season in which male dancers experienced significantly more injuries ($p<0.05$). On the other hand, the position in the ensemble was related to the injury occurrence in our study. Members of the corps de ballet experienced a significantly higher number of injuries. Similar results were reported by Allen et al. (2012), who described the members of the corps de ballet as the youngest in the ensemble, with least professional experience. The results of previous studies showed a significant difference in daily workload (both duration and intensity) between dancers of different rank in a ballet company, indicating a need to consider ranking in scheduling work activities to avoid increased injury risk due to fatigue (Twitchett, Angioi, Koutedakis, & Wyon, 2010b).

The main limitations of the study are the small number of participants and the retrospective design. The presented results cover only a part of the ensemble. The retrospective design using the self-reported data on injuries relies on the dancers' recollection of the injuries. Since the dancers are very used to being injured and dancing 'through injuries', it is possible that they forgot about some of the musculoskeletal complaints and injuries they experienced.

Conclusion

Due to a high volume of physical work, musculoskeletal injuries are very common in professional ballet dancers. This study described the injuries of the ballet dancers of the Croatian National Theatre in Zagreb during the past year. The type of injuries, as well as factors related to injuries, mostly conform to the professional ballet injuries reported in other studies. Since the reasons behind injury occurrence are multifactorial, the preventive efforts to reduce their number should rely on an ongoing prospective monitoring.

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References

1. Allen, N., Nevill, A., Brooks, J., Koutedakis, Y., & Wyon, M. (2012). Ballet injuries: injury incidence and severity over 1 year. *Journal of Orthopaedic & Sports Physical Therapy, 42*(9), 781-790.
2. Bronner, S., Ojofeitimi, S., & Mayers, L. (2006). Comprehensive Surveillance of Dance Injuries. A Proposal for Uniform Reporting Guidelines for Professional Companies. *Journal of Dance Medicine & Science*, *10*(3-4), 69-80.
3. Byhring, S., & Bø, K. (2002). Musculoskeletal injuries in the Norwegian National Ballet: a prospective cohort study. *Scandinavian Journal of Medicine & Science in Sports, 12*(6), 365-370.
4. Costa, M.S.S., Ferreira, A.S., Orsini, M., Silva, E.B., & Felicio, L.R. (2016). Characteristics and prevalence of musculoskeletal injury in professional and non-professional ballet dancers. *Brazilian Journal of Physical Therapy, 20*(2),166-175.
5. Liederbach M., Hagins M., Gamboa J.M. ,& Welsh T.M. (2012). Assessing and Reporting Dancer Capacities, Risk Factors, and Injuries Recommendations from the IADMS Standard Measures, Consensus Initiative. *Journal of Dance Medicine & Science*,*16*(4), 139-153.
6. Liederbach, M., Schanfein, L., & Kremenic, I.J. (2013). What is known about the effect of fatigue on injury occurrence among dancers? *Journal of Dance Medicine & Science, 17*(3), 101-108.
7. Nilsson, C., Leanderson, J., Wykman, A., & Strender, L.-E. (2001). The injury panorama in a Swedish professional ballet company. *Knee Surgery, Sports Traumatology, Arthroscopy, 9*(4), 242–246.
8. Peer, K.S., & Dubois, K. (2005). Preventing Dance Injuries, Part I: Biomechanical and Physiological Factors. *Injury prevention & performance enhancement, 9*(6), 60-62.
9. Ramkumar, P.N., Farber, J., Arnouk, J., Varner, K.E., & McCulloch, P.C. (2016). Injuries in a Professional Ballet Dance Company. A 10-year Retrospective Study. *Journal of Dance Medicine & Science, 20*(1), 30-37.
10. Smith, P.J., Gerrie, B.J., Varner, K.E., McCulloch, P.C., Lintner, D.M., & Harris, J.D. (2015). Incidence and Prevalence of Musculoskeletal Injury in Ballet. A Systematic Review. *The Orthopaedic Journal of Sports Medicine, 3*(7), 1-9.
11. Twitchett, E., Brodrick, A., Nevill, A.M., Koutedakis, Y., Angioi, M., & Wyon, M. (2010a). Does Physical Fitness Affect Injury Occurrence and Time Loss Due to Injury in Elite Vocational Ballet Students? *Journal of Dance Medicine & Science, 14*(1), 26-31.
12. Twitchett, E., Angioi, M., Koutedakis, Y., & Wyon, M. (2010b). The Demands of a Working Day Among Female Professional Ballet Dancers. *Journal of Dance Medicine & Science, 14*(4), 127-132.
13. Wanke, E.M., Arendt, M., Helmgard, M., & Groneberg, D.A. (2013). Occupational accidents in professional dance with focus on gender differences. *Journal of Occupational Medicine and Toxicology*, *8*, 35.

CHRONOLOGICAL DIFFERENCES IN ACQUISITION OF DANCE STRUCTURES' ELEMENTS EVALUATED BY COMPETENT JUDGES

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Abstract

The research was conducted on a sample of 20 male participants at the IDO World Championships in show dance 2014 finals held in Prague. The entire participants sample has been divided into three sub-samples defined on the basis of age groups (children, juniors and adults). The variables sample were scores awarded by seven individual judges for performance technique, composition, image and show. The main objective of the research was to determine levels, differences and dynamics of acquisition of technique, composition, show and image of different age dancers, by performing analysis of the individual judges' scores. Processing of the data obtained in this research was conducted by using standard statistical procedures. The results obtained indicated that acquisition of technical structures of dance increased together with the age group. Older the age group, higher was the technical training level and mastery over specific dance structures. The same situation was evident with other applied variables (composition, image and show), which is much higher among the adults than among the children and juniors.

Key words: *show dance, children, juniors, adults, scores, individual judges*

Introduction

Evaluation in dance has been defined by the International Dance Organization (IDO) rules and regulations. Top results of dancers are determined by a long-term process of learning the dance structures of movement. Evaluation in dance directs development of specific dance discipline and development of the very dancer, because the judges indicate the quality of performing specific choreographic routine by their score (Srdić, Kozarski, & Jovanovic, 2014). Competitions in dancing take place in rounds of competition, where a number of dancers passes to the next round based on certain score given by odd number of judges (usually 7) from different countries. Judges at IDO competitions are selected according to specific criteria, based on number of participation and quality of dancers in previous championships (IDO Dance Sport Rules, 2014).

Show dance is a very popular and unique dance discipline dominated by dance techniques of ballet, jazz ballet and contemporary and modern dance. The main task is to produce a show through technique and good dancing, while respecting the principles of good composition and good presentation of the dancers on stage with a striking aesthetic, visual, emotional and character expression. International Dance Organization (IDO) stipulated a method for scoring and evaluation of dance elements in such way as to evaluate performance technique, dancers' creativity, image and show of the dancers (IDO Dance Sport Rules, 2014). While judging at the show dance competition in 2014, a 4-dimensional scoring system of judging was used, where the dancers (dance numbers) were awarded a minimum of 1 and a maximum of 10 points in each dimension, so that each dancer received a minimum of 4 and maximum of 40 points. Dimensions at judging were technique (T), composition/choreography (C), image (I) and show (S) and TCIS system, has also been called a 4-dimensional judging system. IDO judging system with its well designed criteria and in particular bearing in mind the issue of the judges' impartiality with whom other dancing organisations meet while judging the dancers (Prosen & Zagorc, 2013; Dugi, 2015).

Work method

The participants sample in this research consists of male dancers, participants to the finals of the World Show Dance Championships 2014 in Prague. All participants forming the total number of 20 dancers, were divided into three sub-samples consisting of: children (under 11 years) - 7 participants, juniors (12-15 years) - 7 participants and adults (16 and above) - 6 participants.

For analysis of levels, difference and dynamics of development of the dance structures acquisition the scores by seven individual judges were analysed from the following elements: technique, composition, image and show. Qualifications and method of appointing the judges for the show dance competition, subject of the research, were defined by IDO rules and regulations.

Processing of the data obtained in this research was conducted by using standard statistical procedures. Results of participants of all age groups in all applied variables were first analysed by standard descriptive methods, and then the measures of central tendency and variability measures were calculated. The following values were calculated: arithmetic mean - *Mean,* minimum value - *Min,* maximum value - *Max,* standard deviation - *Std. Dev.* Discriminative value of the individual judges scoring, that is the relative variability of individual variables (scores) was assessed on the basis of these measures, which also tested the hypothesis of normal distribution of results (score): *Skewness coefficient and Kurtosis coefficient.*

Results and discussion

Table 1 shows basic statistical parameters of scoring for technique in the finals for participants of all three age groups and it is visible that the dancers of different age groups differ from each other in the individual judges' scores in the element of performance technique. Average values of the individual judges' scores for technique vary depending on the age group of the participants - dancers. There has been evident tendency for increase of average values of scores for performance technique from younger age groups (children) to the oldest age group (adults), which is similar to the results of evaluation of the technical dimension with gymnasts (Erceg, Kalinski, & Milic, 2014). The value of standard deviations and maximum and minimum results (scores) shows that the mostly expressed variability of scores is among the children age group, and the lowest among the adults age group (no score is lower than 7.00). Skewnness value among the children and juniors age groups have a negative sign indicating that arithmetic means are in the zone of higher scores. Kurtosis value indicates that distribution of scores among the juniors age group significantly deviates from normal distribution. Negative Kurtosis values among the children and adults age groups indicate that the curve is flattened and that there is a greater blur (platykurtic distribution) of the results. The junior age group is specific, since it includes larger age range, 12 to 15, and this may partly explain deviation from normal distribution. Intense and sudden changes due to puberty, and biological growth and development factors are specific for juniors and thus abilities to perform certain movement structures are limited from biological aspect. At the same time the effects of systematic training process are not to be ignored, which together with other factors significantly affect transformational processes of the dancers formation (Srdić et al., 2013).

Table 1: Basic statistical parameters of scores for performance technique in the finals

	N	Mean	Min	Max	St. Dev	Skewness	Kurtosis
Children	7	7.12	5.71	8.43	1.06	-.152	-1.994
Juniors	7	7.63	6.00	8.43	.78	-1.80	4.06
Adults	6	8.09	7.00	9.29	.80	.315	-.108

Table 2 shows basic statistical parameters of scores for dance structures composition in the finals for participants of all three age groups and analysis evidently showed that average values of the individual judges' scores for composition mutually vary depending on the age group of the dancers with very different variability. The best average values of scores for composition of dance structures were achieved by the adult age group dancers (8.14) and the lowest by the children age group (7.02). Such result is understandable and expected, given the length of systematic training and experience gained in the participants' competitions - dancers in the adult age group.

The value of standard deviations and maximum and minimum values of the scores indicate that the mostly expressed variability of the scores is among the children age groups and the lowest among the adults age group. Value of Skewness among all age groups indicates that distribution of scores does not deviate significantly from normal distribution. Value of Kurtosis has a negative sign and it is significantly less than 2.75 indicating that the results have a tendency, they are blur to a significant degree (platykurtic distribution). The reason for this value of Kurtosis may be seeked in non-homogeneity of the participants' sample (different age groups of the participants). Dancers in the adults age group have a higher level of acquisition of technique dance elements and thus their coaches - choreographers have more possibilities to combine them, that is create more demanding compositions. Accordingly, difficulty level of performance of dance structures is on different levels, as expected, due to the supposed systematic and gradual increase of knowledge and acquisition of dance structures and this probably reflected against the aforesaid differences in choreography, during the judging. Deviations from normal distribution while evaluating the dimensions of choreography could be explained by the fact that there is no strictly defined content of the choreography structure, which would indicate what elements should form the basic choreography structure. The aforesaid freedom of coaches and dancers in creating dance compositions may be different from expectations of judges and thus cause differences in distribution of results. It can also be assumed that the judges probably expect more of the dancers in the finals and during the evaluation they focus more on the mistakes while performing choreographies rather than the good sides of the composition. Given the importance of psychological preparation of dancers, the winner will probably be the one who is mentally more stable, because in case of minor differences between the dancers, the one that makes fewer mistakes while performing the choreography will have advantage.

Table 2: Basic statistical parameters of scores for performance composition in the finals

	N	Mean	Min	Max	St. Dev	Skewness	Kurtosis
Children	7	7.02	6.14	8.00	.66	.204	-1.240
Juniors	7	7.73	7.14	8.57	.59	.588	-1.87
Adults	6	8.14	7.14	9.43	.93	.391	-1.71

Table 3 shows basic statistical parameters of scores for image for participants of all three age groups. Shifting in the individual judges' average scores for image shows, as well as in other variables applied in the research, the tendency of increase from younger age group to the oldest age group of the dancers. The best average values of scores for image were achieved by the participating dancers of the adult age group (8.04), and the lowest by the children age group dancers (7.51), but significantly better in respect to the average values of scores for technique of dance structures performance (7.02). Value of standard deviations and maximum and minimum values of the scores indicate that the mostly expressed variability of the scores is among the children age group and the lowest among the adults age group. Value of Skewness among all age groups indicates that distribution of scores does not deviate significantly from normal distribution. Value of Kurtosis is significantly less than 2.75 which indicates that the results (scores) obtained were blur.

Table 3: Basic statistical parameters of scores for performance image in the finals

	N	Mean	Min	Max	St. Dev	Skewness	Kurtosis
Children	7	7.51	6.57	8.43	.638	.051	-.563
Juniors	7	7.81	7.14	8.57	.513	.204	-1.190
Adults	6	8.04	7.29	9.29	.742	.904	.327

Table 4 shows basic statistical parameters of scores for show for participants of all three age groups and analysis shows that average values of the individual judges' scores for show vary depending on the age groups with very different variability. It is not difficult to observe that participants - dancers of the adults age group, on average, have more expressive scores than the other age groups (8.04) which is completely understandable. Table 4 also evidently shows that the children have somewhat higher average values of the scores for show (7.53) compared to the average values of the score for previously evaluated dimensions, which implies that coaches consciously make efforts to improve the impression of the judges in this dimension. Values of standard deviations and maximum and minimum values of the scores indicate that the mostly expressed variability of the scores is among the children age groups, but equally so among the adults age group.

Table 4: Basic statistical parameters of scores for performance show in the finals

	N	Mean	Min	Max	St. Dev	Skewness	Kurtosis
Children	7	7.53	6.71	8.71	.736	.751	-.865
Juniors	7	7.81	7.29	8.57	.434	.629	.283
Adults	6	8.04	6.86	9.29	.893	-.017	-.972

Based on the results obtained it can be concluded that average values of the scores from all evaluated elements are the lowest with the children age group and the highest among the adults age group, as expected. The children age group has the highest average values of the scores for elements of show (7.53) and image (7.51), and the lowest average values of the scores for composition element (7.02) and technique elements (7.02). The reason for such results (scores) obtained can be attributed to the learning process and acquisition of specific motor skills in dance that the children are in. The situation is similar among the juniors age group where the highest average score is also for the elements of show and image (7.81), and the lowest for technique element (7.63), but significantly higher than the children age group which speaks of gradual process of learning and acquiring new dance knowledge and their focused development. In the adult age group, the highest average values were for composition (8.14) and technique (8.09), while the average values score for image and show were slightly lower and they were (8.04). Possible reason for these results can be attributed to higher expectations of evaluators in terms of stage appearance and show dimension, the so-called subjective dimensions while evaluating the dancers. Judges probably expect a high level of manifestation of image and show from the dancers, as well as a more significant influence of the choreographers among the dancers when these two dimensions are in question.

The fact that image and show among dancers have better scores could indicate that it is conditionally saying ''more easy'' for the choreographers to create a story (show) among the younger dancers groups, because the concept and idea of the story in these are more clear and are usually linked to specific topics such as characters from dance fairy tales, cartoons and appropriate topics for that age. That is in the line with Weeks (2005). On the other hand, it is logical that so much attention is given to image and show, because coaches - choreographers are aware that these are their chances for better success, given the low level of acquisition of dance technique elements which are evident in this research also. Finally, a question may be posed, How can a good show be created without a good dancing (technique), because, for development of the dancers, it is necessary to devote greater attention to the accuracy of technique performance compared to competitive success? (Morris, 2008). And this is certainly contrary to the principles of multilevel development of athletes. In general, it can be concluded that coaches, aware of the level of knowledge of dancers, in a competitive contest imposed a new game, in which they have invested and tried to impose other dimensions during evaluation. This could in turn indicate that the judges recognised the aforesaid aspirations and objectively evaluated the dancers. Determining possible correlations between the placements of dancers with certain dimensions during the judging, that is, existence of the judges' preferences in evaluation of dancers should be the subject of further research and analysis.

It is not difficult to conclude from the results obtained that acquisition of dance technical structures increases together with the age group, older the age, higher is the technical training level and mastery over specific dance structures. The same situation was evident with other applied variables, which is much higher among the adults compared to the children and juniors.

Conclusion

Based on the results obtained a tendency of the average results increase is evident from younger to older age groups. The adults age group has the highest scores from the individual judges for all the evaluated elements as it was expected, given the length of systematic training exercise and the experience they have gained in previous competitions.

The lowest average results for scores for all the evaluated elements were achieved by the children, which is understandable, because the children are in the process of learning and acquisition of specific motor skills in dance. The juniors age group achieved better results (scores) than the children, but lower than the adults.

It can be concluded from the results obtained that acquisition of dance technical structures increases together with the age group of the dancers, older the age group, higher is the technical training and mastery over specific dance structures. The same situation was evident with other applied variables (composition, image and show), which is much higher among the seniors than among the pioneers and juniors. Variability of the scores among juniors is explained by excessive age range, defined by IDO competition regulations (12-15 years). Choreographers knowingly ''force'' dancers in dimensions of image and show in younger age groups, given their lower level of technical elements acquisition.

Reference

1. Dugi, L. (2015). *Organisation and system of sport dance competition. [Unpublished thesis].* Čakovec: Medjimursko veleuciliste. [In Croatian]
2. Erceg, T., Kalinski, S. D., & Milić, M. (2014). The Score Differences between Elite European Junior and Senior Women Gymnasts. *Kinesiology: international journal of fundamental and applied kinesiology*, *46*(Supplement 2), 88-94.
3. International Dance Organization. (2014). *IDO Dance Sport Rules.* http://www.ido-dance.com/ceis/ido/rules/competitionRules.html (date accessed 12th November 2016)
4. Morris, G. (2008). Artistry or mere technique? The value of the ballet competition. *Research In Dance Education*, *9*(1), 39-54. doi:10.1080/14647890801924550
5. Prosen, J., & Zagorc, M. (2013). Pozitivni premiki tudi v športnem plesu-nov sodniški sistem 2.0. *Sport: Revija Za Teoreticna in Prakticna Vprasanja Sporta*, *61*. [In Slovenian.]
6. Srdić, V., Bajrić, O., Oreb, G., Lolić, V., & Zagorc, M. (2013). Regression analysis of connection between morphological, motor and functional abilities with the success of performance of technical elements in dance. *Acta Kinesiologica*, *7*(1), 60-65.
7. Srdić, V., Kozarski, D., & Jovanović, M. (2014). *Ples. [Dance.]* Banja Luka: Pan-European University "Apeiron" [In Serbian.]
8. Weeks, J. (2005). The Judges Weigh In. *Dance Magazine*, *79*(10), 6-10.

BASIC MOTOR ABILITES AND DANCING EFFICIENCY OF THE FEMALE STUDENTS AT FACULTY OF KINESIOLOGY IN ZAGREB

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Abstract

The aim of the study was to determine the correlation between motor abilities and the rate of efficiency in performing folk and social dances of 80 female students at Faculty of Kinesiology. Efficiency in dancing was represented by the marks given to the subjects after performing each dance by five experts on the basis of a video recording. The variables' sample to determine motor abilities consisted of the results achieved by measuring motor abilities of coordination, realization of rhythmical structures, balance, movement frequency, flexibility and explosive strength. Statistically significant relation between a predictor set of the students' motor abilities and the overall dancing efficiency criterion (R= 0.58), predictor set and the folk dances efficiency criterion (R=0.63) ($p<0.01$) was established by the means of regression analysis. The students with a higher level of rhythmic abilities, coordination, flexibility and movement frequency will be more successful in performing dancing structures.

Key words: *motor abilities, dancing efficiency, female students*

Introduction

Dance is a conventional aesthetic movement many authors consider a combination of sport and art (Bijelić, 2006; Šifrar & Zaletel, 2014). As a kinesiology operator, dance is functional from the transformational, educational and pedagogical effects (Li & Yoa, 2005). Different dancing techniques demand different hierarchy structure of basic motor and functional abilities as well as morphological characteristics of the dancers efficient in performing specific dancing techniques. According to the authors who have done research on efficiency in different dancing techniques, it is evident that the success in folk dances (Srhoj, 2002) is influenced by a high level of coordination in rhythm, agility of feet on the dance floor and repetitive strength of torso. The similar findings resulted from the research of Vlašić, Oreb and Furjan-Mandić (2007), in which the correlation between efficiency in performing folk dances and motor space is defined by realization of rhythmic structures, coordination, explosive strength and flexibility. The efficiency in doing sport, standard and Latin dances is conditioned by a somewhat different motor structure. Model of an ideal motor structure of a sport dancer was presented in the research of Uzunović, Kostić and Miletić, 2009, in which it was determined that coordination, movement frequency velocity, balance, coordination in rhythm and flexibility assessment variables account for 66% of the dancers' efficiency variance, while movement frequency velocity, explosive strength, static balance and flexibility assessment variables account for 71% of the efficiency variance of the standard dances' competitors. It has been established on the sample of Latin dancers that speed, coordination and flexibility have important influence on efficiency in competitions (Uzunović & Kostić, 2005). The authors Srhoj, Katić and Kaliterna (2006) (according to Šifrar and Zaletel, 2014) found that, regardless of the dance genre, general motor abilities of dancers are based primarily on power strength, coordination and frequency of movements, which is expected due to the choreographic structure of movement patterns.

On the basis of the above mentioned facts, a question arises, whether the female students (a motor selected sample, not dancers), who have higher level of basic motor abilities important for efficiency in folk and social dances, would be more efficient in demonstrating folk and social dances. The aim of the research was to establish a correlation between motor abilities and the efficiency of the female students at Faculty of Kinesiology in performing folk and social dances.

Methods

The sample of subjects consisted of 85 graduate female students at Faculty of Kinesiology, aged 21-23, who had passed the course Dance, attended by students in the 5th semester for 75 classes (15 theoretical and 60 practical, covers mastering 28 Croatian folk and 12 social dance). The dancing efficiency assessment variables have been marks of the judges for 5 folk and 5 social dances. The selected dances have been evaluated by five competent field experts on the basis of a video recording. A demonstration of five folk and social dances to the music that had been recorded beforehand, which ensured same conditions for all of the students (tempo, rhythm), followed. The judges had been instructed on assessment criteria, they were independent and the assessment was made simultaneously. Dancing competence has been evaluated using marks from 1-5 and the assessment results have been presented on the Likert's five degrees' scale. The course *Dance* plan, structural analysis of the particular dance, diversity of the rhythm and tempo as well as ethnic determination were taken into account when choosing the folk and social dances. The same criteria had been followed in the classes at the time of teaching and training. The group of the folk dances consisted of *Sotiš* (Adriatic dancing region), *Došla sam vam japa* (Alpine dancing region), *Slavonsko kolo* (Pannonian dancing region), *Poskočica* (Adriatic dancing region) and *Vrličko kolo* (Dinaric dancing region). The above mentioned dances cover all Croatian dancing regions, they are performed in pairs or circle and they have different rhythm and tempo. The group of social dances consisted of *English Waltz, Rumba, Cha-cha-cha, Samba* and *Slowfox*. The attention was given to the diversity of rhythm and tempo, the structure of movement and to the choice of dances that start from different initial positions (either right or left foot is the starting foot of the dancer) when social dances were chosen. Dancing images that should have been demonstrated in each dance were defined precisely. The variables' sample to assess motor abilities has consisted of the results achieved by measuring motor abilities (14 tests) for which the influence on dancing efficiency had already been determined in the previous research (Uzunović et al., 2005; Kostić, et al., 2006; Srhoj, et al., 2006; Vlašić, et al., 2007). The evaluation has been done using the following motor tests: Coordination: FEWB - *figure of eight with a bend,* OCB - *obstacle course backwards*, SS - *side-steps,* SS360 - *side-steps with a 360° turn.* Rhythmic structures' realization: DWR - *drumming without the rhythm*, DWFH - *drumming with feet and hands*, ORT - *Oreb's rhythm test*. Balance: S1FEO - *standing on a foot on the balance bench with eyes open*, S2FEC - *standing on both feet on the balance bench with eyes closed*. Frequency of movement: HT - *hand tapping*, FT - *foot tapping*. Flexibility: S&R- *sit-and-reach* and to evaluate explosive strength: SLJ – *standing long-jump*, SARGENT - *Sargent test* bibliography. The evaluation of motor abilities was done within the classes of the course Dance*,* after the planned course topics had been thought and trained.

Results

Table 1: Descriptive parameters of the individual dances evaluations, overall efficiency in performing folk dances (EPFD), overall efficiency in performing social dance (EPSD), total efficiency of the female students (TE) and descriptive parameters to evaluate motor abilities of the female students

Dance	AM	SD		Motor ability	AM	SD
Sotiš	3,49	0,70		**Fewb**	18,98	1,75
Japa	3,45	0,81		**Ocb**	9,97	2,13
Slkolo	3,11	1,05		**Ss**	9,34	0,73
Posko	3,63	0,88		**Ss360**	10,64	0,89
Vrlika	3,16	0,86		**Dwr**	16,74	2,14
Eng	3,40	0,85		**Dwfh**	14,26	3,27
Rumba	3,27	0,95		**Ort**	7,37	0,59
Cha	3,08	1,00		**S1feo**	7,86	6,29
Samba	3,11	0,87		**S2fec**	1,92	0,52
Slow	3,17	0,82		**Ht**	45,50	2,64
EPFD	16,84	3,67		**Ft**	38,27	4,54
EPSD	16,02	3,77		**S&r**	55,47	6,69
TE	32,85	6,53		**Slj**	196,30	19,16
				Sargent	39,00	5,23

The results of the descriptive parameters for evaluation of motor abilities of the female students (Table 1) point at an average mark, a little over 3, for folk and social dances, the highest mark being given for the dance Poskočica (3,63) and the lowest for Slavonsko kolo (3,11). The lowest average mark for social dances is for Cha-cha-cha (3,08) and the top one for English Waltz (3,40). When observing the average mark of the total success in performing folk (16,84), that is social dances (16,02), it becomes evident that the female students have been more efficient when performing folk dances. Descriptive indicators for evaluating students' motor abilities (Table 1) illustrate that the students achieved better test results when doing FEWB - *figure of eight with a bend* OCB, SS360 - *side-steps with a 360° turn*, DWFH - *drumming with feet and hands*, HT - *hand tapping*, FT - *foot tapping*, S&R- *sit-and-reach*) and SLJ – *standing long-jump.* It has been calculated an average correlation and Cronbach's reliability coefficient of the marks given by five judges for each of ten dances (Table 2). Correlation coefficients are higher than 0.85 for folk and 0.88 for social dances (p>0.05), which shows 72%, i.e. 87% agreement in the process of evaluating the students' efficiency in performing dances.

Table 2: Correlations of the judges' marks and Cronbach's reliability coefficient for each dance individually

Dance	Sotiš	Japa	Slkolo	Posko	Vrlika	Eng	Rumba	Cha	Samba	Slow
AVR	0.89	0.85	0.91	0.89	0.87	0.94	0.90	0.95	0.88	0.90
alpha	0.97	0.96	0.98	0.98	0.97	0.99	0.98	0.99	0.97	0.98

The relation between some motor abilities and efficiency in performing folk and social dances as well as the overall students' efficiency was determined by regression analysis (Table 3).

Table 3: Regression analysis of the motor abilities and the variables of the overall dancing efficiency (TE), folk dances' efficiency (EPFD) and social dances' efficiency of the female students (EPSD)

	Total efficiency R=0,58 R^2=0,34 Adj.R^2=0,20 F=2,367 p<0,01 Std. Err. =5,86					Folk Dances' Efficiency R=0,63 R^2=0,40 Adj.R^2=0,27 F=3,07 p=0,00 Std. Err. =3,14					Social dances' efficiency R=0,46 R^2=0,21 Adj.R^2=0,04 F=1,22 p=0,29 Std. Err.=3,70				
Female students	B	S.E.	Beta	t	p	B	S.E.	Beta	t	p	B	S.E.	Beta	t	p
Fewb	0,18	0,52	0,05	0,35	0,73	0,07	0,28	0,04	0,27	0,79	0,11	0,33	0,05	0,32	0,75
Ocb	-0,71	0,40	-0,23	-1,79	0,08	-0,37	0,21	-0,21	-1,73	0,09	-0,34	0,25	-0,19	-1,37	0,18
Ss	-0,09	1,59	-0,01	-0,06	0,96	-0,99	0,85	-0,20	-1,17	0,25	0,90	1,00	0,18	0,90	0,37
Ss360	-1,40	1,09	-0,19	-1,29	0,20	-0,41	0,58	-0,10	-0,71	0,48	-0,99	0,69	-0,23	-1,43	0,16
Dwr	0,83	0,40	0,27	2,11	0,04	0,43	0,21	0,25	2,02	0,05	0,41	0,25	0,23	1,64	0,11
Dwfh	0,45	0,24	0,23	1,89	0,06	0,27	0,13	0,24	2,08	0,04	0,18	0,15	0,16	1,22	0,23
Ort	-1,01	1,39	-0,09	-0,73	0,47	-0,43	0,75	-0,07	-0,58	0,57	-0,58	0,88	-0,09	-0,66	0,51
S1feo	-0,08	0,13	-0,07	-0,61	0,55	-0,11	0,07	-0,20	-1,69	0,10	0,04	0,08	0,06	0,47	0,64
S2fec	-1,25	1,45	-0,10	-0,86	0,39	-0,63	0,78	-0,09	-0,80	0,43	-0,63	0,92	-0,09	-0,69	0,50
Ht	-0,28	0,28	-0,11	-0,98	0,33	-0,25	0,15	-0,18	-1,66	0,10	-0,03	0,18	-0,02	-0,15	0,88
Ft	0,08	0,16	0,06	0,48	0,63	0,10	0,09	0,12	1,09	0,28	-0,02	0,10	-0,02	-0,16	0,87
S&r	0,15	0,11	0,16	1,32	0,19	0,10	0,06	0,18	1,63	0,11	0,05	0,07	0,09	0,72	0,48
Slj	-0,07	0,05	-0,21	-1,46	0,15	-0,04	0,03	-0,21	-1,51	0,14	-0,03	0,03	-0,16	-1,03	0,31
Sargent	0,06	0,17	0,05	0,34	0,73	0,01	0,09	0,01	0,11	0,91	0,05	0,10	0,07	0,45	0,66

The correlation between the motor abilities' predictor set of the female students and the criterion of the overall dancing ability is statistically significant (R=0,58) at the 0,01 fault level. The predictors with the highest contribution to the explanation of the correlation with the criterion are *DWR - drumming without the rhythm* (Beta=0,27) and *DWFH - drumming with feet and hands* (Beta=0,23) for rhythmic structures' realisation assessment at the 0,05 fault level and, with a slightly lesser contribution, the *OCB - obstacle course backwards* (Beta=-0,23) for coordination assessment. The correlation between the female students' motor abilities' predictor set and the folk dance efficiency criterion is statistically significant (R=0,63) at the 0,01 fault level. The predictors with the highest contribution to the explanation of the correlation with the criterion are *DWR - drumming without the rhythm* (Beta=0,25) and *DWFH - drumming with feet and hands* (Beta=0,24) for rhythmic structures' realisation assessment at the 0,05 fault level. The tests for coordination (*OCB – obstacle course backwards)* (Beta=-0,21), balance *(S1FEO - standing on a foot on the balance bench with eyes open*) (Beta=-0,20), frequency of movement *(HT - hand tapping)* (Beta=-0,18) and flexibility assessment *(S&R- sit-and-reach*) (Beta=0,18) show notably lesser contribution. No statistically significant correlation has been established between the variables' predictor set and the social dances' efficiency criterion.

Discussion

According to the descriptive analysis results (Table 1), the female students have achieved better results in performing folk (16,84) than social dances (16,02). Better realisation of the folk dances is caused by a strong aesthetic component of the social dances, which is extremely important when doing a demonstration, and this has represented an additional component for students who had to present it along with a good performing technique of specific dancing elements. The students got the highest average mark for dance Poskočica (3,63) and the lowest for Slavonsko kolo (3,11). When it comes to social dances, the highest average grade was for English Waltz (3,40) and the lowest for Cha-cha-cha (3,08). The most complicated folk, as well as social dances in regard to motor skills and rhythm have been evaluated with the lowest marks. The better results of the female students become apparent when the descriptive results of the motor abilities' assessment tests are analysed (Table 1) FEWB - figure of eight with a bend, SS360 - side-steps with a 360° turn, DWFH - drumming with feet and hands; HT - hand tapping; FT - foot tapping, S&R- sit-and-reach and SLJ – standing long-jump, which is partially in accordance with the previous study done on the sample of female students at Faculty of Kinesiology (Vlašić, 2006). Statistically significant correlation (Table 3) has been established between students' motor abilities and the overall dancing efficiency criterion (R=0,58) and the predictors with the highest contribution to the correlation with the criterion have been DWR - drumming without the rhythm (Beta=0,27) and DWFH - drumming with feet and hands (Beta=0,23) for rhythmic structures' realization assessment, and with a slightly lower correlation contribution has been OCB - obstacle course backwards (Beta=-0,23) for coordination assessment. Rhythmic structure realisation assessment tests confirmed once more an undoubtable influence of rhythmic abilities on the efficient realisation of dancing structures of the folk and social dances, which has already been confirmed in other numerous research on the correlation of motor abilities and dancing efficiency (Srhoj, 2002; Uzunović et al., 2005; Kostić, et al., 2006; Srhoj, et al., 2006; Vlašić, et al., 2007). The plan of the course Dance must be at a quite demanding level because an opulence of folk and social dances are being thought, trained and mastered in classes, so the correlation between rhythmic abilities' tests and the overall dancing efficiency of the female students is fully justified. Coordination as an ability the high level of which implies dancing efficiency, including at the same time rhythm coordination (Uzunović, et al., 2009; Lukić, Gerdijan, Bijelić, Zagorc & Radisavljević, 2012; Šifrar & Zaletel, 2014), has emerged as such in this study as well. The reason why OCB - obstacle course backwards proved to be the most significant of the four tests, is probably because the subjects have to move at the same time in a coordinated fashion and in an unusual way. The high level of ability expressed in this test must be present when performing different dances as well. Namely, dances involve moving in pairs, in circle, in different directions, while the given rhythm should be maintained at different tempo that can be changed even during a particular dance as well. The correlation between the students' motor abilities' predictor set and the folk dance efficiency criterion (R=0,63) (Table 3) is also statistically significant. The predictors with the highest contribution to the correlation with the criterion are DWR - drumming without the rhythm (Beta=0,25) and DWFH - drumming with feet and hands (Beta=0,24) for rhythmic structures' realization assessment at the 0,05 fault level, which is fully justifiable and expected and it is in accordance with all above mentioned. Furthermore, it is connected with the influence of rhythmic abilities on the dancing efficiency in general and in folk dances as well. The coordination (OCB-obstacle course backwards; Beta=-0,21), balance (S1FEO - standing on a foot on the balance bench with eyes open; Beta=-0,20), frequency of movement (HT - hand tapping; Beta=-0,18) and flexibility assessment tests (S&R- sit-and-reach; Beta=-0,18) distinguish from the other tests, together with the rhythmic strictures' realisation abilities' test, even though the former have a considerably lesser contribution to the explanation of the motor abilities' set with the folk dances' efficiency. Focusing onto these tests in particular, completes the picture of the motor abilities that have a crucial role in efficient performance of dancing structures, what numerous research conducted on the dancer sample have already proved (Uzunović, Kostić, 2005; Uzunović, at al., 2005; Kostić, et al., 2006; Uzunović et al., 2009). No statistically significant correlation has been determined by applying regression analysis between variables' predictor set and the female students' social dances' efficiency criterion (Table 3). Such results could be due to the fact that social dances follow folk dances in the topics' sequence of the course, and the same sequence has been applied for the video recording. In this way, less physical exertion was required by students and they were more relaxed, since they had already experienced learning and training quite demanding folk dances. It must also be stressed that social dances are closer and more familiar to the students than folk dances are.

Conclusion

Finally, it is possible to determine that the female students of Faculty of Kinesiology in Zagreb who performed better in tests on basic motor abilities relevant for doing folk and social dances efficiently have been evaluated with higher marks when demonstrating dances. In other words, there has been established the correlation between rhythmic structures' realisation, coordination, balance and flexibility assessment tests and dancing efficiency on the sample of female students who are not dancers, which has previously been established on the sample of dancers, which furthermore contributes to the fact that dancing efficiency is defined by the above mentioned motor abilities.

References

1. Bijelić, S. (2006). Plesovi. Banja Luka: Atlantik BB.
2. Kostić R, Uzunović S, Zagorc M, Oreb G, & Jocić D. (2006). Relations of success in Latin-American dances with coordination abilities. 12. FIS komunikacije, nacionalnog naučnog skupa sa međunarodnim učešćem [The 12th FIS communications, national scientific conference with international participation]. Niš: Fakultet fizičke kulture; 2006. 33 p.
3. Li, X.-X., Yao, Y. (2005). Effect of dance-sport on physical-psychological health of uneversity students. *Chinese journal of Clinical Rehabilitation, 9(40),*19-192
4. Lukić A, Gerdijan N, Bijelić S, Zagorc M, & Radisavljević L. (2012). Motor skill efficiency as a quality predictor of technical performance in dance sport. *Serb J Sports Sci. 6(2),* 77-82.
5. Srhoj, L. (2002). Effect of motor abilites on performing the Hvar folk dance cicilion in 11-years old girls. *Collegium Antropologicum, 26(2),*539-543.

6. Srhoj, LJ., Katić, R., Kaliterna, A. (2006). Motor abilities in dance structure performance in female students. *Collegium Antropologicum*, *30(2)*, 335-341.
7. Šifrar, T.,& Zaletel P.(2014). The influence of motor abilities and morphological characteristics on the performance of sports dancers. *Acta Kinesiologica*, 8(2),48-54.
8. Vlašić J., Oreb G., Furjan-Mandić G. (2007). Motor and morphological characteristics of female university students and the efficiency of performing folk dances. *Kinesiology*, *39(2007),* 1:49-61.
9. Uzunović, S., Kostić, R., Zagorc, M., Oreb, G., & Jocić, D. (2005). The effect of coordination skills on the success in standard sports dancing. In N. Dikic, S. Zivanic, S. Ostojic & Z. Tornjanski (Eds.), *Book of Abstracts of 10th Annual Congress European College of Sport Science, Belgrade*, 2005. (pp. 270-271). Belgrade: Fakultet sporta i fizičkog vaspitanja.
10. Uzunović, S., & Kostić, R. (2005). A study of success in Latin American sport dancing. *Facta universitatis, 3(1)*, 23-25.
11. Uzunović, S., Kostić, R., Miletić, Đ. (2009). Motor status of competitive young sport dancers-gender differences. *Acta Kinesiologica*, *3(1)*, 83-88.

PHYSICAL LOAD AND ENERGY EXPENDITURE IN RECREATIONAL DANCE: SWING, ZUMBA AND SOCIAL DANCE

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Introduction

Regular physical engagement with recreational sports is among the important components of a adult healthy lifestyle. In sports and recreational disciplines is relevant to what intensity they are carried out, since their aim is the positive impact on both the cardiovascular and the respiratory system, as well as on muscle and energy system. Dancing can be good option to maintain motor and functional abilities long into old age and, in particular, the development of coordination, flexibility, balance the repetitive strength (Keogh et al., 2009).

Various surveys established that recreational dancing helps make the best of both physical, health as well as mental fitness (Hopkins et al., 1990). At the Mayo Clinic researchers carried out several studies about recreational dancing: positive effect on muscle tone, improved coordination, reduced stress, increased energy and strength. National Heart, Lung and Blood Institute (NHLBI) has proven dancing to reduce the risk of heart disease, reduce blood pressure, regulate body weight and to strengthen bones in the leg muscles of the pelvic girdle also reduces the risk of developing Alzheimer disease and dementia.

Loads of sport dance are high as sport dancers reach the heart rate (HR) of 192 beats per minute (bpm) in quickstep and even more in most Latin-American dances up to 210 bpm (Zagorc, Karpljuk & Friedl, 1999). Similarly, authors found that the average HR of Slovenian sport dancers of all ten dances (Latin-American and ballroom dances) amounted to 187.2 bpm, while in jive and quickstep HR was more than 200 bpm, which means that dancers stayed half of the time in the level of high-intensity load (80-90%) during dance competition. (Zagorc, Karpljuk & Friedl, 1999). Sport dancers achieved maximum HR while dancing Latin-American dances, especially passodoble (includes a lot of jumps, quick movement around the dance area) and jive (containing jumping, leaps, music for this dance is the fastest of all - like music for rock'n'roll dance).

Several researchers also examined the energy consumption in dance. Blanksky and Reidy (1988) found that intensity during dancing modern dance and the Latin-American dances was on level more than 80% of their maximum oxygen consumption. Hollmann and Hettinger (Zagorc 2000) noted that oxygen consumption during dances ranged between 43 to 61 ml/kg/min. Therefore, researchers concluded that requires extraordinary anaerobic and aerobic capacity.

Zumba as a popular form of dance aerobics has in comparison with other forms of aerobics (step and Body Pump) the highest energetic consumption (Leitgeb, 2016). La Crosse Exercise and Health Program at the University of Wisconsin showed on average exercising HR 154 bpm, which represented 79% of the maximum HR. The average energy consumption of the exercising amounted to 370 Kcal in one training unit. In accordance with the guidelines of exercising in reaching goals to improve cardio vascular capacity, we should practice in the range of 64-94% of maximum HR or 40-85% VO2 max. The exercising to maintain weight or lose some weight, we should exercise in units of at least 300 kcal. (ACSM, 2010). The level of intensity largely depends on the teacher how much he is able to motivate participants (Otto et al., 2011).

In general, in one-hour training people consume from 400 to 800 Kcal, depending of course on the style of dance and how the dancers move around the room. Social dancers, measured by pedometers, travel in one training unit (1 hour) almost eight km (Mayo Clinic research centre, 1994). Total consumption of energy in the social dancing was 265 Kcal/hour, swing dances 235 kcals/hour while aerobics workout energy consumption was over 540 kcals/hour (Vaszily, 2005).

As can be seen from the results of various studies and comparisons between them, delivering accurate results of energy consumed in recreational dance is quite a challenging task, because of an effect of large number of factors. Also the self-engagement, enthusiasm and desirability of a participant probably contribute to the higher or lower level of consumed energy.

In our study we try to analyze the physical loads and energy consumption of recreational dancers who attended dance classes of social dance, Zumba dance aerobics and swing at various dance schools in Slovenia. We wanted to determine whether there are statistically significant differences in workload and energy consumption between different styles of dance disciplines and different age categories. We compared group of social dances which consisted of some standard and Latin American dances (English waltz, Cha-cha-cha, disco hustle, samba, jive, Viennese waltz, quickstep, blues), group of aerobic dance Zumba as a high-intensity dance exercise in latino rhythms, and group of Swing, dance from the 50s and 60s years with a high tempo and demanding choreography (6 stepper swing, lindy-hop, jive).

Methods

The sample represented 140 dancers aged 20 to 70 years, who danced three different dance styles: social dance (93) swing (12) and Zumba (35). All three groups were tested according to a predetermined protocol, which includes 60 minutes of recreational sports with a 5-second breaks between dances. For a comparison of the load and energy consumption by age, we divided sample into three age groups: the youngest age group, made up of all recreational dancers under the age of 40 years, second group between 40 and 60 years of age and the third group consisted of participants aged over 60 years. The reasons for doing so were mainly in the aspects of how the examinees from different age groups are active in everyday life. The first group is composed of pupils, students and workers who had somehow only just started to work and so we expect them to be the most active group. The second group consisted of people who are in the workplace already well established, as well as those who are just about to retire. Last, the third group represented the people who have already retired. Depending on the type of which we have studied social dancing, second group was expected to be the most numerous; we had 25 subjects in the age first group, 50 in second and 18 in third age group. Participants also answered questionnaires about their personal data.

The music was created for social dance groups. The length of the music was at 2 minutes and 30 seconds. So dancers always follow the sequence of two same dance, the first selection at a slower pace, the other with a faster pace. Break between dances amounted to five seconds.

The only variable that we have not managed to unify was the involvement of teachers and their individual approach to the selection of dance steps. Choreography by itself can affect the intensity of the dance, but despite the various steps on the recreational level, there are no large differences in the intensity of their own performance. Thus, we can neglect different selection steps.

Heart rate (HR) and energy consumption were measured with a Polar team2 system, where the data is collected in real-time to a central computer. For statistical analysis, we used the SPSS program. To determine the differences in HR and energy consumption in different groups, as well as by dance style and age, we used one-way analysis of variance (ANOVA).

Results

It is obvious from the actual average value that the average HR decreases according to the age group (Table 1). All participants performed equally long workout, dancing to the same music at the same speed, and in some places have all had the same choreography. In the youngest age group, the average HR is considerably higher than in the oldest age group, the difference is 23 beats bpm. However, the percentage share, which represents a level of intensity of each age group according to their maximum possible value is almost the same. Minimal differences showed that the activity of the recreational dance class for each individual represents the same load in relative terms to their age.

Table 1: Comparison of average HR between the different age groups

	Under 40 years		40-60 years		Over 60 years		F	p(F)
	AVG	SD	AVG	SD	AVG	SD		
HR (bpm)	129,9	15,8	119,4	15,4	107,2	13,7	11,624	,000 *

Comparison of energy consumption in three different age groups showed about the same energy consumption (663-680Kcal). Comparison of both load and energy consumption in a given training unit showed no statistically significant difference. Recreational dancing exercise has obvious the same influence on participants of different ages.

Table 2: Comparison of HR, energy consumption, age, the maximum average heart rate, the average percentage of the maximum HR in different age categories

	Under 40y.	40-60 y.	Over 60 y.
Average HR (bpm)	130	119	107
Average energy consumption (Kcal)	663,12	680,04	668,3
Average age (years)	32,44	49,86	66
Average max HR (bpm)	187,56	170,14	154
Average percentage of max HR (%)	69,2%	70,2%	69,6%

Comparison of the load between different dance groups showed, that Zumba exercise is energetically much more demanding than social dance and swing, as well as its own form of exercise is much more dynamic and intense throughout the training unit.

Average HR of the whole group of social dances amounted 127 bpm, but there were individuals who have had an average HR over entire workout from 174 to 157 bpm, which accounted for 90.2% and 85.6% of maximum HR, or the highest intensity level of exercise. In Zumba exercise, the mean HR of the exercising was much higher, with the average for the whole group 160 bpm. Individuals in Zumba also achieved the average of 187 and 178 bpm, which accounted for 97.6% and 93.6% of their maximum possible HR, which is high intensity work, already in the area of anaerobic activity. Swing is a much more specific dance form of recreation, so we had available a small number of subjects, namely 12 dancers. The design exercise was quite similar to that carried out in the course of social dances, so we expected similar results also in this dance group. Average HR of the whole group was slightly higher than that of social dances and amounted on average 134bpm. However, none of the individuals did not achieve markedly higher average HR, the highest amounted to 153 and 151 bpm, which accounted for 78.9% and 79% of their maximum possible HR.

Table 3: Heart rates in different dance groups and differences in intensity between dance styles

	Social dance		Zumba		Swing		F	p(F)
	AVG	SD	AVG	SD	AVG	SD		
HR (bpm)	126,99	15,06	159,86	10,74	134,4	10,8	60,408	,000 *

Zumba is in terms of intensity far in the foreground, as on average subjects exercised with 84.3% of their maximum possible HR, swing dancers with 69.3% of their maximum HR, social dancers with 68.9% of maximum HR.

Table 4: Post Hoc test in HR between groups

Dependable variable	(I) Group	(J) Group	p(F)
Average HR (bpm)	Social dance	Zumba	**,000**
		Swing	,087
	Zumba	Social dance	**,000**
		Swing	**,000**
	Swing	Social dance	,087
		Zumba	**,000**

When comparing the results regarding to the percentage of maximum HR, swing dance and social dances represents virtually the same load for the exercising, since the higher difference in average HR values in swing are primarily the result of a younger participants of swing dance classes. The results of a post hoc test indicate that differences in the exercising load occurred between the social dances and Zumba, also between swing and Zumba.

Zumba seems to be most energy demanding of all the three dance styles, with an average consumption of the entire group amounted to 783 Kcal in training unit. The average HR in Zumba was quite similar and we did not record large variations between individuals. Otherwise has happened with energy consumption. Here we had individuals who spent the 1500 Kcal in the training unit, the lowest energy consumed was 576 Kcal. The average energy consumption of the social dance group was 657 Kcal per exercise unit and in swing dance on average 709 Kcal. There have been significant differences between individuals as well in average HR as in energy consumption, which can be attributed to the different engagement of each individual, as all the other conditions were the same (speed and length of the music, the complexity of choreographies, etc.). Obviously the decision for individual intensity of movement is crucial in overall energy consumption in one exercise unit. Some of the dancers were very enthusiastic and involved - through the whole training unit practiced in a much higher pace and perform movements with greater amplitude and greater energy input (Figure 1).

Results of the load and energy consumption in three dance styles clearly emphasized maximum of energy consumed in Zumba, followed by the swing, the lowest energy consumption presented in social dances. In any case, our results showed that in all three dance styles comes to large energy consumption during an exercise unit.

The results of a post hoc test indicate that only statistically significant difference in energy consumption occur between the social dances and Zumba.

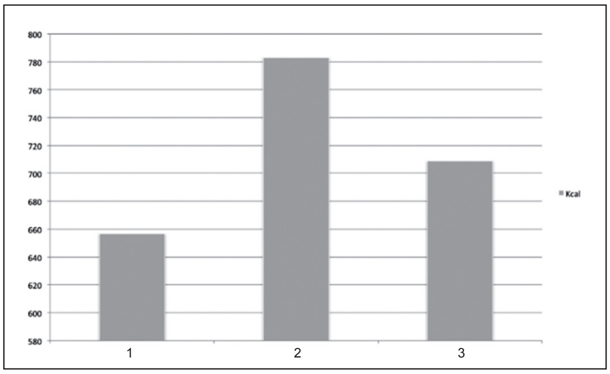

Figure 1: Energy consumption in social dance (1), Zumba (2) and swing (3)

Conclusion

Dealing with sport and recreational activities both in Slovenia and around the world is increasing. The data analysis showed that the recreational dance in terms of load and energy consumption is considerably more complicated than it looks at first glance. The reason for this can be attributed to the considerable complexity of the movement, broad age range of participants and a large number of different dance styles, which each in its own way require different intensity of individual participation in dancing.

There have not been a lot of research measuring the workload and energy consumption during recreational dancers. Among those who have been available to us, we can draw some parallels especially with a load in Zumba. Compared with all other dance exercise programs, maximum values of HR are reached in Zumba exercise.

Larger deviations arise from the energy consumed. The subjects from the University of Wisconsin on average spend 570 Kcal, from Adelphi University 396-444 Kcal, but our subjects spent 783 Kcal, all in a one-hour workout. Such variations in Zumba are probably consequence of different choreography selection for each training unit. In addition, the intensity also largely depends on the teacher's ability of leading the exercise and power of his/her motivation.

Male dancers spend 769 Kcal/hour, the female dancers 579 Kcal/hour, as the entire group on average spent 674 Kcal/hour. Given the fact that dancers carried our entire spectrum of social dance program, results coincide with the findings from the Mayo Clinic (400-800 Kcal consumed in hour of exercise, depending mainly on the style of performed dance).

Vaszily (2005) published otherwise; the average energy consumption in its trial was 265 Kcal/hour, which is significantly less than the above-mentioned research. Given the fact that it was not possible to obtain sufficiently precise information on the progress of his measurements, his differences can be interpreted in several ways. Our dancers were conducting an active dancing throughout the exercise, which is not always the practice of social dance courses, where there is a lot of pauses during the teaching. Our sample of measured subjects covered a very wide age range, which definitely affects the average energy consumed by the group. Many times we notice the lack of younger age groups in the social dances courses.

The results of our research will contribute to the understanding of dance as a form of recreational exercise, which can be performed also in high intensity and has positive effects for the individual and his or her health. The obtained results of the study may also help in designing programs in recreational exercise for all older people who need qualitative physical activity. Results also provide the necessary guidance on how to better organize recreational dance classes. In addition, they allows us more precise selection of dance styles; depending of course on what we want to achieve with exercise.

References

1. ACSM (American College of Sport Medicine) (2010). *Guidelines for Exercise Testing and Prescription*.
2. Blanksky, B.A., Reidy, P.W. (1988). Heart rate and estimated energy expenditure during ballroom dancing. Br. J. sport Med., 22(2): 57-60.
3. Darby, L.A, Browder, K.D., Reeves, B.D. (1995). The effects of cadence, impact and step on physiological responses to aerobic dance exercise. Res Q Exerc Sport, 66(3): 231-238.
4. Hopkins, D.R., Murrah, B., Hoeger, W.W. & Rhodes, R.C., (1990). Effect of lowimpact aerobic dance on the functional fitness of elderly women. *Gerontologist*, 30: 189-192.
5. Keogh, J., Kilding, A., Pidgeon, P., Ashley, L. & Gillis, D. (2009). Physical benefits of dancing for healthy older adults: A review. *Journal of Aging and Physical Activity*, 17: 479–500.
6. Kirkendall, D.T., Calabrese, L.H. (1983). Physiological aspects of dance. *Clin Sports Med*, 2(3): 525-537.
7. Koutekadis, Y., Sharp NCC. (1999). The fit and healthy dancer. Chichester: John Wiley and Sons.

8. Leitgeb, L. (2016). Body composition and heart rate of women participating different aerobics exercise – bachler thesis. Ljubljana: Faculty of Sport.
9. Mayo Clinic research centre (1994). Social dancing. Available on: http://www.nbea.com/archives6.htm
10. Mayo Clinic (2011). *Metabolism and weight loss: How you burn calories*. Available on http://www.mayoclinic.com/health/metabolism/WT00006
11. Otto, R.M., Maniguet, E., Peters, A., Boutagy, N., Gabbard, A., Wygand, J.W. et al. (2011). The energy cost of Zumba exercise. *Medicine and Science in Sports and Exercise*, 43(5): 329.
12. Vaszily, B. (2005). *The Health Benefits of Dancing -- Including Specific Benefits of Different Dances*, available on http://ezinearticles.com/?The-Health-Benefits-of-Dancing----Including-Specific-Benefits-of-Different-Dances&id=92587)
13. Zagorc, M. (2000). Družabni in športni ples. Ljubljana: ZPVUT, Plesna zveza Slovenije.
14. Zagorc, M., Karpljuk, D., Friedl, M. (1999). Analysis of functional loads of top sport dancers. In: MILANOVIĆ, Dragan (Ed.). 2nd International Scientific Conference Kineziology for 21st century, Dubrovnik, Croatia, 22. - 26. 09. 1999. *Kineziology for 21. century : proceedings book*. Zagreb: Faculty of Kinesiology: 240-243.

THE EVALUATION OF CROATIAN VERSION OF SOCIAL GOAL ORIENTATION SCALE

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Abstract

Social goal orientation scale by Stuntz and Weiss (2003), consisting of three subscales measuring coach praise, friendship and peer acceptance, was translated to Croatian and extended by an item for each subscale. The aim of this study is to evaluate the metric properties of Croatian version of the Social goal orientation scale. For that purpose, the scale was applied to the sample of 257 junior basketball and football players, aged 16 to 18 years. Factor validity of the scale was established by principle component analysis with varimax rotation of axes. Three factors were extracted; their interpretation confirms that translated version measures the same latent dimensions as original scale. The reliability of subscales assessed by Cronbach's alpha coefficients exceeds 0,85 for each subscale. The conclusion is that Croatian version of Social goal orientation scale have good metric properties and is suitable measure for Croatian adolescent athletes.

Key words: *personal and situational factors, sport success, metric properties*

Introduction

Goal perspective theory by Nicholls (1989) greatly influenced the research in the field of motivation. The concept of task and ego orientation was, and still is one of the most studied in the sport psychology. It is undeniable that the construction of The Task and Ego Orientation in Sport Questionnaire (TEOSQ; Duda & Nicholls, 1992) helped researchers to enter the field of study. The same happened in Croatia; the publication of translated TEOSQ (Barić et al., 2002) activated the rising interest in the orientation research. Although the social goal orientations were early mentioned as probable important factors in describing and explaining achievement behavior (Urdan and Maehr, 1995), they were neglected in sport psychology until construction of Social goal orientation scale by Stuntz and Weiss (2003). In this work, Croatian version of Social goal orientation scale is presented and evaluated, with aim to help future researchers of Goal perspective theory in sport.

Methods

Social goal orientation scale by Stuntz and Weiss (2003) was developed to measure friendship, peer acceptance, and coach praise as ways of defining success in youth sport. It consists of three subscales; each of them have five items with responses on a five-point Lickert-type scale (1 = strongly disagree, 5 = strongly agree). The scale was translated and modified by D. Crnjac for his doctoral research (Crnjac, 2017) done on the samples of athletes from combat sports. The questionnaire was translated with the help of two sport psychologists; one item was added to each subscale making the total of 18 items. The original items in English are in Table 1; translated items in Croatian are in Table 5. The total result in subscales is defined as unweighted sum of item results.

The scale was given to the sample of 257 junior basketball and football players, aged 16 to 18 years. They were measured in small groups, in their sport clubs. Ethics approval of the research was obtained by the Faculty of Kinesiology's Research Ethics Committee; the permissions were acquired from the sport clubs and parents of the athletes.

All data analyses were done by software package Statistica 13.

Results and discussion

The metric properties of three subscale items are in the Table 1. All the items in all three subscales have high projections on the first principle component of each subscale, and show remarkable item-total correlations. The means of items are near, or not to far from the central value 3. In all 18 items, the full range of answers (1-5) is observed; standard deviations confirm adequate variability of the results.

The metric characteristics of the total result of subscales are in Table 2. In all three subscales only one eigenvalue greater than 1 was observed; the percentages of total variance explained are very high. The average inter-item correlations exceed 0,5; in all three sets, the lowest observed correlation is 0,36. Therefore, regardless small number of items, the values of Cronbach's alpha coefficient are high; the lowest estimation of reliability is 0,85 for the third scale. In this research, internal consistency of three subscales is higher than calculated by Stuntz and Weiss (2003). For the Coach praise orientation, Friendship orientation and Peer acceptance orientation subscale, Stuntz and Weiss (2003) report Cronbach's alpha coefficients of 0,80, 0,77 and 0,75, respectively. The values are remarkably lower than obtained in this study, even when coefficients are determined on the set of original five items (Table 1). The participants in Stuntz and Weiss (2003) research were much younger (11 - 15 years) compared with participants in this study (16 – 18 years); it is possible that the concept of social goal orientation is not fully developed in younger adolescents, and it is possible that the age can generate lower reliability of the questionnaires measuring it.

The correlations of the total results in the Coach praise orientation, Friendship orientation and Peer acceptance orientation subscale (Table 3) confirm that Social goal orientation scale consists of three correlated, but distinct subscales. The component analysis (Table 4 -6) confirms that the scale measures three separate latent dimensions. Spectral decomposition of 18-item correlation matrix of the Social goal orientation scale resulted with three eigenvalues greater than one. The principle axes in oblique varimax position show very well defined structure, almost ideal simple structure with clearly recognized Coach praise orientation, Friendship orientation and Peer acceptance orientation factors. At the same time, projections on the first principle component show that all the items belong to the same set and measure the same object of measurement. The correlations of the oblique varimax factors confirm the existence of a dimension of higher rank.

Table 1: Descriptive statistics, values on first principle component and item-total correlations of the Croatian version of Social goal orientation scale

		Mean	SD	K1	Rit	A_{min}
Coach praise orientation						
1.	My coach praises my performance.	3,13	1,018	-0,780	0,654	0,846
2.	My coach praises me.	3,18	0,994	-0,808	0,699	0,839
3.	My coach smiles and cheers.	3,40	1,082	-0,785	0,684	0,841
4.	My coach tells me I did a good job.	3,79	1,059	-0,799	0,694	0,839
5.	I please my coach when I perform well.	3,82	0,986	-0,789	0,682	0,842
6.	When I have a bad day, my coach helps me to get better. (*Added by Crnjac*)	3,39	1,207	-0,708	0,590	0,861
Friendship orientation						
7.	I have a close sport friend who cares about my feelings.	3,54	1,042	-0,834	0,742	0,861
8.	I have a close sport friend that really understands me.	3,60	1,034	-0,849	0,762	0,858
9.	My sport friend looks out for me.	3,42	1,066	-0,828	0,736	0,862
10.	I share experiences with a close sport friend.	3,72	1,012	-0,759	0,653	0,875
11.	My sport friend encourages me after I make a mistake.	3,79	1,021	-0,754	0,648	0,876
12.	Boys from my club would never hang me out to dry. (*Added by Crnjac*)	3,75	1,038	-0,770	0,669	0,873
Group acceptance orientation						
13.	Everyone on the team wants me for a friend.	3,59	0,911	-0,834	0,595	0,838
14.	Other kids on my team pay attention to what I say.	3,21	1,064	-0,849	0,569	0,842
15.	Teammates want to be with me.	3,49	0,932	-0,828	0,725	0,817
16.	I often get asked to play with teammates.	3,52	0,992	-0,759	0,722	0,816
17.	I'm the most popular person on my team. (*Initially from Ego orientation scale of TEOSQ; Duda & Nicholls, 1992*)	2,95	1,295	-0,754	0,651	0,830
18.	When I want a company to go to the movie or need somebody to play video games with me, I always find someone from my club. (*Added by Crnjac*)	3,44	1,261	-0,770	0,639	0,832

Legend: SD = Standard deviation; K1=value on the first standardized principle component; Rit=item–total correlation; A_{min}=value of Cronbach's alpha coefficient if item is deleted from the total result.

Table 2: Metric properties of the total result in the Coach praise orientation, Friendship orientation and Group acceptance orientation subscales of the Social goal orientation scale

Subscales of Social goal orientation scale	**Coach praise orientation**	**Friendship orientation**	**Group acceptance orientation**
Number of items	6	6	6
Number of valid cases	257	257	257
Mean	20,71	21,83	20,19
Standard deviation	4,932	4,967	4,954
Minimum value	6	6	6
Maximum value	30	30	30
First eigenvalue of correlation matrix and percentage of total variance	3,64037 (60,67%)	3,84037 (64,01%)	3,55137 (59,19)
Average inter-item correlation	0,535	0,571	0,515
Cronbach's alpha coefficient of reliability	0,867	0,887	0,854
Standardized Cronbach's alpha coefficient	,870	0,887	0,861

Table 3: The correlations of total result in the Coach praise orientation, Friendship orientation and Peer acceptance orientation subscale

Subscale	Coach praise	Friendship	Peer acceptance
Coach praise	1,000	0,281	0,302
Friendship	0,281	1,000	0,666
Peer acceptance	0,302	0,666	1,000

Table 4: The eigenvalues greater than one of 18-item correlation matrix of the Social goal orientation scale, and the percentage of total variance explained

	Eigenvalue	Percentage of total variance
1.	6,857469	38,097
2.	2,967263	16,485
3.	1,409899	7,833

Table 5: Results of component analysis with oblique varimax rotation of 18 items of Social goal orientation scale

	Item	**K_1**	**K_2**	**K_3**	**F_1**	**C_1**	**F_2**	**C_2**	**F_3**	**C_3**
1.	My coach praises my performance.	-,423	,653	,223	-,082	-,137	**,768**	**,222**	,242	,095
2.	My coach praises me.	-,515	,623	,180	,017	-,104	**,781**	**,220**	,274	,083
3.	My coach smiles and cheers.	-,397	,690	-,110	,109	,013	**,795**	**,236**	-,032	-,087
4.	My coach tells me I did a good job.	-,469	,644	-,072	,147	,007	**,784**	**,226**	,053	-,056
5.	I please my coach when I perform well.	-,483	,620	-,031	,137	-,008	**,769**	**,219**	,098	-,031
6.	When I have a bad day, my coach helps me to get better.	-,436	,557	-,284	,295	,114	**,696**	**,200**	-,102	-,164
7.	I have a close sport friend who cares about my feelings.	-,729	-,186	-,384	**,804**	**,273**	,154	-,006	,206	-,122
8.	I have a close sport friend that really understands me.	-,730	-,207	-,402	**,824**	**,284**	,135	-,012	,200	-,129
9.	My sport friend looks out for me.	-,709	-,275	-,361	**,806**	**,270**	,064	-,035	,236	-,103
10.	I share experiences with a close sport friend.	-,693	-,263	-,097	**,615**	**,143**	,064	-,035	,420	,034
11.	My sport friend encourages me after I make a mistake.	-,602	-,305	-,331	**,724**	**,249**	-,009	-,051	,202	-,093
12.	Boys from my club would never hang me out to dry.	-,727	-,182	-,138	**,638**	**,157**	,152	-,008	,387	,008
13.	Everyone on the team wants me for a friend.	-,631	-,230	,383	,243	-,094	,058	-,035	**,732**	**,280**
14.	Other kids on my team pay attention to what I say.	-,604	-,237	,280	,296	-,047	,042	-,037	**,640**	**,224**
15.	Teammates want to be with me.	-,698	-,186	,461	,221	-,129	,126	-,018	**,819**	**,323**
16.	I often get asked to play with teammates.	-,693	-,204	,403	,263	-,100	,109	-,023	**,777**	**,293**
17.	I'm the most popular person on my team.	-,669	-,139	,192	,365	-,010	,160	-,002	**,587**	**,174**
18.	When I want a company to go to the movie or need somebody to play video games with me, I always find someone from my club.	-,705	-,119	,120	,431	,025	,195	,007	**,549**	**,137**

Legend: K= projection on principle component; F=varimax factor loadings; C= factor score coefficients

Table 6: The correlations of the oblique varimax factors interpreted as Coach praise orientation, Friendship orientation and Peer acceptance orientation subscale

Factor	Friendship	Coach praise	Peer acceptance
Friendship	1,000	0,280	0,705
Coach praise	0,280	1,000	0,307
Peer acceptance	0,705	0,307	1,000

Conclusion

The study of metric properties of Croatian version of the Social goal orientation scale by Stuntz and Weiss (2003) confirms that translated and extended version is appropriate instrument for adolescent population in Croatia. It has the same latent structure as original scale, and even better internal consistency. With this new instrument, the Croatian researchers of sport motivation and Goal perspective theory can widen the field of study.

References

1. Barić, R., Cecić-Erpič, S., & Babić, V. (2002). Intrinsic motivation and goal orientation in track-and-field children. Kinesiology, 34(1), 50-60.
2. Crnjac, D. (2017). Socijalna okolina i sudjelovanje starijih adolescenata u nekim borilačkim sportovima. Unpublished doctoral dissertation, Zagreb: Faculty of Kinesiology, University of Zagreb.
3. Duda, J.L., & Nicholls, J.G. (1992). Dimensions of achievement motivation in schoolwork and sport. Journal of Educational Psychology, 84(3), 290-299.
4. Nicholls, J. G. (1989). The competitive ethos and democratic education. Cambridge, MA: Harvard University Press.
5. Stuntz, C. P., & Weiss, M. R. (2003). Influence of social goal orientations and peers on unsportsmanlike play. Research Quarterly for Exercise and Sport,74(4), 421-435.
6. Urdan, T C, & Maehr, M. L. (1995). Beyond a two-goal theory of motivation and achievement: A case for social goals. Review of Educational Research, 65,213-243.

GET YOUR FEEDBACK! A SAMPLE OF EVALUATION REPORT FOR PE TEACHER-STUDENT AT FIELD TRAINING

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Abstract

PE teacher-student need to understand of how to get feedback about teaching skills through parts of class, so this study aims to design a sample of evaluation parameter for PE teacher-student to help them also after their study ,study data collected by(n=70) PE teacher-student stuff members at department of teaching method and curriculum and using questionnaire with 5axis, our study focused only on 2 axis (Aims and content of curriculum).Based on result of the questionnaire, then designed A sample of evaluation report. Outcomes were 34 phrases under new 5 axes in a sample of evaluation report. This phases have a relative importance according to analytic statistical of questionnaire for stuff members with min (88.41) max (100) and for PE teacher-student with min (87.10) max (96.77), throughout these phrases Designed A sample of evaluation report with 34 phrases. This study reached A sample of evaluation report for PE teacher-student at field training with 5 axes they can get their feedback through one study year and see their results after using the report.

Key words: *Evaluation report, PE teacher-student, field training*

Introduction

Evaluation is a key component of physical education class and one of the main goals is to make PE teacher succeeded and for achieving this goal we have to start with PE teacher-student at evaluation part (Samia, Galila., 2015) ,one of the most important basic norms of evaluation : flexibility, Sequence, Clarity& Ease of use (Boyee Ann 1992), Also evaluation is very important to know which areweakness pointsthat facing PE teacher-student and getting solved (Jenkinson, K.A, Benson A.C(2010), Theaim of this study is to design A **Sample of Evaluation report for PE teacher-student at field training**with this norms and to resolve weakness points

Methods

Sample of subjects: PE teacher-student stuff members at department of teaching method and curriculum(70) who used questionnaire with 5axis, our study focused on two axis (Aims and content of curriculum)

Table 1: Characteristic of the sample

Sample	Number	%
Stuff		
Basic	23	76,67
Reconnaissance	5	23,33
Total	28	100
PE teacher-student		
Basic	31	67,39
Reconnaissance	11	32,39
Total	42	100
Total Basic	54	
Total Reconnaissance	16	
Total	70	

Data Analysis

This study used only two axes from the five axesafter opinionsof experts which related for the sample, it was first and second axes (Curriculum Objectives- Curriculum Content).

Table 2: Experts opinion

Axes	Repetitions	%
Curriculum Objectives	**7**	**100**
Curriculum Content	**6**	**85,71**
Curriculum teaching methods	6	85,71
Curriculum evaluation	7	100
Curriculum development	6	85,71

After this we designed the questionerwith 34 phrases under new 5 axis

Table 3: Questioner Axes and phrases

#	Axes	Phrases
1	Warming Up	1-5
2	Physical Preparation	6-12
3	The Main Part	13-24
4	The Final Part	25-28
5	Sports Shows	29-34

Table 4: Relative importance and Relative weightfor stuff and PE teacher students

Phrase Number	Stuff N=23		PE teacher-student N=31	
	Relative importance	Relative weight	Relative importance	Relative weight
First Axe				
1	100	69	95,70	89
2	98,55	68	96,77	90
3	92,75	64	95,70	89
4	92,75	64	87,10	81
5	98,55	68	92,47	86
Second axe				
6	98,55	68	94,62	88
7	92,75	64	94,62	88
8	97,10	67	87,10	81
9	88,41	61	95,70	89
10	92,75	64	87,10	81
11	92,75	64	92,47	86
12	98,55	68	94,62	88
Third Axe				
13	98,55	68	96,77	90
14	97,10	67	90,32	84
15	100	69	93,55	31
16	98,55	68	94,62	88
17	98,55	68	91,40	85
18	98,55	68	87,10	81
19	92,75	64	95,70	89

20	92,75	64	87,10	81
21	98,55	68	92,47	86
22	97,10	67	90,32	84
23	97,10	67	92,74	86
24	97,10	67	93,55	87
Fourth Axe				
25	94,20	65	89,25	83
26	92,75	64	95,70	89
27	92,75	64	87,10	81
28	98,55	68	92,47	86
Fifth Axe				
30	92,75	64	92,47	86
31	100	69	92,47	86
32	100	69	90,32	84
33	100	69	92,47	86
34	98,55	68	95,70	89

Discussion

We found that there are differences in relative importance of phrases between both of staff member and students views of faculty as shown in Table (3), of warming-up axis, whereas the highest relative importance for views of staff members of in the phrasesNo. (1) whichis “student uses different types of warming-up” either for opinions of students, phrase No.(2) was “warming-up includes specific information about its importance for thebodyadaptation and avoiding injuries.”It appears also correspondence inboth of staff members and teacher-students at both parameters of fitness preparation of the phrase applied fitness preparation in composition of the regulatory free-axis, as shown This is in line is agree with result of Boyee Ann Bbjrdthat found a basic criterion for evaluating such inclusiveness and not rely on assessment is a regulatory one.Despite the differing views of students and staff members in many phrases and Parameters, it contains less, but relative importance of staff members was (88.41) and teachers-students was a significant relative (87.10)so that has been used all phrases that got on relative importance higher than 85%, irrespective of differing importance of the two categories, which was reached on the proposed model with 34 statement to five axes.

Conclusion

The increasing of weakness points which faces PE teacher-student had us to focus on which better way to avoid this phase to help them also after study. And the aim of the study it was reach a sample of evaluation report of PE teacher-student at field training, So it’s important to keep their feedback to increase their strong points and avoid their weak. In the end it should be said that a feedback every time and comparer between first time and the last it’s very important to know their level and how to develop it.

Reference

1. Blanch SalamaMetias (2011)Strategy of teaching
2. Boyee Ann (1992)“A proposed physical education curriculum”, DD, the floridastata university.
3. Jenkinson, K.A, Benson A.C (2010) Barriers to providing physical education and physical zctivity in Victorian state secondary schools rmit university Australia.
4. SamiaGhanem,GalilaElswerki (2010) “Physical education teaching for the future,cairo,Egypt.
5. zinbomar, ghadaGalal (2015) evaluation of physical education

Appendix of A Sample of Evaluation report for PE teacher-student at field training

A Sample of Evaluation report for PE teacher-student at field training PE teacher- student Name:											
After Assessment	Grade - Date				Evaluation (how to adjusted)	cons	Evaluation (how to develop)	pros	Before assessment	Assessment Axes	#
										warming Up	A
										Using a lot of types of warming up	1
										warming up include information about how to avoid injuries	2
										PE teacher -student has to using dedicated timeof warming up	3
										tools appropriated with numbers of students	4
										how to choose appropriate music for warming u	5
										fitness Preparing	B
										student gives information about general components of fitness	6
										Improve the general components of physical fitness	7
										Improve the special components of physical fitness for skills	8
										how to apply the physical preparing as a circuit training styles	9
										PE teacher student has to using dedicated timefor physical	10
										availbile tools with number of student	11
										12. how to choose appropriate music for this part	12
										the main part	C
										it's has include the information about the skill	13
										how to use last skills which they learned before with a new one	14
										how to apply the practice part with variety of applications	15
										how to teach the skill gradually	16
										how to correct the mistakes	17
										how to apply the skill with many of types	18
										how to teach this parton its dedicated time	19
										available tools with number of students	20
										how to choose appropriate music with this part	21
										using the activities which learned before	22

										how to link between last skills and new one	23
										how to be creative in educational tools which using in the Class	24
										the final part	D
										including information about importance of relaxation	25
										the aching this part its dedicated time	26
										available tools with number of students	27
										how to choose appropriate music for relaxation	28
										E sports shows	E
										including information about sports shows and how it can increase the beauty of moves	29
										preparing and planning for sports shows	30
										how to make the main parts of sports shows	31
										knowing about many moves and forms for shows	32
										how to choose the good music relegated with moves which choose	33
										how to be creative	34

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