

# 9th International scientific conference on kinesiology: Proceedings

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9<sup>th</sup>  
**INTERNATIONAL  
SCIENTIFIC  
CONFERENCE ON  
KINESIOLOGY**

Opatija, Croatia, September 15 - 19, 2021

# **PROCEEDINGS**

*Editors-in-Chief*  
Sanja Šalaj and Dario Škegro

*Organiser: University of Zagreb, Faculty of Kinesiology, Croatia*  
*Under the patronage of: Croatian Academy of Sciences and Arts*





# 9<sup>TH</sup> INTERNATIONAL SCIENTIFIC CONFERENCE ON KINESIOLOGY

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## Proceedings

**Editors-in-Chief**

Sanja Šalaj and Dario Škegro

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## ***Dear Colleagues, Conference delegates and readers***

At the beginning of this foreword, we would like to express our excitement about getting together again. Almost two years after Covid 19 restrictions moved us completely to the digital sphere, we are delighted that we can rejoin once again in the beautiful city of Opatija. It was hard to adapt to all the new rules, sometimes confusing and illogical but the scientific community has once again found and is still finding the answers. As never before, scientific community has been united to gain new knowledge, to get to know “the enemy” and to fulfill its duties and repay its debts to the society. To this end, Kinesiology is not an exception either. Hundreds of scientific projects, papers and communications were created and conducted to understand how physical activity, exercise and sports can be effective in off-court battle. At the end of the day, scientist from different fields of Kinesiology tried hard to provide all the necessary information on how to stay safe and fit at the same time.

We believe you share our excitement to meet again in person. The Conference was planned for 2020 in May, but the pandemics stopped it. First choice was postponement to May 2021, but the pandemics was tough, and here we are, September 2021, year, and a half after, still in epidemiological frames, but here. 9<sup>th</sup> edition of the International Scientific Conference on Kinesiology is rolling. Beside more or less standard tentative sections in various fields of kinesiology, this year Conference organizes two satellite symposiums on Social Aspects of Sport in Southeastern Europe and Prevention and Rehabilitation of Sport Injuries. The latter is related to presentation of postgraduate specialist study program that we are establishing at the Faculty of Kinesiology in this field. The Proceedings contains 251 papers or abstracts published by 583 authors from 23 countries all over the world. It is a great opportunity to point out the important anniversary that we are all proud of – Scientific journal Kinesiology celebrates 50 years since its first issue. Web of Science – Core Collection membership and impact factor 1,452 for the year 2020 proves that the Faculty of Kinesiology and its employees are continuously producing top-level scientific products.

Once again highly respected patronage is given by the Croatian Academy of Sciences and Arts. This patronage is appreciated and important for the Conference since it is approved by the highest scientific authority in Croatia. Focusing on great international relations with our partners and collaboration institutions we warmly thank The Beijing Sports University, China, The Faculty of Sports Studies, Masaryk University, Brno, Czech Republic, The Faculty of Kinesiology, University of Split, Croatia, The Faculty of Sport and Physical Education, Novi Sad, Serbia for their involvement in the Conference and The Faculty of Physical Education and Sports, Alexandru Ioan Cuza University of Iasi, Romania.

Special appreciation goes to all the authors, reviewers, section editors, members of the Organizing and Program Committees and technical support staff. Without their great effort Conference and Proceedings would not be possible. In hope that all the participants will have successful and fruitful work at the Conference we wish to see you again in 10<sup>th</sup> International Scientific Conference on Kinesiology without any restrictions. Stay healthy and good luck!

Organising Committee



## CONTENTS

## INVITED LECTURES

<b>Wladimir Andreff</b> ECONOMIC ANALYSIS AND FORECASTING OF OLYMPIC MEDAL TOTALS .....	24
<b>Jay Coakley</b> POST-PANDEMIC SPORTS: TENSIONS, TRANSITIONS, & TRENDS .....	25
<b>Carl Foster</b> SESSION RPE: A TOOL FOR MONITORING EXERCISE TRAINING .....	26
<b>Radoslaw Kossakowski</b> ANTI-SYSTEM PERFORMANCE. IDENTITY AND POLITICS OF ULTRAS FANDOM .....	27
<b>Matthieu Lenoir</b> DEVELOPMENT OF MOTOR COMPETENCE AS A GATEWAY TO HEALTHY LIFE AND OPTIMAL SPORTS PERFORMANCE .....	28
<b>Lex Mauger</b> CAVING TO PAIN: THE ROLE OF EXERCISE-INDUCED PAIN IN ENDURANCE PERFORMANCE .....	29
<b>Tim Meyer</b> CURRENT CONCEPTS OF SCREENING FOR CARDIOVASCULAR DISEASE IN ATHLETES .....	30
<b>Richard Mills</b> KICKING OFF IN THE “NEW WORLD”: FOOTBALL, CRISES, AND INTERWAR YUGOSLAV-SOUTH AMERICAN RELATIONS .....	31
<b>Rado Pišot</b> THE ROLE OF CHILDREN’S MOTOR COMPETENCIES IN CONTEMPORARY SOCIETY - CAN THEY SURVIVE BEING PHYSICALLY INACTIVE? .....	32
<b>Pierre Samozino</b> FORCE-VELOCITY-POWER PROFILE: FROM THEORY TO PRACTICE .....	33
<b>Shuhong Xiao, Yunyun Hou</b> RESEARCH ON VALUE ASSESSMENT OF SPORTS EVENTS BASED ON THE THEORY OF VALUE CHAIN MANAGEMENT .....	34
<b>Liang Yu, Zhi Bo Zhou, Zheng Song Wang, Xiao Lan Zhu</b> THE EFFECTS OF SMALL SIDED GAMES COMBINED WITH KAATSU TRAINING ON REPEATED SPRINT ABILITY IN YOUTH SOCCER PLAYERS .....	37

## ADAPTED PHYSICAL ACTIVITY AND KINESITHERAPY

<b>Petar Čuljak, Šime Mijić, Grgur Bulović</b> EFFECTS OF ECCENTRIC AND HEAVY-SLOW RESISTANCE TRAINING ON LATERAL EPICONDYLITIS REHABILITATION .....	44
<b>Zrinka Djukić Koroljević, Valentina Matijević, Branka Matković</b> BOBATH CONCEPT VS CONVENTIONAL MEDICAL GYMNASTICS IN MILD MOTOR DEFICIT HABILITATION OF CHILDREN .....	45
<b>Neven Gladović, Tatjana Trošt Bobić, Dino Bartoluci, Irena Vuglovečki</b> COMBINATION OF MANUAL YUMEIHO THERAPY AND EXERCISE TO REDUCE DEPRESSION AND NEUROPATHIC PAIN IN PATIENTS WITH CHRONIC NONSPECIFIC LOW BACK PAIN .....	46
<b>Matija Jandrić</b> DYNAMIC AND STATIC BALANCE PERFORMANCE AND LOWER EXTREMITY ASYMMETRIES IN HIGH SCHOOL STUDENTS .....	50

<b>Zhong-Ye Jiang, Hao Su, Guo-Huan Cao, Tian-Hao Wen, Jia Shao</b> THE EFFECTS OF MITOCHONDRIAL ENERGY METABOLISM INDUCED BY HIIT IN SKELETAL MUSCLES DEGENERATION CAUSED BY AGE DEVELOPMENT .....	57
<b>Andelka Knezović Svetec</b> LUMBAR EXTENSION STRENGTH TRAINING AND CHRONIC LOW BACK PAIN .....	58
<b>Yingkui Li, Youhua Li</b> EFFECTS OF TAI CHI COMBINED WITH ZHAN ZHUANG GONG ON THE BALANCE CAPABILITY OF AMATEUR FOOTBALL PLAYERS WITH FUNCTIONAL ANKLE INSTABILITY .....	59
<b>Youhua Li, Yingkui Li</b> EFFECT OF TAI CHI COMBINED WITH KINESIO TAPING ON POSTURE CONTROL OF COLLEGE FOOTBALL PLAYERS WITH FUNCTIONAL ANKLE INSTABILITY .....	60
<b>Marius Neculăeș, Paul Lucaci</b> THE ROLE OF STABILOMETRY IN THE FUNCTIONAL RE-EDUCATION OF PATIENT WITH STROKE .....	61
<b>Sanja Novak Orlić, Ivana Jurković, Andrea Miškulin</b> EARLY ONSET OF INTERVENTIONAL TREATMENT AS A PREDICTOR OF SUCCESSFUL MOTOR DEVELOPMENT .....	65
<b>Snježana Schuster, Goran Bobić, Monika Talan Mihaljević</b> POSSIBLE EFFECT OF PHYSIOTHERAPY ON REDUCING THE INCIDENCE OF INJURIES IN TAEKWONDO COMPETITORS .....	69
<b>Alena Skotáková, Zdenko Reguli, Petr Vajda</b> CONCERNS OF CONFLICT SITUATIONS OF PERSONS USING A WHEELCHAIR BEFORE AND AFTER A SELF-DEFENSE COURSE .....	73
<b>Nikola Stračárová</b> INCLUSIVE SPORTING AREA .....	77
<b>Bogdan-Constantin Ungurean, Adrian Cojocariu</b> BODY MASS INDEX IN CHILDREN WITH AND WITHOUT INTELLECTUAL DISABILITY: DISTRIBUTION AND IMPLICATIONS .....	81
<b>Goran Vasić, Siniša Nikolić<sup>5</sup></b> EFFECT OF WALKING AND KINESITHERAPY ON LOW BACK PAIN .....	85
<b>Jadranka Vlašić, Neda Aleksić, Marina Đelić</b> THE FIRST 1,000 DAYS OF LIFE- AN OPPORTUNITY FOR MUSIC AND DANCE MOVEMENT. A REVIEW .....	86
<b>Jianzhong Wu, Junqiang Qiu, Guoqiang Geng, Ziyi Xia</b> TRAINING LOAD MONITORING FOR ATHLETES OF CHINA PARA-TAEKWONDO TEAM .....	90
<b>BIOMECHANICS AND MOTOR CONTROL</b>	
<b>Vesna Babić, Ivan Milinović, Aleš Dolenc, Maja Babić, Marko Čule</b> DIFFERENCES IN THE PERFORMANCE OF THE UHCJ20M TEST BY THE DOMINANT AND NON-DOMINANT LEG .....	92
<b>Marijo Baković, Ivan Brkljačić, Josip Jularić</b> THE USE OF REACTIVE STRENGTH INDEX TO EVALUATE UNILATERAL HORIZONTAL DROP JUMP PERFORMANCE IN CHILDREN .....	97
<b>Ante Burger, Nikola Foretić, Miodrag Spasić, Nenad Rogulj, Vladan Papić</b> HANDBALL JUMP SHOOT KINEMATICS – DIFFERENCES BETWEEN CROATIAN ELITE AND PROFESSIONAL PLAYERS .....	102
<b>Stipe Čubrić, Tomislav Rupčić, Vjekoslav Cigrovski, Bojan Matković, Peter Šagat</b> RELATIONSHIP BETWEEN PRESSURE FORCE AND SOME KINEMATIC PARAMETERS WHEN PERFORMING JUMP SHOT IN BASKETBALL .....	107

<b>Damjan Bruno, Saša Vuk</b> KINEMATICS AND KINETICS OF A SINGLE SET UNTIL FAILURE USING MAGNESIUM CARBONATE DURING DEADLIFT OF TOP-LEVEL POWERLIFTERS .....	112
<b>Mihail Michi Geambesa, Andreea Ungureanu, Andreea Rosca, Alexandru Chivaran, Mihnea Ion Marin, Ligia Rusu</b> BIOMECHANICAL EVALUATION ASPECT OF PES PLANUS BASED ON SUBTALAR JOINT ANALYSIS .....	116
<b>Marta Gimunová, Martin Zvonař, Kateřina Kolářová, Tomáš Vodička</b> THE ROLL-OVER PATTERN AND PLANTAR PRESSURE DISTRIBUTION CHANGES DURING THE FIRST GAIT DEVELOPMENT IN TODDLERS AND THE EFFECT OF GENDER .....	120
<b>Željko Hraski, Slobodan Dragičević</b> COMPARATIVE KINAMATIC ANALYSIS OF RUN-UP AND HOP IN A PREPARATORY ACROBATIC SERIES FOR BACKWARD SOMERSAULTS .....	125
<b>Hans Isselée, Henri De Vroey, Marco Konings, Antoon De Laat</b> EFFECT OF CONTROLLED SUBMAXIMAL TEETH CLENCHING ON STATIC POSTURAL CONTROL AND DURING VOLUNTARY DYNAMIC MOTOR PERFORMANCE TASKS .....	129
<b>Katerina Jencikova, Mario Kasović, Martin Zvonar</b> THE INFLUENCE OF SCHOOL BAG WEIGHT ON BACK PAIN IN PRIMARY-SCHOOL AGE CHILDREN (CZECH REPUBLIC) .....	130
<b>Feng Li, Vedran Dukarić, Dražen Orešković, Slobodan Simović, Zhongchun Bi</b> DIFFERENCES IN KINEMATIC PARAMETERS OF BASKETBALL JUMP SHOT PERFORMED FROM DIFFERENT SHOOTING POSITIONS .....	136
<b>Marija Lorgjer, Magdalena Lelonek, Ivan Prskalo</b> HAND-EYE COORDINATION EVALUATED ON A SAMPLE OF CROATIAN AND POLISH FEMALE UNIVERSITY STUDENTS OF EARLY CHILDHOOD AND PRESCHOOL EDUCATION .....	140
<b>Lucija Miličić, Kamenka Živčić</b> DIFFERENCES IN KINEMATICAL PARAMETERS BETWEEN MEN AND WOMEN IN TSUKAHARA ENTRY ON VAULT IN ARTISTIC GYMNASTICS .....	145
<b>Melis Mladineo Brničević, Lidija Vlahović</b> KINEMATIC CHARACTERISTICS OF 60M HURDLE RUNNING IN YOUTH ATHLETES .....	149
<b>Catalin Popa, Eduard Robert Sakizlian, Doina Miron, Oana Alis Sandu, Mihnea Marin, Mihai Robert Rusu, Ligia Rusu</b> ANALYSIS OF VARIABILITY OF LUMBAR SPINE MOBILITY DURING RAISING AN OBJECT .....	154
<b>Tomislav Rupčić, Stipe Čubrić, Damir Knjaz</b> DIFFERENCES IN SOME KINEMATIC PARAMETERS IN PASSING THE BALL WITH THE DOMINANT AND NON-DOMINANT HAND IN BASKETBALL .....	155
<b>Jelena Stosic, Santiago Veiga, Alfonso Trinidad, Milivoj Dopsaj, Enrique Navarro</b> BODY INCLINATIONS IN MALES AND FEMALES IN SWIMMING RESUMPTION AFTER PUSH-OFF START .....	160
<b>Ivan Šerbetar, Ivana Nikolić, Predrag Zarevski</b> VISUAL-MOTOR INTEGRATION IS RELATED TO GROSS-MOTOR COORDINATION IN NORMALLY DEVELOPING CHILDREN AGED FIVE .....	161
<b>MANAGEMENT OF SPORT</b>	
<b>Snježana Boranić Živoder, Sanda Čorak, Zrinka Marušić</b> TOURISTS' PARTICIPATION IN OUTDOOR ACTIVITIES ON THE ADRIATIC: WATER BASED VS. OTHER SPORTS .....	166
<b>Boris Bursać, Danijel Knežević, Kristina Bučar</b> DEVELOPING SPORTS TOURISM FOR PEOPLE WITH DISABILITIES .....	170
<b>Katija Kovačić, Eli Marušić, Duje Petričević</b> STRATEGY AND PERFORMANCE OF THE YOUTH FOOTBALL ACADEMIES .....	175

<b>Mario Kasović, Bruno Škrinjarić, Ivan Ivezić</b> MACRO AND MESO INDICATORS OF SUCCESS OF EUROPEAN COUNTRIES IN ELITE TRIATHLON FROM 2009 TO 2017 .....	180
<b>Adam Kyselica, Tomáš Sedláček</b> CZECH FOOTBALL LEAGUE DEVELOPMENT .....	187
<b>Janja Ricov</b> RELATIONSHIP OF PUBLIC FINANCING OF SPORTS PROGRAMS WITH ATHLETES' ACHIEVEMENTS - THE CITY OF ZAGREB - CASE (STUDY) .....	192
<b>Antonela Sinković, Valent Sinković, Dragan Milanović</b> CORRELATION OF ECONOMIC, GEOGRAPHICAL AND DEMOGRAPHIC CHARACTERISTICS OF THE WORLD COUNTRIES WHICH HAVE WON MEDALS AT THE WORLD AND OLYMPIC ROWING CHAMPIONSHIPS .....	196
<b>Lucas Šaravanja, Sanela Škorić</b> DIFFERENCES IN EXPENDITURE ON SPORTS PRODUCTS AND SERVICES BETWEEN STUDENTS OF FACULTY OF KINESIOLOGY ZAGREB .....	200
<b>Sanela Škorić, Nebojša Maksimović, Radenko Matić</b> PREFERRED LEADERSHIP STYLES AMONG CROATIAN AND SERBIAN STUDENTS .....	204
<b>MEDICINE OF SPORT AND EXERCISE</b>	
<b>Adriana Albu, Ionut Onose, Raluca Mihaela Onose, Beatrice Abalasei</b> APPRECIATION OF THE NUTRITION OF ADOLESCENTS FROM TWO HIGH SCHOOLS WITH SPORTS PROGRAM IN THE AREA OF MOLDOVA - ROMANIA .....	210
<b>Marko Badrić, Leona Roca, Ivan Prskalo</b> DIFFERENCES IN THE LEVEL OF CARDIORESPIRATORY FITNESS IN RELATION TO NUTRITION STATUS OF CHILDREN IN PRIMARY EDUCATION .....	216
<b>Marko Čule, Ivan Milinović, Davor Pavlović</b> DIFFERENCES IN BODY COMPOSITION AND CARDIOVASCULAR SYSTEM PARAMETERS IN UNIVERSITY STUDENTS ACCORDING TO SELF RATED HEALTH STATUS .....	221
<b>Luka Davidović, Bruno Lovreković, Daniel Peškirić</b> USE OF PLATELET-RICH PLASMA (PRP) IN TREATMENT OF MUSCULOSKELETAL INJURIES .....	225
<b>Arunas Emeljanovas, Brigita Mieziene, Natalija Fatkulina, Rimantas Stukas</b> THE IMPORTANCE OF PHYSICAL ACTIVITY FOR ADHERENCE TO MEDITERRANEAN DIET IN YOUNG ADULTS .....	226
<b>Petra Jurić, Maroje Sorić</b> ASSOCIATIONS OF SLEEP QUALITY WITH CARDIOVASCULAR DISEASE RISK FACTORS IN ADOLESCENTS .....	227
<b>Josip Karuc, Marko Šarlija, Marjeta Mišigoj-Duraković, Goran Marković, Vedran Hadžić</b> FORECASTING INJURY AMONG ATHLETIC AND NON-ATHLETIC YOUTH: USAGE OF THE ARTIFICIAL INTELLIGENCE METHODS .....	228
<b>Erol Kovačević, Denis Čaušević, Izet Bajramović, Josipa Nakić, Elvir Kazazović, Ensar Abazović</b> PREVALENCE OF OBESITY AMONG STUDENTS AT UNIVERSITY OF SARAJEVO .....	229
<b>Lavinia La Grasta Sabolić, Maja Cigrovski Berković, Marija Požgaj Šepec, Gordana Stipančić</b> DOES CARDIORESPIRATORY FITNESS ATTENUATE CARDIOMETABOLIC RISK IN OBESE ADOLESCENTS? .....	235
<b>Feng Liang, Zhou Zhihui, Cao Jianmin, Wang Xiaoting, Qi Bing, Leng Bo, Dai Jin</b> EFFECT OF CAFFEINE INGESTION ON BADMINTON PERFORMANCE .....	236
<b>Bruno Lovreković, Luka Davidović, Daniel Peškirić, Milan Milošević</b> PLATELET - RICH PLASMA (PRP) INJECTIONS TO ACCELERATE RECOVERY IN A PROFESSIONAL ATHLETE: A CASE REPORT .....	237

<b>Dora Marić, Šime Veršić, Antonela Sinković</b> DOPING ATTITUDES AND DOPING KNOWLEDGE OF COMPETITIVE CROATIAN ROWERS .....	238
<b>Antonio Martinko, Filip Koradžija, Maroje Sorić</b> ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY AND SLEEP IN ACTIVE ADULTS: A SUBJECT-SPECIFIC ANALYSIS .....	243
<b>Martina Mavrin Jeličić</b> THE PREVALENCE OF WORK-RELATED MUSCULOSKELETAL DISORDERS AMONG URBAN BUS DRIVERS IN ZAGREB .....	244
<b>Kazys Milašius, Yeldana Yerzhanova, Zhanna Sabyrbek, Galiya Madiyeva, Ermek Dilmakhanbetov, Zhanna Kalmatayeva</b> NUTRITION HABITS AND DIET REGIME OF KAZAKHSTAN STUDENTS ENROLLED IN PHYSICAL EDUCATION AND SPORTS PROGRAM .....	248
<b>Milan Milošević</b> RELATIVE ENERGY DEFICIENCY IN SPORTS AND STRESS FRACTURES .....	253
<b>Josipa Nakić, Asim Bradić, Erol Kovačević, Ensar Abazović</b> OCCUPATIONAL KINESIOLOGY: PREVALENCE OF MUSCULOSKELETAL DISORDERS AND MANUAL HANDLING IN PRINTING INDUSTRY .....	254
<b>Marija Rakovac, Dubravka Sajković</b> PHYSICAL FITNESS AND INJURIES IN CLASSICAL BALLET ENSEMBLE: A RETROSPECTIVE STUDY .....	259
<b>Ivan Struhár, Vojtěch Grün, Tomáš Vencúrik</b> THE INFLUENCE OF THE TESTING PROTOCOL FOR THE MAXIMAL RATE OF OXYGEN UPTAKE. CAN WE TEST THE MAXIMAL VALUES? .....	260
<b>Boštjan Šimunič, Stefano Lazzer, Carlo Reggiani, Enrico Rejc, Rado Pišot, Marco Narici, Hans Degens</b> TENSIOMYOGRAPHY DETECTS EARLY ATROPHY BEFORE CHANGES IN MUSCLE ARCHITECTURE .....	265
<b>Renato Šunjerga, Hrvoje Karninčić</b> ALCOHOL AND SMOKING HABITS IN COMBAT SPORTS ATHLETES .....	266
<b>Kaja Teraž</b> HYDRATION STATUS OF SEMI-PROFESSIONAL MALE AND FEMALE SLOVENIAN HANDBALL PLAYERS .....	270
<b>Petr Váňa, Jana Juříková, Martina Bernaciková, Alena Žáková, Marie Budíková, Radim Polasek, Jakub Mazur, Petr Hedbávný</b> DECREASE IN SALIVARY LYSOZYME MAY NOT BE PARALLELED BY A DECREASE IN SALIVARY IMMUNOGLOBULIN A (SIGA) AFTER PROLONGED INTENSE SPORTS LOAD IN ADOLESCENT MALE GYMNASTS. A PILOT STUDY .....	274
<b>Goran Vrgoč, Jean-Marie Fayard, Bertrand Sonnery-Cottet, Pádraig O'Loughlin, Geoffroy Dubois de Mont Marin, Benjamin Freychet, Thais D. Vieira, Mathieu Thauinat</b> PARTIAL ACL TEARS IN YOUNG AND ACTIVE PATIENTS: IS A CONSERVATIVE TREATMENT WAY TO GO? .....	279
<b>Laikang Yu, Li Zhao</b> EFFECTS OF AEROBIC EXERCISE ON BEHAVIORAL PERFORMANCE OF APP/PS1/TAU TRANSGENIC MICE .....	280
<b>Alena Žáková, Filip Tokár, Petr Váňa, Martina Bernaciková, Jana Juříková, Radek Ševčík</b> DETERMINATION OF IGA AND LYSOZYME CONCENTRATIONS IN SALIVA AS A STATE OF MUCOSAL IMMUNITY IN ATHLETIC YOUTH .....	281
<b>Marija Martina Žanetić, Tatjana Trošt Bobić, Marjeta Mišigoj-Duraković</b> SPECIFIC CHANGES IN PHYSICAL ACTIVITY AMONG ADOLESCENTS DURING A FOUR-YEAR PERIOD .....	282

## PHYSICAL CONDITIONING

<b>Daniel Bok, Jere Gulin, Dario Škegro</b> VALIDITY OF THE 30-15 INTERMITTENT FITNESS TEST FOR MEASURING MAXIMAL OXYGEN UPTAKE IN PHYSICALLY ACTIVE INDIVIDUALS .....	288
<b>Nera Budalica, Marijana Čavala, Josefina Đuzel</b> THE EFFECTS OF MUSIC ON PHYSICAL ASPECTS OF ISOMETRIC STRENGTH EXERCISE – EXAMPLE OF PRONE PLANK .....	294
<b>Jan Cazha, Jan Cacek, Tomas Vodicka</b> CHANGES AND DIFFERENCES IN BODY COMPOSITION AND STRENGTH ABILITIES OF ATHLETES IN FITNESS AND BODYBUILDING AT APPROPRIATE INTERVALS OF REST .....	299
<b>Whitfield East, Michael McGurk, Kevin Bigelman</b> PREDICTING HIGH DEMAND SOLDIER TASK PERFORMANCE .....	300
<b>Patrik Horvat, Filip Živković, Cvita Gregov</b> INJURIES OF CROATIAN BASEBALL PLAYERS IN THE 2018 SEASON .....	301
<b>Marijan Jozić, Hrvoje Sertić, Miroslav Zečić</b> MORPHOLOGICAL ASSESSMENT OF INTERVENTION AND SPECIAL POLICE MEMBERS .....	308
<b>Nemanja Lakicevic, Roberto Roklicer, Ambra Gentile, Maria Isabel Cardona</b> THE INFLUENCE OF RAPID WEIGHT LOSS ON MOOD STATE IN JUDO ATHLETES .....	312
<b>Chaoyue Ma, Tom Comyns, Yapu Liang</b> RELATIONSHIP BETWEEN COUNTERMOVEMENT JUMP CHARACTERISTICS INCLUDING REACTIVE STRENGTH INDEX-MODIFIED AND MEASURES OF STRENGTH .....	313
<b>Vlad-Alexandru Muntianu, Florin-Petruț Trofin</b> AEROBIC ENDURANCE OF JUNIOR FOOTBALL PLAYERS .....	317
<b>Kirsti Pedak, Indrek Rannama, Boriss Bazanov, Kristijan Port</b> FACTOR STRUCTURE OF THE FUNCTIONAL MOVEMENT SCREEN TEST COMPLEX IN YOUNG COMPETITIVE ATHLETES .....	318
<b>Coskun Rodoplu, Ramiz Arabaci</b> NON-INVASIVE INVESTIGATION ON HEART RATE VARIABILITY AND ENERGY EXPENDITURE DURING COMPETITION AND PHYSICAL ACTIVITY OF CHESS PLAYERS .....	322
<b>Roberto Roklicer, Nemanja Lakicevic, Valdemar Stajer, Tatjana Trivic, Antonino Bianco, Patrik Drid</b> THE EFFECTS OF RAPID WEIGHT LOSS ON HAND GRIP IN JUDO ATHLETES .....	326
<b>Matilda Šola, Cvita Gregov</b> INJURY ANALYSIS IN THE CROATIAN FIRST WOMEN'S BASKETBALL LEAGUE DURING 2017/2018 SEASON .....	327
<b>Tomas Vencurik, Dominik Bokuvka, Jiri Nykodym, Ivan Struhar</b> ASSOCIATION BETWEEN REACTIVE AGILITY AND SPEED AND POWER CHARACTERISTICS IN WOMEN'S BASKETBALL .....	331
<b>Vlatko Vučetić, Jere Gulin, Stipo Dajaković</b> ANALYSIS OF METABOLIC DEMANDS IN SIDEWAYS RUNNING .....	335
<b>Saša Vuk, Leo Bašić</b> THE EFFECT OF LIFTING STRAPS ON PULL-UP REPETITION NUMBER .....	339
<b>Mila Vukadinović Jurišić, Jelena Obradović, Dušan Rakonjac</b> RELATION BETWEEN BODY COMPOSITION AND AGILITY OF FEMALE HANDBALL PLAYERS .....	344
<b>Hongwen Wei, Junjie Zhang</b> POST-ACTIVATION POTENTIATION EFFECT OF DIFFERENT RESISTANCE EXERCISES COMBINED WITH BLOOD FLOW RESTRICTION ON SUBSEQUENT SPEED AND POWER PERFORMANCE .....	345



**PHYSICAL EDUCATION**

<b>Bojan Babin, Lidija Vlahović, Melis Mladineo Brničević</b> CORRELATION BETWEEN MOTOR ABILITIES AND SETTING FROM THE MIDDLE VOLLEYBALL POSITION IN ELEVEN-YEAR-OLD FEMALE PUPILS .....	348
<b>Zvonimira Biondić, Mateja Kunješić Sušilović</b> INFLUENCE OF WORKING CONDITIONS ON MOTOR SKILLS OF ELEMENTARY EDUCATION CHILDREN .....	352
<b>Romana Caput-Jogunica, Sanja Ćurković</b> EXPLORING STUDENTS' PREVIOUS EXPERIENCES AND EXPECTATIONS ABOUT PHYSICAL EDUCATION AT THE UNIVERSITY .....	356
<b>Jun Choi Hong, Mohammed Hamdan Hashem Mohammed</b> THE EFFECTS OF TAEKWONDO PHYSICAL EDUCATION COURSE ON MUSCULOSKELETAL FITNESS OF MALE UNIVERSITY STUDENTS: A CONTROLLED STUDY .....	361
<b>Josip Cvenić, Iva Macan, Magdalena Šipušić</b> ADOPTION OF MAJORETTE DANCE STRUCTURES IN PRESCHOOL CHILDREN .....	362
<b>Karla Đolo, Zoran Grgantov</b> ABSOLUTE AND RELATIVE RELIABILITY OF THE MODIFIED SHUTTLE RUN TEST IN YOUTH FEMALE VOLLEYBALL PLAYERS .....	366
<b>Marijana Hraski, Vatroslav Horvat, Snježana Mraković</b> SECULAR CHANGES IN MOTOR ABILITIES OF PRESCHOOL CHILDREN FROM CITY OF ZAGREB IN PERIOD FROM 2009-2019 .....	370
<b>Marija Ivanković, Zoran Čuljak</b> DYNAMICS OF LEARNING THE OVERHEAD SERVE IN VOLLEYBALL SCHOOL BY APPLYING THREE DIFFERENT METHODS .....	374
<b>Tomislav Jelić, Željko Kovačević, Nenad Rogulj, Marijana Čavala, Josefina Đuzel</b> RECREATIONAL KINESIOLOGICAL ENGAGEMENT AND SELF-RESPECT IN STUDENTS OF DIFFERENT AGES .....	379
<b>Dajana Karaula, Dean Kontić, Klara Šiljeg</b> IMPACT OF SPECIFIC WATER COMPETENCIES ON THE KNOWLEDGE OF SWIMMING IN FIRST AND SECOND-GRADE ELEMENTARY SCHOOL CHILDREN IN THE DUBROVNIK COUNTY .....	385
<b>Ivana Klaričić, Tihomir Vidranski, Mirela Šunda</b> RELATIONSHIP OF STUDENTS' AGE, GENDER AND INITIAL STATUS WITH PROGRESS IN CARDIORESPIRATORY FITNESS ASSESSED BY TWO FIELD TESTS .....	390
<b>Lucija Konstantin, Ema Ištuk, Vilko Petrić</b> EVALUATION OF THE DANCE SPORT PROGRAMME FOR PRESCHOOL CHILDREN: EFFECT ON THE LEVEL OF MOTOR ACHIEVEMENTS .....	395
<b>Jurica Lovrinčević, Petar Otković, Tihomir Vidranski</b> THE INFLUENCE OF ANXIETY ON LEARNING A TUCK JUMP (ON A HORSE VAULT) WITH STUDENTS OF CLASS TEACHER STUDIES .....	399
<b>Tonći Mašina, Milan Milošević, Sanja Ćurković</b> SELF-ESTEEM DIFFERENCES AMONG MEDICAL STUDENTS ACCORDING TO GENDER AND YEAR OF STUDY (GENERATION) .....	403
<b>Mohammed Hamdan Hashem Mohammed, Jun Choi Hong</b> THE EFFECTS OF JUDO PHYSICAL EDUCATION COURSE ON MUSCULOSKELETAL FITNESS OF MALE UNIVERSITY STUDENTS: A CONTROLLED STUDY .....	408
<b>Ivana Nikolić, Snježana Mraković, Srna Jenko Miholić</b> RELATIONSHIP OF CARDIORESPIRATORY FITNESS AND PHYSICAL ACTIVITY LEVEL OF PUPILS .....	409

<b>Josipa Peršun, Katarina Knjaz, Srna Jenko Miholić</b> PHYSICAL ACTIVITY AND PHYSICAL EDUCATION CLASSES FOR STUDENTS DURING THE COVID - 19 PANDEMIC .....	413
<b>Vilko Petrić, Lidija Vujičić, Mirela Peić</b> THE CORRELATION OF DIFFERENT PHYSICAL ENVIRONMENTS IN EARLY EDUCATION INSTITUTIONS WITH THE LEVEL OF CHILDREN'S MOTOR ACHIEVEMENT DEVELOPMENT .....	419
<b>Vanja Petrović, Jelena Alić, Gordana Ivković</b> MANIFESTATION OF GENDER DIFFERENCES IN TEMPERAMENT OF PRESCHOOL CHILDREN CONCERNING THE ENGAGEMENT IN PHYSICAL ACTIVITY IN LEISURE TIME .....	423
<b>Michal Průžek, Branislav Antala, Iveta Cihová, Dario Novak, Jana Vašíčková, Martina Luptáková, Xueshuang Wang, Lubor Tománek</b> INCLUSIVE PHYSICAL EDUCATION IN OPINIONS OF HIGH SCHOOL MALE STUDENTS FROM SLOVAKIA, CZECH REPUBLIC AND CROATIA .....	428
<b>Ozren Rađenović, Ivan Jurak, Vjerman Švaić</b> CORRELATION OF MORPHOLOGICAL CHARACTERISTICS AND COORDINATION PERFORMANCE .....	432
<b>Ivan Segedi, Dominik Žanetić, Hrvoje Sertić</b> RELATION OF MOTOR LEARNING PROCESS AND SKILL RELATED ANXIETY IN JUDO .....	433
<b>Mümine Soytürk, Özden Tepeköylü Öztürk</b> AN INVESTIGATION OF DECISION-MAKING STRATEGIES AND SOLUTION – FOCUSED APPROACH OF STUDENTS IN THE FACULTY OF SPORT SCIENCES .....	438
<b>Vesna Štemberger, Tanja Petrušić</b> THE IMPORTANCE OF DIFFERENT FORMS OF WITHIN-CLASS GROUPING AND TEACHER'S NONVERBAL COMMUNICATION FOR ACHIEVING HIGHER MVPA AND VPA LEVELS IN PE LESSONS .....	439
<b>Nataša Sturza Milić, Tanja Nedimović, Tamara Korac Živojinović</b> THE BELIEFS OF RELEVANT ADULTS (COACHES AND PRESCHOOL TEACHERS) REGARDING THE OPTIMAL TIME FOR INTRODUCING CHILDREN TO SPORTS .....	444
<b>Anca-Raluca Tanasă, Florin-Petruț Trofin, Cristina-Elena Moraru</b> AN ANALYSIS OF EXTRACURRICULAR PHYSICAL ACTIVITIES AMONG MIDDLE-SCHOOLERS .....	445
<b>Margareta Teskera, Krešimir Hrg, Mirela Šunda, Boris Neljak, Hrvoje Podnar</b> EFFECTS OF USING MOBILE APPLICATION DURING CLASSES ON STUDENT ATTITUDES TOWARD PHYSICAL EDUCATION .....	449
<b>Zvonimir Tomac, Biljana Trajkovski, Bojan Babin</b> DIFFERENCES IN KINANTROPOLOGICAL CHARACTERISTICS IN YOUNGER SCHOOL CHILDREN WITH REGARDS TO ENGAGEMENT IN SPORTS ACTIVITIES .....	453
<b>Braco Tomljenović, Damir Lauš, Sanjin Tomljenović</b> DISCRIMINANT ANALYSIS OF PRIMARY EDUCATION FOURTH GRADE FEMALE AND MALE PUPILS IN MEASURES OF MORPHOLOGICAL AND ANTHROPOMETRIC FEATURES .....	457
<b>Frane Tomljenović, Filip Bolčević, Braco Tomljenović</b> DIFFERENCES IN MANIFEST MOTOR SKILL TESTS BETWEEN PUPILS ATTENDING THE FOURTH GRADE IN URBAN AND RURAL SCHOOLS .....	461
<b>Biljana Trajkovski, Iva Blažević, Tatjana Gerekarovska</b> IMPACT OF DIFFERENT GENERAL PREPARATORY EXERCISES ON THE PHYSIOLOGICAL WORKLOAD IN PUPILS IN PHYSICAL EDUCATION .....	466
<b>Donata Vidaković Samaržija, Lara Pavelić Karamatić</b> DIFFERENCES IN ATTITUDES OF MALE AND FEMALE PUPILS TOWARDS THE SUBJECT OF PHYSICAL EDUCATION WITH RESPECT TO AGE .....	471

<b>Xueshuang Wang, Jin Sun</b> THE ORIGIN AND DEVELOPMENT OF INTERNATIONAL AND COMPARATIVE PHYSICAL EDUCATION IN CHINA — ALSO ON THE CONSTRUCTION OF A NEW KNOWLEDGE SYSTEM .....	475
<b>Marija Zegnal Koretić, Marija Lorger, Romana Romanov</b> MORPHOLOGICAL CHARACTERISTICS OF YOUNGER ADOLESCENTS IN RELATION TO AGE AND SEX .....	476
<b>Conghuan Zhao, Chengmengxue Sun</b> THE STATUS AND INFLUENCING FACTORS OF THE DEVELOPMENT OF UNDERGRADUATES' SELF-LEADERSHIP IN CHINESE SPORT UNIVERSITIES – A CASE STUDY OF BEIJING SPORT UNIVERSITY .....	483
<b>Katarina Žigman, Antonio Martinko, Luka Milanović</b> DIFFERENCES BETWEEN FIFTH AND SIXTH GRADERS SOCCER PLAYERS, HANDBALL PLAYERS AND STUDENTS WHO DO NOT DO SPORTS IN INDICATORS OF CONDITION PREPAREDNESS .....	486
<b>SATELLITE SYMPOSIUM SOCIAL ASPECTS OF SPORT IN SOUTHEASTERN EUROPE NEVER-ENDING TRANSITIONS</b>	
<b>Dunja Antunovic, Sunčica Bartoluci</b> SPORT, GENDER, AND AUDIENCE ENGAGEMENT: AN ANALYSIS OF BROADCASTERS' SOCIAL MEDIA PAGES .....	488
<b>Sunčica Bartoluci, Benjamin Perasović, Vanja Dergić</b> FEMALE FANS WITHIN THE ULTRAS SUBCULTURE .....	489
<b>Stipica Grgić, Dora Tot</b> SPORT DIPLOMACY: FLN FOOTBALL TEAM IN YUGOSLAVIA .....	493
<b>Tea Gutović, Doris Matošić, Dejan Madić, Goran Kuvačić, Borislav Obradović, Dragan Marinković</b> THE PEER VIOLENCE IN YOUTH SPORT: COACHES AND YOUTH PERSPECTIVES IN TWO SOUTHEASTERN COUNTRIES .....	496
<b>Ivan Hrستیć, Marko Mustapić</b> SPORT AND THE EMIGRANT IDENTITY: AN ANALYSIS OF MEDIA DISCOURSE REGARDING NEW ZEALANDERS OF CROATIAN ORIGIN PLAYING FOR THE CROATIAN NATIONAL RUGBY TEAM .....	497
<b>Rahela Jurković</b> INTEGRATION INTO SOCIETY THROUGH SPORT: A CASE STUDY OF HESTIA FC, THE FIRST REFUGEE AND MIGRANT WOMEN'S FOOTBALL TEAM IN GREECE .....	501
<b>Ruža Karlović, Ivana Glavina Jelaš, Jurica Pačelat, Krešimir Šimić</b> CROATIAN POLICE OFFICERS' SATISFACTION WITH RUNNING WORKOUT PROGRAM AS IMPROVEMENT TOOL FOR POLICE PERFORMANCE .....	505
<b>Rašeljka Krnić</b> SPORTS ORGANIZATIONS AND COMMUNITY DEVELOPMENT: THE EXAMPLE OF FUTSAL DINAMO FOOTBALL CLUB .....	506
<b>Dora Medimorec</b> THE POSITION OF WOMEN IN SPORT IN CROATIAN SOCIETY-A LITERATURE REVIEW .....	510
<b>Nikola Mijatov</b> PLAYING TO OLD RULES: PROFESSIONAL SPORT OF SOCIALIST YUGOSLAVIA AND ITS TRANSITION TO CAPITALISM IN THE 1990S. ....	514
<b>Ivana Milovanović, Ambra Gentile, Antonio Bianco, Stefano Boca</b> SOME FORMS OF EXPRESSING PEER VIOLENCE IN YOUTH SPORT: THE CASES OF ITALY AND SERBIA .....	518
<b>Marina Mučalo, Marin Galić</b> TRANSITION OF SPORTS JOURNALISM STUDIES IN THE COUNTRIES OF THE FORMER YUGOSLAVIA .....	519

<b>Marko Mustapić</b> BASKETBALL'S 'MEMORY BOX': A DISCOURSE ANALYSIS OF DRAŽEN PETROVIĆ BIOGRAPHIES ...	523
<b>Andrej Ivan Nuredinović, Dino Vukušić</b> 30 YEARS OF CULTURAL TRAUMA - FRAMING OF THE EVENTS OF 1 OF MAY 1990 IN MASS MEDIA .....	527
<b>Saša Pišot, Ivana Milovanović</b> ATHLETE'S BODY AS A "MEAN OF PRODUCTION" AND EMBODIED CULTURAL CAPITAL .....	532
<b>Sandra Radenović</b> REBRANDING OF RED STAR AND DYNAMO SPORTS SOCIETIES – A CONSEQUENCE OF TRANSITION AND/OR POSTMODERN CHAOS? .....	533
<b>Matija Mato Škerbić</b> WHAT MAKES THE SPORT A VALUABLE HUMAN ACTIVITY? A SPORT-PHILOSOPHICAL PERSPECTIVE .....	537
<b>Marija Todorović, Branka Matijejić</b> TWITTER AS AN ORGANIZATIONAL MECHANISM IN PROFESSIONAL SPORT - EXAMPLE OF EUROLEAGUE PLAYERS SYNDICAL ORGANIZING .....	538
<b>Marita Ukić</b> BMX AT THE 2020 OLYMPICS: THE COMMERCIALIZATION OF A SUBCULTURE .....	542
<b>SOCIAL SCIENCES AND HUMANITIES</b>	
<b>Airnel Abarra, Tamas Doczi</b> BODYBUILDING AND FUNCTIONAL FITNESS WOMEN IMAGE AND IDENTITIES: INSIGHTS FROM SELECTED HUNGARIAN WOMEN ATHLETES .....	546
<b>Vaiva Balciuniene</b> GENDER DIFFERENCES IN BODY IMAGE CONCERNS, DISORDERED EATING, AND QUALITY OF LIFE IN THE SAMPLE OF LITHUANIAN STUDENTS: THE RESULTS OF THE PILOT STUDY .....	547
<b>Filip Bolčević, Frane Tomljenović, Nikola Prlenda</b> DID THE SUPERB ACHIEVEMENTS OF THE CROATIAN SAILORS IN RIO DE JANEIRO INFLUENCE THE ATTITUDE CHANGES TOWARDS SAILING BETWEEN TWO GENERATIONS OF STUDENTS? .....	554
<b>Yeu-Yao Cheng, Alexander Klas, Rebecca Ataman, Shannon Chou, Sepehr Pouresa</b> OPPORTUNITIES FOR UNDERGRADUATE KINESIOLOGY PROGRAMS IN CANADA: PERSPECTIVES FROM RECENT GRADUATES .....	558
<b>Jitka Čihounková</b> KARATEKA'S IDENTIFICATION WITH THE TRADITIONAL KARATEDO THEORY .....	559
<b>Ivan Čolakovac, Iva Barković</b> FIFTY YEARS OF JOURNAL KINESIOLOGY - BIBLIOMETRIC ANALYSIS .....	562
<b>Ivan Dominković, Jerko Čaleta, Luka Dominković</b> CORRELATION BETWEEN NUMBER OF MEDALS WON IN ATHLETICS AT THE OLYMPIC GAMES AND WORLD CHAMPIONSHIPS OF WORLD COUNTRIES AND THEIR GEOGRAPHIC, DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS .....	563
<b>Irena Durdová, Aleš Sekot</b> PHYSICAL ACTIVITIES OF UNIVERSITY STUDENTS DURING THE COVID 19 PANDEMIC .....	567
<b>Nikola Foretić, Zoran Nikolovski, Vladimir Pavlinović</b> HANDBALL COACH MATCH STRESS RESPONSES: A PRELIMINARY STUDY .....	570
<b>Marin Galić</b> THE BEST CROATIAN MALE TENNIS PLAYERS AT A TURNING POINT – STUDIES OR PROFESSIONAL SPORT .....	574

<b>Ivana Glavina Jelaš, Ruža Karlović, Jurica Pačelat</b> TESTING THE EFFECTIVENESS OF A RUNNING PROGRAMME ON THE MENTAL HEALTH OF CROATIAN POLICE OFFICERS .....	578
<b>Eslem Gokcek, Recep Gorgulu</b> THEORY OF IRONIC PROCESSES OF MENTAL CONTROL IN SPORT-RELATED MOTOR PERFORMANCE: A SYSTEMATIC REVIEW .....	586
<b>Recep Gorgulu</b> THE RECIPROCAL RELATIONSHIP BETWEEN SOCIAL LOAFING AND INTERMITTENT ENDURANCE PERFORMANCE: THE MODERATING ROLE OF THE NARCISSISM IN BASKETBALL PLAYERS .....	587
<b>Miroslav Hrženjak, Vladimir Takšić, Ksenija Bosnar</b> THE MEASURE OF EMOTIONAL INTELLIGENCE OF COACHES AS PERCEIVED BY ATHLETES .....	591
<b>Dajana Jašić</b> SUDDEN INTERRUPTION OF THE SPORTS CAREER OF TOP CROATIAN ATHLETES .....	596
<b>Tea Magdić, Gordana Ivković, Melanija Miodrag</b> PERSONALITY TRAITS OF VOLLEYBALL AND BASKETBALL PLAYERS IN REGARDS TO POSITION AND PROFESSIONALISM .....	600
<b>Darija Omrčen, Matea Perkušić</b> ANALYSIS OF THE LANGUAGE OF SPORT-RELATED RESEARCH .....	605
<b>Özden Tepeköylü Öztürk, Orhan Deymeci, Mümine, Soytürk</b> ROLE AMBIGUITY IN ATHLETES: IMPACT OF COACH COMMUNICATION SKILLS .....	610
<b>Miriam Palomo-Nieto, Luis Miguel Ruiz Pérez, Donald N. Roberson Jr.</b> THE IMPACT OF ELITE SPORT ON THE FAMILY .....	611
<b>Jelena Pavičić Vukičević, Sara Antonini, Sara Čavrag</b> RELATIONSHIP BETWEEN EXPOSURE TO SEXUAL VIOLENCE AND ATTITUDES ABOUT GENDER EQUALITY IN SPORT .....	613
<b>Danica Piršl, Samir Ljajić, Tea Piršl</b> MANAGEMENT OF REFLECTIVE AND STRATEGIC LEARNING IN HYBRID SPORTS SCIENCES E-LEARNING ENVIRONMENT .....	617
<b>Rebeka Prosoli, Marc Lochbaum, Renata Barić</b> EMOTIONAL REACTIONS OF PARENTS WATCHING THEIR CHILD COMPETE .....	621
<b>Josipa Radaš, Jasmina Parlov, Gordana Furjan-Mandić, Darko Katović</b> THE INFLUENCE OF GIVING DIFFERENT FEEDBACK ON THE LEVEL OF LEARNING IN ARTISTIC SWIMMING .....	626
<b>Aleš Sekot</b> PARENTS AND THEIR CHILDREN'S SPORTS .....	631
<b>Nikša Sviličić, Tajana Obradović</b> AGRESSIVE RHETORIC AND RITUALS IN SPORTS AND INTERFERENCE WITH COMMUNICATION AND MOTIVATIONAL ASPECTS OF TRAINING .....	636
<b>Dario Škegro, Zrinko Čustonja</b> FRANJO BUČAR'S ADMISSION TO INTERNATIONAL OLYMPIC COMMITTEE – CAUSES AND CONSEQUENCES .....	641
<b>Suzana Šop</b> "SPORTS" CITIZENSHIP .....	644
<b>Kuan Tao, Tianxiao Guo, Qingrui Hu, Yanfei Shen</b> CASCADED CNN FOR PLAYER DETECTION AND AN ADAPTIVE TEAM MEMBERSHIP CLASSIFICATION APPROACH IN ICE HOCKEY GAMES .....	648

<b>Dario Vrdoljak, Mirjana Milić</b> ANALYSIS OF THE PSYCHOSENSORY STATUS OF PRESCHOOL CHILDREN BY USING TESTS OF THE NTC SYSTEM OF LEARNING .....	649
<b>Qiong Wang, Zhongchun Bi, Feng Li</b> ANALYSIS OF BASKETBALL PERFORMANCE OF SCREEN SWITCHING IN THE NBA TV BROADCAST .....	650
<b>Ana Žnidarec Čučković, Katarina Ohnjec</b> ACCEPTABILITY ASPECT OF RIGHT TO EDUCATION AS A PROVIDER FOR TEACHER SKILLS IN PHYSICAL EDUCATION .....	656
<b>SPORTS RECREATION</b>	
<b>Hrvoje Ajman, Josip Cvenić</b> DIFFERENCES IN MORPHOLOGICAL CHARACTERISTICS, MOTOR ABILITIES AND FUNCTIONAL CAPACITIES BETWEEN STUDENTS OF FOOTBALL AND RECREATION SPECIALIZATION AT THE FACULTY OF EDUCATION IN OSIJEK .....	662
<b>Loris Benassi, Hermina Maras Benassi</b> THE HISTORY OF SPORTS TOURISM AT THE “RIVIERA” IN POREČ AT THE TIME OF SOCIALIST YUGOSLAVIA .....	665
<b>Iva Blažević, Danijela Lazarić-Zec, Loris Benassi</b> ENGAGEMENT IN ORGANIZED FORMS OF PHYSICAL ACTIVITY IN THE ISTRIA COUNTY .....	670
<b>Elżbieta Cieśla, Magdalena Lelonek, Marzena Cieśla, Edyta Suliga</b> THE TIME SPENT ON COMPUTER GAMES, TV AND THE REDUCED MOTOR FITNESS OF 6-YEAR-OLD CHILDREN .....	674
<b>Ana Đerek, Danijel Jurakić</b> EFFECTS OF PERSONALIZED RECREATIONAL GROUP EXERCISE PROGRAMME ON HEALTH-RELATED FITNESS: A QUASI-EXPERIMENTAL STUDY .....	679
<b>Maja Horvatin, Alen Plevnik, Jadranka Vlašić</b> ATTITUDE TOWARDS DANCE OF ZAGREB FITNESS CENTER USERS .....	683
<b>Sara Jovanović, Zsolt Katona, Tijana Šćepanović, Aleksandra Dragin, Maja Mijatov, Bojan Rašković, Darinka Korovljev</b> DIFFERENCES IN MAIN MOTIVES OF PARTICIPATING IN NAUTICAL TOURISM AND SPORT ACTIVITIES DURING THE WATERTOUR PROJECT ACCORDING TO THE GENDER .....	687
<b>Andrea Martincová, Lenka Svobodová, Martin Sebera</b> PREDICTIVE MODEL OF FALL PREVENTION IN OLDER ADULTS - PILOT STUDY .....	688
<b>Tena Matolić</b> THE INFLUENCE OF YOGA ON THE SUBJECTIVE PERCEPTION OF STRESS, ANXIETY AND DEPRESSION IN INDIVIDUALS WITH AND WITHOUT PREVIOUS YOGA EXPERIENCE .....	689
<b>Mislav Papec, Mirna Andrijašević, Andrea Vrbik</b> CAN HIGH SCHOOL TEACHERS REDUCE STRESS (AT THEIR WORKPLACE) WITH PHYSICAL ACTIVITY? .....	693
<b>Željko Pedišić, Tena Matolić, Hrvoje Podnar, Ivan Radman, Marija Rakovac, Pavel Háp, Jorma Savola, Heidi Pekkola, Matleena Livson, Stjepan Heimer, Danijel Jurakić, Pekka Oja</b> SPORTS CLUB FOR HEALTH (SCFORH): 12 YEARS OF A SUCCESSFUL EUROPEAN INITIATIVE .....	698
<b>Marijana Ranisavljev, Nikola Todorović, Sara Jovanović, Sergej M. Ostojić</b> ASSESSMENT OF PHYSICAL FITNESS IN THE ELDERLY: CROSS-SECTIONAL STUDY .....	699
<b>Bojan Raskovic, Ferenc Gyori, Borislav Obradovic, Milan Cvetkovic, Zita Hajdune Petrovsky</b> GENDER DIFFERENCES IN RELATION TO SPORTS ACTIVITIES APPLIED IN CAMPS ALONG THE TISZA RIVER .....	700
<b>Zdenko Reguli, Michal Suchánek</b> SPECIAL PERFORMANCE IN AIKIDO TRAINING: THE RATE OF FALLING TECHNIQUES .....	701



<b>Valdemar Stajer, Darinka Korovljević, Igor Jukić, Nebojša Maksimović, Sergej Ostojic</b> EFFECTIVE PHYSICAL ACTIVITY INTERVENTIONS AT WORKPLACE: SPORT4HEALTH NETWORK .....	705
<b>Nebojša Trajković, Miroslav Zečić, Mario Baić, Damir Pekas, Špela Bogataj</b> DIFFERENCES IN MOTIVATION FOR PHYSICAL EXERCISE AMONG PEOPLE WITH DIFFERENT EDUCATIONAL LEVELS .....	706
<b>TOP-LEVEL SPORT</b>	
<b>Mario Baić, Włodzimierz Starosta, Damir Pekas</b> COMPARISON OF TWO DIFFERENT GROUPS OF TOP LEVEL WRESTLERS .....	712
<b>Valentin Barišić, Ivan Mikulić, Tihana Nemčić, Goran Sporiš, Stipo Dajaković</b> DETERMINATION OF STABILITY OF PERFORMANCE INDICATORS IN FOOTBALL .....	716
<b>Ivan Belčić, Lana Ružić, Slaven Krtalić</b> FITNESS LEVEL AND QUALITY OF HANDBALL REFEREES IN REGARD TO THEIR AGE .....	721
<b>Danijel Bertović, Tomislav Hublin, Zlatan Bilić</b> DIFFERENCES IN SITUATIONAL EFFICIENCY PARAMETERS OF SERVE AND SERVE RETURN BETWEEN MATCH WINNERS AND LOSERS IN 2019 AUSTRALIAN OPEN .....	725
<b>Goran Bobić, Snježana Schuster, Mile Marinčić</b> HANDBALL PERFORMANCE INDICATORS OF WINNING TEAMS IN GROUP STAGE MATCHES OF THE 2016 OLYMPIC GAMES TOURNAMENT. IS THERE ANY DIFFERENCE BETWEEN THE WINNERS? .....	730
<b>Lidija Bojić-Čačić, Dinko Vuleta, Dragan Milanović</b> DIFFERENCES IN ANTHROPOMETRIC CHARACTERISTICS BETWEEN THE CROATIAN FEMALE WING HANDBALL PLAYERS OF DIFFERENT AGE CATEGORIES .....	734
<b>Marko Cetinić, Stjepan Strukar, Sanja Ljubičić</b> ANALYSIS OF THE DEVELOPMENTAL TRENDS IN RESULTS OF DISCUS THROWERS IN CROATIA FROM 2008 TO 2020 .....	738
<b>Adrian Cojocariu, Beatrice Abalaeși, Bogdan Ungurean, Petruța Martinaș</b> THE EFFECT OF A FIVE-WEEK TRAINING ON UPPER LIMBS SPECIFIC ENDURANCE-SPEED MOTOR ABILITY IN ELITE ATHLETES OF QWAN KI DO MARTIAL ART .....	742
<b>Ivana Dabo, Mia Perić, Nera Budalica</b> DOES THE ARTISTIC SWIMMERS' PHYSICAL APPEARANCE INFLUENCE THE JUDGES' FIGURE SCORES? .....	743
<b>Ruta Dadelienė, Ricardas Nekrišius, Stanislav Dadelo</b> HIGH INTENSITY TRAINING LOAD IMPACT TO MUSCLE OXIGENATION AND CONCENTRATION OF LACTATE IN KAYAK ELITE ATHLETES .....	747
<b>Sunčica Delaš Kalinski, Ana Kezić, Ana Penjak</b> TRENDS IN BEAM EXERCISE STRUCTURES OF ARTISTIC GYMNASTICS THROUGH FIVE OLYMPIC CYCLES .....	748
<b>Tomislav Đurković, Maja Ban, Mateja Krmpotić</b> COMPARISON OF WINNING PLAYING MODELS ON THREE LEVELS OF COMPETITION IN THE VOLLEYBALL WORLD LEAGUE .....	752
<b>Alan Franjković, Bojan Matković</b> DIFFERENCES BETWEEN NATIONAL HOCKEY LEAGUE (NHL) AND KONTINENTAL HOCKEY LEAGUE (KHL) IN ATTACK ACTIONS – PILOT STUDY .....	756
<b>Igor Gruić</b> TEAM HANDBALL - STATE OF THE ART .....	761

<b>Mladen Hraste, Nikša Đurović, Ljubica Stanišić</b> PRIORITIES AND RANKINGS FOR OFFENSIVE BASELINER TENNIS PLAYER: THE ANALYTIC HIERARCHY PROCESS (AHP) .....	767
<b>Ana Kezić, Sunčica Delaš Kalinski, Ana Penjak</b> TOP LEVEL FLOOR ROUTINES STRUCTURE AT THE OLYMPIC GAMES: THE IMPACT OF ACROBATIC AND DANCE ELEMENTS .....	771
<b>Damir Knjaz, Vedran Dukarić, Mateja Očić, Ivan Bon, Maja Horvatin</b> YOUTH BASKETBALL AND HANDBALL PLAYERS: DIFFERENCES IN DYNAMIC BALANCE TEST PARAMETERS .....	776
<b>Jiamin Kong</b> ANALYSIS OF THE TECHNICAL CHARACTERISTICS OF WORLD ELITE WOMEN TAEKWONDO HEAD SCORING—A CASE STUDY .....	780
<b>Jiamin Kong</b> ANALYSIS OF THE TECHNICAL CHARACTERISTICS OF WORLD ELITE WOMEN TAEKWONDO ATHLETE RUTH GBAGBI HEAD SCORING .....	781
<b>Goran Leko, Dajana Karaula, Lucija Kralj</b> ANALYSIS OF THE TREND OF RESULTS DEVELOPMENT IN THE DISCIPLINES OF BREASTSTROKE TECHNIQUE FOR SWIMMERS AT WORLD CHAMPIONSHIPS .....	782
<b>Jiaqi Liu</b> ANALYSIS ON THE SCORING TECHNICAL CHARACTERISTICS OF WORLD HIGH-LEVEL FEMALE TAEKWONDO ATHLETE MATEA JELIC .....	787
<b>Sanja Ljubičić, Ljubomir Antekolović, Marijo Baković</b> THE ANALYSIS OF DEVELOPMENTAL TRENDS IN THE OLYMPIC RESULTS OF WOMEN'S HIGH JUMP .....	788
<b>Nenad Marelić, Marko Marelić, Tomislav Đurković</b> CORRELATION BETWEEN SELECTED ANTHROPOMETRIC VARIABLES AND QUALITY OF UNDERHAND SERVE RECEPTION PERFORMANCE IN VOLLEYBALL .....	793
<b>Rasa Mikalonytė, Rūtenis Paulauskas</b> CHANGES IN PHYSICAL DEMANDS BETWEEN GAME PARTS OF JUNIOR FEMALE HANDBALL GAMES .....	797
<b>Andrija Mikša, Marko Milanović, Tonći Jerak</b> STANDARD PERFORMANCE INDICATORS AS FACTORS OF MEN'S TEAM PERFORMANCE AT THE 2019 WORLD HANDBALL CHAMPIONSHIP .....	798
<b>Ivan Mikulić, Mihael Mindek, Valentin Barišić</b> DIFFERENCES IN PASSING BETWEEN QUALIFIED AND NON-QUALIFIED TEAMS FOR THE KNOCKOUT STAGE IN WORLD CUP 2018 .....	803
<b>Luka Milanović, Kristijan Mitrečić, Marin Dadić</b> DIFFERENCES BETWEEN WINNING AND LOSING TEAMS AT THE 2018 FIFA WORLD CUP IN RUSSIA IN SITUATIONAL PARAMETERS OF A FOOTBALL MATCH .....	808
<b>Mirjana Milić, Zoran Grgantov</b> ABSOLUTE AND RELATIVE RELIABILITY OF SPECIFIC VERTICAL JUMPING TESTS IN SENIOR FEMALE VOLLEYBALL PLAYERS .....	813
<b>Saša Milovuković, Vedran Budetić, Branimir Budetić</b> DIFFERENCES IN THE TREND LINE OF TOP 100-M DASH RESULTS IN ATHLETES WITH DIFFERENT DEGREES OF VISION IMPAIRMENT .....	817
<b>Marijo Možnik, Tomislav Krističević, Lucija Milčić</b> DIFFICULTY VALUES IN MEN'S ARTISTIC GYMNASTICS AT 2019 EUROPEAN AND WORLD CHAMPIONSHIPS .....	821
<b>Tihana Nemčić</b> GOALKEEPER ACTIVITY AND EFFICIENCY IN FUTSAL .....	825

<b>Alexandru Oprean, Marin Chirazi, Rares-Alexandru Puni</b> BODY COMPOSITON EVOLUTION OF ROMANIAN PROFESSIONAL RUGBY PLAYERS – FORWARDS ....	829
<b>Tomislav Paripović, Petar Barbaros, Mario Oršolić</b> DIFFERENCES IN PARAMETERS OF SERVICE SITUATIONAL EFFICIENCY BETWEEN MAN PLAYERS WHO WON AND LOST MATCHES AT WIMBLEDON 2017 .....	833
<b>Karmen Reinpõld, Indrek Rannama</b> SEASONAL CHANGES IN LABORATORY CYCLING PERFORMANCE, METABOLIC ECONOMY AND PEDALLING EFFICACY IN COMPETITIVE ROAD CYCLISTS .....	837
<b>Tomica Rešetar, Anja Toplek, Nenad Marelić</b> PERFORMANCE INDICATORS OF SERVE RECEPTION FOR DIFFERENT PLAYER ROLES IN FEMALE VOLLEYBALL HIGH-LEVEL COMPETITIONS .....	841
<b>Asta Sarkauskiene, Gabriele Navardauskiene</b> THE PHYSICAL LOAD AND SPORTING ACHIEVEMENTS OF THE PROFESSIONAL ROAD CYCLIST R. N. DURING THE OLYMPIC CYCLE .....	846
<b>Aleksandar Selmanović, Tonći Jerak, Vicko Mihaljević</b> THE RELATION IN QUANTITY OF BALL PASSES AND EFFECTIVENESS IN ELITE EUROPEAN BASKETBALL .....	850
<b>Hrvoje Sivrić, Zrinko Čustonja, Damir Rukavina</b> BALL PASSING OF FUTSAL PLAYERS WITH DIFFERENT COMPETITIVE PERFORMANCE .....	856
<b>Stjepan Strukar, Marija Ivanković, Dražen Harasin</b> ANALYSIS OF THE DEVELOPMENTAL TRENDS IN RESULTS OF SHOT PUTTERS IN CROATIA FROM 2008 TO 2020 .....	861
<b>Nebojša Trajković, Goran Sporiš, Slobodan Andrašić</b> DIFFERENCE IN PHYSICAL PERFORMANCE IN ADOLESCENT SOCCER PLAYERS ACCORDING TO THEIR LEVEL .....	865
<b>Tatjana Trivic, Zoran S. Milosevic, Patrik Drid</b> HANDGRIP STRENGTH DURING OFFICIAL JUDO COMPETITION .....	866
<b>Ognjen Uljević, Neven Kovačević, Ivan Rukavina, Dean Kontić</b> DIFFERENCES AMONG SELECTED AND NO-SELECTED MALE WATER POLO PLAYERS IN MORPHOLOGICAL CHARACTERISTICS AND PHYSICAL FITNESS CAPACITY .....	867
<b>Monika Vajdić, Petar Barbaros, Ivan Bon</b> THE DIFFERENCE IN THE PARAMETERS OF SITUATIONAL EFFICIENCY OF SERVE AND RETURN OF SERVE BETWEEN WINNERS AND DEFEATED MEN PLAYERS ON THE ROLAND GARROS 2018 .....	872
<b>Bartol Vukelić, Goran Leko, Klara Šiljeg</b> EVALUATION OF SCORING SYSTEMS IN SWIMMING RESULTS .....	877
<b>Dinko Vuleta, Krešimir Pažin, Katarina Ohnjec, Marko Milanović</b> WINNING AND LOSING WOMEN’S HANDBALL TEAMS AT THE OLYMPIC HANDBALL TOURNAMENT RIO 2016 .....	881
<b>Yuting Yang, Suying Wu</b> A STUDY ON THE FOUL BEHAVIOR CHARACTERISTICS OF BIANCA WALKDEN, A WORLD ELITE FEMALE ATHLETE .....	885
<b>Siyuan Zhang, Jianzhong Wu</b> A STUDY ON THE CHARACTERISTICS OF THE WORLD’S EXCELENT FEMALE TAEKWONDO ATHLETE LEE AHREUM’S SCORING AND LOSS OF SCORING .....	886
<b>Yang Zhao, Dan Wang</b> RESEARH ON THE CHARACTERISTICS OF PANIPAK’S LOSING POINTS IN TAEKWONDO WOMEN’S 49KG ELITE ATHLETE .....	887
<b>Conference paper and abstract reviewers .....</b>	889
<b>Index of authors .....</b>	890



# Invited lectures

**9<sup>th</sup> INTERNATIONAL  
SCIENTIFIC  
CONFERENCE ON  
KINESIOLOGY**





## ECONOMIC ANALYSIS AND FORECASTING OF OLYMPIC MEDAL TOTALS

**Wladimir Andreff**

*University Paris 1 Panthéon Sorbonne, France*

Among the many topics dealt with in sports economics, one is of interest for non-economists: how can we explain and then forecast the Olympic medal totals of a country? Most sciences provide explanations based on individual variables (athletes good shape, training, doping, etc.). Economists are used to model macro-variables supposed to be explanatory.

This kind of literature started up with and found its basic modelling with Bernard & Busse (2004), then Andreff et al. (2008); the latter was able to exactly forecast 70% of the medal totals distribution at the 2008 Beijing Olympics, and even 88% with a two medals error margin. Major determinants of medals distribution usually appear to be GDP, population or GDP per capita, and a home country effect, plus various different additional variables from one model to the other. After briefly sketching these potential additional variables, a model used to explain the Summer Olympics outcomes since 1992 (Scelles et al., 2020) will be presented with its econometric estimation results. Then the model has been used to forecast the distribution of medal totals per nation at the 2020 (then postponed to 2021) Tokyo Olympic Games.

Since a model never can “guess” exactly 100% of the future, a final discussion will be introduced about the (probably observed) gaps between forecasts and actually achieved medal totals of some nations at the Tokyo Games, which variables may be missing and the overall interest of such modelling. The presented model is used to forecast the medal totals at the Paris 2024 Olympics. A similar model has been successfully adapted to Winter Games (Andreff, 2013) and has detected the possible impact of doping on medal wins.

**Key words:** *Olympic Games, medals totals, macroeconomic variables, forecasts*

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- \* Honorary Professor, University Paris 1 Panthéon-Sorbonne; President of the Scientific Council at the Observatory of the sports economy, French Ministry of Sports, [andreff@club-internet.fr](mailto:andreff@club-internet.fr)

## POST-PANDEMIC SPORTS: TENSIONS, TRANSITIONS, & TRENDS

**Jay Coakley**

*University of Colorado in Colorado Springs, USA*

The focus of this presentation is on tensions in post-pandemic sports and the anticipated transitions and trends that will occur in the post pandemic era. The premise of the presentation is that issues and questions about the organization of sports that have emerged during the pandemic have created tensions that will influence the organization of sports. While efforts to restore and increase the profitability of commercial sports there will also be efforts to establish new sport forms that reflect the interests of participants. The resulting tensions will initiate a transitional period during which diverse trends will emerge. The sustainability of specific trends depends on the dynamics of power relations among those with vested interests in various sport forms and the abilities of sport organizations to secure sponsorships and media coverage over an extended period. The sustainability and expansion of commercial sports, such as the top professional fixtures/leagues in the United States, depends primarily on spectator interest, corporate sponsorships, media rights, and government support. The sustainability of local, grass roots, and participant-driven sports depend on popular support, the recruitment and socialization of participants, their organizational abilities, and their effective distribution of self-produced media. Although the future of sports will be created rather than predicted, the presentation will focus on probable trends over the next decade and the social, economic, and political factors that will influence their sustainability.



## SESSION RPE: A TOOL FOR MONITORING EXERCISE TRAINING

**Carl Foster**

*University of Wisconsin-La Crosse, USA*

The sRPE method was developed ~25 years ago as a modification of Borg's RPE method. It was designed to estimate the intensity of an entire training session, rather than momentary intensity estimated by Borg's method. With >20,000 citations since 1995, it has become well-accepted method of measuring the internal training load. Early studies demonstrated that sRPE correlated well with objective measures of internal training load, such as %VO<sub>2</sub>max, %HRR & [BL]. It has been shown to be useful in a variety of exercise modes ranging from aerobic to resistance to games, and effective in populations ranging from patients to elite athletes. The sRPE is a reasonable estimate of the average RPE acquired across an exercise session, and, at constant intensity, displays an upward drift with more prolonged exercise, suggesting that it measures accumulated fatigue in addition to intensity. Originally designed to be acquired ~30 minutes following an exercise session, sRPE has been shown to be temporally robust, across periods ranging from 1 minute to 14 days following an exercise session. Within the TRIMP concept, sRPE and indices derived from sRPE, predicts both positive and negative training outcomes, As such sRPE contributes to understanding how training periodization can optimize training outcomes or predict maladaptations such as overtraining syndrome. sRPE has the advantage of extreme simplicity. While not ideal for precise recording of the details of the external training load (distance, acceleration), it has large advantages compared to more technologically demanding methods relative to evaluating the internal training load.

## ANTI-SYSTEM PERFORMANCE. IDENTITY AND POLITICS OF ULTRAS FANDOM

**Radosław Kossakowski**

*University of Gdańsk, Poland*

Ultras fans groups are a phenomenon that connects the global and the local. On the one hand, these groups have spread all over the world – from Brazil, through the USA, Europe and Indonesia, presenting similar means of expression during matches (chants, flags, choreographies). On the other hand, in every corner of the world they refer to local identities, the core of which is the local club. Devotion to locally developed identities is the common ground of ultras culture, but not the only one, as cultivating local traditions is only one of the dimensions of what is called *mentalita ultras*. The term refers to the specific lifestyle and modus operandi of ultras groups around the world. Other dimensions of this mentality include loyalty, brotherhood (less often sisterhood), particular consumption styles (both stimulants and clothing brands), inclinations to violence (both symbolic and physical), but most of all - a specific anti-system, antagonistic attitude. A characteristic feature of ultras culture is the communication of disagreement, resistance, and the difference that appears between ultras from different countries concerns the object of resistance. For example, ultras from Poland, Balkan, Hungary (the overwhelming majority) are firmly opposed to left-wing and LGBT-right movements. In Indonesia (and many other countries) opposition is raised by the police and football authorities. In North Africa (Morocco, Egypt) and Turkey, *mentalita ultras* was directed against the political authorities (whose decisions also hit the ultras movement).

The antagonistic attitude is also associated with a sense of uniqueness, authenticity, because the ultras movement present itself as guardians of traditions not spoiled by so called ‘modern football’ (Against Modern Football is another dimensions of antisystem and antagonistic ultras’ attitude). As anti-system attitude is connected with rivalry in the football field (fans from one country may hate, for example, the police, but simultaneously they hate each other), it requires being courageous, and willing to violence. The ultras culture is therefore ‘military’ in nature (which is necessary in violent confrontations, but also in planning defense/attack), and consequently limits the role of women.

One of the most important question to be solved is: is it possible to reconcile an antagonistically oriented identity/ *mentalita ultras* with inclusivity? If there are left-wing, progressive ideologies in the ultras groups (as is the case in some European countries), are they legitimated only if they are ‘against’ ideologies (and therefore must – paradoxically – be as exclusive as the right-wing)? So do the left-wing ultras groups also build their identity on having an ‘enemy’? Similar questions will be asked during the presentation, along with a discussion of possible – analytical – assumptions.

## DEVELOPMENT OF MOTOR COMPETENCE AS A GATEWAY TO HEALTHY LIFE AND OPTIMAL SPORTS PERFORMANCE

**Matthieu Lenoir**

*Department of Movement and Sports Sciences, Faculty of Medicine and Health sciences, Gent University, Belgium*

Motor competence (MC) is defined as the ability to organise body parts in a coordinated manner to translate an intention into a successful motor outcome. Ideally, that outcome is tuned to the demands of a specific situation in daily life, work, or sports. MC is positively associated with psychological, emotional, and social development, as well as with health benefits from childhood to far into adult life. In this lecture three topics related to MC will be overviewed. First, an analysis of the current state of MC from the second year of life is proof of a downward secular trend that potentially affects all children in modern societies. This trend mimics the secular trend of physical fitness in children and adolescents that has been documented since the 70ies of the previous century. Second, research and practice has indicated that such a negative trend can easily be remediated at a very limited financial and societal cost. Key to the remediation is the optimal use of existing structures in society, like schools, sports clubs and federations to stimulate MC from a developmental perspective. Ironically, the Covid-19 pandemic has, apart from all negative health and economical consequences, provide very convincing data on the necessity of such stimulation on a regular and continuous basis. In the third part of the lecture the connection between motor development and talent identification in sports is made, underlining the value of an optimal development of general MC as a foundation of sport participation, talent identification, talent development, and talent transfer. This part builds upon the idea that a solid and generic MC level acquired in the first years of life gives the athlete the advantage of learning new and complex skills faster and with less effort, facilitating athletic development in a particular sport, and even transfer to another sport.

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## CAVING TO PAIN: THE ROLE OF EXERCISE-INDUCED PAIN IN ENDURANCE PERFORMANCE

**Lex Mauger**

*Reader in Exercise Physiology*

*University of Kent, UK*

Vigorous exercise creates a noxious metabolic environment in and around the exercising musculature which causes naturally occurring transient pain (exercise-induced pain; EIP). The magnitude of this EIP is usually proportional to the exercise intensity and/or duration and may affect the performance of that exercise. Consequently, tolerance of EIP is an important determinant of success, which is evidenced by better-trained individuals having a higher pain tolerance, and exercise training causing an increase in pain tolerance alongside parallel improvements in performance. The mechanisms by which EIP may affect exercise performance are debated, but it is likely that they are a combination of physiological and psychological origin. The severity of its impact, and the combination of the causal mechanisms are likely to be specific to the individual, the type of exercise and the environment it is performed in. Experimental studies suggest that the higher pain tolerance of trained athletes can be attributed to improved coping mechanisms and that this can occur independently of physiological adaptation. Furthermore, nociceptive stimuli have been shown to induce supraspinal fatigue and reduce maximal voluntary contraction. However, exploring the relationship between EIP and exercise performance is challenging because of the need to use an experimental pain model that can be induced independently of exercise and that replicates the perception of EIP. The intramuscular injection of hypertonic saline solution has been suggested to closely replicate EIP, but there are a limited number of studies on human performance which use this technique. Over the last 10 years, my research team at the University of Kent have explored the relationship between EIP and endurance performance. This talk provides a background to EIP and will go on to present the key studies from my lab which assess the impact of both alleviating and exacerbating EIP during exercise, with a specific focus on those studies which use hypertonic saline as a means of inducing muscle pain.

## CURRENT CONCEPTS OF SCREENING FOR CARDIOVASCULAR DISEASE IN ATHLETES

**Tim Meyer**

*Saarland University, Germany*

Albeit rare, serious cardiac events still occur among athletes with cardiovascular disease. The vast majority of these cases is registered among older athletes in recreational sport and much more frequently among males than among females. However, sudden deaths in elite athletes usually get a lot of public attention and - on top of all individual tragedy - have the potential to damage the reputation of sport. Therefore, several national and international associations have decided to conduct screening examinations to identify athletes at risk at an early stage and advise them to modify their activities or reduce risk by medication. Target groups as well as screening strategies vary based upon available financial resources and regional disease patterns. A major difference between the US and the European approach has recently been addressed by the introduction of the "Seattle criteria" to assess resting ECGs in athletes. They help to improve specificity of ECG evaluations enormously and should, thus, be known by each sports physician involved in screening procedures. Unavoidably, screening will fail to identify existing disease in a few cases ("false negatives") which means that intervention strategies for cardiac events (resuscitation, defibrillator) have to be available and known to medical protagonists.

## KICKING OFF IN THE “NEW WORLD”: FOOTBALL, CRISES, AND INTERWAR YUGOSLAV-SOUTH AMERICAN RELATIONS

**Richard Mills**

*University of East Anglia, Norwich, United Kingdom*

In 1934, the national football team of the young Kingdom of Yugoslavia hosted Brazil in Belgrade. The game was the first visit by a South American side, although six of the home players who featured in an impressive 8-4 victory had already encountered South American football first-hand. Yet, that ostensibly collective experience masks the deeply divided nature of previous interactions with a faraway continent: the South Slav players who came together in Belgrade had ventured across the Equator separately.

This lecture examines two very different tours, alongside the tense political situation that shaped them: the first, Yugoslavia's participation in the inaugural World Cup of 1930, was marred by a Croatian player boycott and bitter arguments over the division of the spoils; the second, Hajduk Split's tour of 1931, provided an opportunity for leading Croatian footballers to experience the kind of spectacles they had been compelled to abstain from the previous year. Both expeditions occurred at a time of burgeoning transnational interactions between Europe and South America. They shed light upon the fragility of interwar Yugoslav politics, particularly concerning broader constitutional questions manifested in the tug-of-war over the Yugoslav Football Association. They offer a means to examine Yugoslavia's relations with South America, and the latter's growing South Slav *émigré* communities, at a time of deep economic instability. Fluid diaspora identities fostered complex relationships with both the 'homeland' and visitors from it. Tours also brought players into contact with royalty, revolution, racial tensions, industrial action, and global crisis, providing opportunities for the troubled Kingdom's inhabitants to assess their place in the world, and vice-versa.

Based upon research and fieldwork at clubs, institutions, archives, and libraries on both continents, the lecture harnesses memoirs, diplomatic correspondence, photographs, contemporary newspapers, and scholarship. In combination, these sources demonstrate that Yugoslav football's tentative steps in the Southern Hemisphere evidently elucidated aspects of the domestic political situation. Our itinerant footballers encountered distant countries and football organisations racked by all-too-familiar difficulties and tensions. They may have ventured '[f]orward, into the distant New World', as one of the players put it, but upon arrival they found many old world problems.

## THE ROLE OF CHILDREN'S MOTOR COMPETENCIES IN CONTEMPORARY SOCIETY - CAN THEY SURVIVE BEING PHYSICALLY INACTIVE?

**Rado Pišot**

*Science and Research Center Koper, Institute for Kinesiology Research, Koper, Slovenia*

**Introduction:** Motor development enables individuals to achieve higher levels of motor competence across different stages of life. Physical activity (PA) is a lever for physical fitness, immune system resilience, and maintaining psychophysical balance. PA has been present throughout human evolution, has shaped our bodies and we simply cannot survive without it. Replacing PA with the help of technological advances is not tenable! PA restriction related to COVID-19 and high exposure to physical inactivity (PI) and “hypokinetic conditions” is just an extreme form of the sedentary lifestyle we have been witnessing for at least the last two decades. A “sociology of sedentarism” is being established and is a new reality, but can science support it?

**Methods:** A review of numerous studies suggests the severe consequences of PI on physical and mental health and a rapid deterioration of various bodily systems.

**Results:** Our post COVID-19 research about the implementation of various forms of PA in children (P5-0381; N3936, 6-12 years) showed a severe drop in the amount of PA. Sports activities at school decreased sharply from 72.2% before to 16.5% during, and children's participation in organized training in sports clubs from 69.7% before to 11.9% during the epidemic, a significant decrease in the time children spent exercising.

The absence of PA quickly leads to the remodulation of motor units and the mechanisms of muscle changes and deterioration, as shown in the bed rest study (BR). Moreover, insulin resistance increases in the short term after a period of PI. Surprisingly, we found the consequences of the COVID-19 restrictions were the same as after BR.

Pronounced sedentary behavior (SB) is associated with body adiposity and cardiovascular risk factors. In addition, the accumulation of SB with only a few pauses leads to further deterioration of the cardiometabolic profile. In this context, it is important to note that children's adiposity at baseline increases SB and decreases moderate and vigorous PA (MVPA) in longitudinal studies. However, this relationship is not bidirectional, suggesting that adiposity influences PA and/or SB and not vice versa.

**Conclusions:** There are increasingly long periods of PI in both active and inactive populations of children and adolescents. Ensuring sufficient, high-quality PA is certainly a challenge but reducing PI in the most vulnerable subgroups must be addressed separately. Along with the world-wide pandemic restrictions, we must be aware that limiting PA may result in systematic poorer health, higher vulnerability to diabetes, cardiovascular disease etc. – a vicious cycle.

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## **FORCE-VELOCITY-POWER PROFILE: FROM THEORY TO PRACTICE**

**Pierre Samozino**

*Université Savoie Mont Blanc, Chambéry, France*

The performance in many sport activities is largely associated to success in movements aiming at accelerating its own body mass as quickly as possible (vertical and horizontal jumps, sprint acceleration). Such performances are mainly determined by the maximal power lower limbs can generate, but also by the underlying individual force-velocity (FV) mechanical profile, and notably the associated FV imbalance. The importance of the FVP profiling approach for sports performance is supported by recent experimental evidence in jumping and sprinting modalities. A better understanding of this approach may lead to improved training interventions. In this context, the aim of this presentation is to propose an update regarding “Force-Velocity-Power profiling” from theory to practice, including theoretical background and new experimental findings about FV profile during jumping and sprint running, description of innovative field methods for performance testing and discussion about the potential interest for training and injury management.

## RESEARCH ON VALUE ASSESSMENT OF SPORTS EVENTS BASED ON THE THEORY OF VALUE CHAIN MANAGEMENT

Shuhong Xiao, Yunyun Hou

Beijing Sport University, China

### Abstract

Sports events are the core business of the sports industry. How to assess event value has attracted much attention of the whole industry in recent years. This paper adopts the methods of literature review, logic analysis, and expert interviews to classify, analyze and summarize the status and achievements of the research on event value assessment at home and abroad. Based on the theory of value chain management, this paper proposed that the value assessment of sports events should be based on the perspective of chain management, and take a comprehensive and systematic view of the interrelated roles of all subjects in the whole supply chain of sports events; the market value and non-market value of events should be considered comprehensively, and the value points of interest-related subjects should be considered comprehensively; the value engineering principle should be used to sort out the value of events factors and conduct to value analysis, so as to build a logically consistent system; the relevant evaluation methods should be used to establish a dynamic evaluation model to assess the their value. It is suggested that future research on event value assessment should dynamically adjust indicator systems, assessment methods and models for different interest-related subjects, so as to assess event value more targeted and accurate.

**Key words:** *Value Assessment of Sports Events; Value Chain Management; Value Engineering; interest-related subjects*

### Introduction

A series of sports dividend policies have been released since October 2014, creating optimal development opportunity for the sports industry. However, as the core of the sports industry, sports events are still at an early development stage. How to assess and improve the value of sports events has become the core issue concerning the development of sports events.

There are numerous studies on value assessment of sports events (eg Peter Rossi, P. H., Lipsey, M. W., & Henry, G. T. 2018; Cornwell, T. B 1995; Bo Liu & Hua Yu 2007). However, there is no holistic, systematic and integral sports event value assessment methods and classification system. Moreover, these methods lack operability. According to the value engineering theory, different subjects have different value cognition of the same products or services. But there are few studies about classifying event value from the perspective of interest-related subjects (Nanzhu Li and Qin Yao, 2009). Therefore, this paper aims to sort out domestic and foreign literature on event value assessment in recent years, summarize previous research results, analyze and generalize the problems existing in these studies, find comprehensive solutions to event value assessment and establish assessment models. It employed the theory of value chain management and the method of value engineering, and studied the event value concerning different interest-related subjects from the perspective of relevant interest-related subjects of sports events. Besides, it also carried out targeted research on indicator systems, assessment methods and models of the events. By doing so, it hopes to make contribution to the scientificity and completeness of the research on event value assessment.

### Research Methods

Firstly, retrieving relevant literature with such key words as event value, event interest-related subjects, event social benefits, media value, sponsorship value, intangible asset value, and value assessment, 159 domestic and foreign documents of this theme from 1995 to 2018 were found and were studied. After reviewing the above 159 documents, this paper logically analyzed the research status of event assessment, concluded existing problems and provide different value assessment indicator systems, methods and models based on value management theory. At the same time, relevant questions were discussed with relevant experts at theme forums, interviews and round-table discussions. Expert opinions were concluded to prove the main ideas of this research.

## Results

Currently there are three commonly used models for assessing the economic value of events, which are input-output (I-O), computable general equilibrium (CGE) and multiplier models. The three types of models have specific assumptions and therefore are suitable for different scenarios. Different events can select evaluation models according to the situation. However, there is no unified and widely accepted assessment system of event market value. In particular, the applicability of the single assessment model still needs expansion. Second, in terms of non-market value assessment, it is hard to employ the traditional method of economic assessment. Therefore, the assessment can only be made by indirect ways, the representatives of which include: CVM, TCM and HPM (See Table 1).

Table 1. Statistical table of classification of non-market value evaluation methods

Non-market value assessment methods	Scope of application	Application examples
Contingent Value Method (CVM)	<ol style="list-style-type: none"> <li>1. methods applied to the pre-game assessment of non-market values.</li> <li>2. direct assessment of user needs.</li> <li>3. relatively mature methods with wide application.</li> </ol>	<ol style="list-style-type: none"> <li>1. Johnson &amp; Whitehead--Non-Market Value Assessment of the Penguins in the US NHL;</li> <li>2. Bruce K. Johnson-- A team from the U.S. NHL, NFL, NBA and MLB and the London Olympics</li> </ol>
Standardized Hedonic Price Method (HPM)	<ol style="list-style-type: none"> <li>1. Valuation through real estate price analysis;</li> <li>2. Indirect measurement of invisible earnings;</li> <li>3. fewer errors</li> </ol>	<ol style="list-style-type: none"> <li>1. Carlino and Coulson Demon prove that the presence of NFL teams and their stadiums leads to real estate price appreciation;</li> <li>2. Charles Tu Washington Redskins - Baseball Team Prince George's, Maryland Home Price Impact</li> </ol>
Cost-benefit model (consumer surplus theory)	<ol style="list-style-type: none"> <li>1. Cost-benefit calculation based on the number of spectators and ticket prices;</li> <li>2. The model is based on the annual ticket sales revenue of the event and the price elasticity during the game;</li> <li>3. The importance of consumer surplus depends on the elasticity of demand</li> </ol>	Alexander, Kern and Neil; Crompton, Howard and Wa - 53 stadiums built from 1961 to 2003

The evaluation method of the sponsorship value of sports events are mainly divided into the following categories:

1. Exposure-based Method. Cornwell believes that exposure-based method include monitor the amount and quality of media coverage obtained from sponsored events, and to estimate direct and indirect audiences (Cornwell and Maignan, 1998). Hulks believed that the above method can estimate the number of spectacular of television and radio media (Hulks, 1980). However, Pham pointed out that these methods cannot provide useful information for evaluating the effectiveness of commercial sponsorship (Pham, 2000).
2. Tracking measurement methods. Most of the international literature has begun to use practice and tracking techniques to measure the effectiveness of sponsorship (Walliser, 2003; Cornwell and Maignan, 1998; McDonald, 1991).
3. Experimental method. Pham argues that experimental methods are superior to consumer tracking methods (Pham, 2000). Nora and other researches also used experimental methods to test the cognitive process of the impact of the matching degree between sponsors and events on its final effects (Nora, 2004).
4. Empirical research methods related to short-term or long-term returns of enterprises (Cornwell and Maignan, 1998). In fact, the tangible effect of sports sponsorship marketing can be calculated from many angles. For example, the stock price and earnings of car sponsors (Cornwell, 1995).

To sum up, the overall model of sponsorship evaluation is relatively scarce and lacks certain scientific standards. It is recommended that improving the research of the sponsorship value evaluation system of the event for different sponsorship purposes in order to assess more complete and comprehensive.

## Discussion

According to Value engineering theory, the value of the event should be classified from the relevant interest-related subjects (such as government, the media, the sponsor), and different index systems, evaluation methods and models should be applied to different interest-related subjects while evaluating, so as to assess in a more targeted and accurate way.

There are some issues about sponsorship valuation. First, it is difficult to determine a unified evaluation standard due to the different objectives of corporate sponsorship (Crompton, 2004). Second, the conformability of sports sponsorship makes it difficult for evaluators to clarify the effects of sports sponsorship (SHEN Jia, 2015). Third, it is difficult to quantify the evaluation indicators of sports sponsorship. many scholars study the sponsorship value of sports events, it is difficult to measure corporate image and customer loyalty, so they cannot establish a measurable evaluation criteria (Dongnan Chen and Yuan Li, 2012; Bo Liu, 2007). Therefore, based on the above problems, we use a dynamic indicator system – the appraisers function diagram for evaluation – to solve the above problems.

Using the theory of value chain management, it is hoped that an event can be decomposed from the top down and realized from the bottom up, and the value of the event can be evaluated by level, subject, and step. At the same time, fully considering the interrelationship between the interest-related subjects of the event. First, defining the supply chain of sports events, constructing the definition of the supply chain of sports events, and analyzing the formation process of the supply chain, the linkage mechanism and the essence of value creation management. It is concluded that supply chain management is composed of contract management, trust management and information management. Contract management is the foundation, trust management is the core, and information management is the guarantee. The three parts are interconnected, influenced and inseparable. Second, building a performance evaluation index system for event value supply chain management. Combining the influence of the essence of supply chain management on the performance of supply chain management, building a supply chain management performance evaluation based on the essence of supply chain management from the four dimensions of strategic supplier relationship, strategic customer relationship, interior lean production and postponement strategy, information sharing and information quality Index system. The value creation process and value realization evaluation must be examined from the perspective of the whole supply chain. Constructing a value evaluation index system based on the supply chain.

## Conclusions

Based on the theory of value engineering, this paper collects 159 international literature related to the value evaluation of sports events based on the classification of event interest-related subjects, respectively studies the different demands of different interest-related subjects as the evaluation subject for events, and then analyzes different influencing factors and evaluation methods and models of the event value evaluation that interest-related subjects are concerned about. The conclusions drawn through content analysis are mainly reflected in the following aspects:

- (1) The classification of event value in existing research is relatively ambiguous and lack scientific basis.
- (2) According to the theory of value engineering, different interest-related subjects have different value demands for the same thing. But existing research from the perspective of interest-related subjects on the value of the event is very exiguous.
- (3) Concerns about event value overlap among different interest-related subjects.
- (4) There are too many qualitative and normative studies on the influencing factors of the value of each event, and there is a lack of quantitative analysis of complete evaluation models and methods with realistic basis and practical significance.
- (5) The existing literature lack of panoramic system research, more research is about economic and social benefits, less research about sponsorship, media, copyright and other commercial value.
- (6) There is no universal method to measure the value of the event. Therefore, the same event has different evaluation methods for different subjects.

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## THE EFFECTS OF SMALL SIDED GAMES COMBINED WITH KAATSU TRAINING ON REPEATED SPRINT ABILITY IN YOUTH SOCCER PLAYERS

Liang Yu, Zhi Bo Zhou, Zheng Song Wang, Xiao Lan Zhu

Beijing Sport University, China

### Abstract

**Objective:** The purpose was to explore the effects of small sided games (SSG) combined with KAATSU training on repeated sprint ability (RSA) in youth soccer players. **Methods:** 34 male U17 players were randomized into 3V3 SSG group (S), 3V3 SSG with KAATSU group (SK) and control group (C) for 4 weeks. Body composition, RSA maximum speed (RSAbest), RSA average speed (RSAMEAN) and RSA decline rate (RSADEC), aerobic power, muscle reoxidation rate (ROR) and muscle strength were measured. **Results:** RSAMEAN and RSAbest of S and SK group were lower than C group ( $P<0.05$ ), RSADEC of SK group was lower than C group ( $P<0.05$ ). Post-RSAMEAN and RSAbest in S and SK group were significantly lower than pre ( $P<0.05$ ), post-RSADEC of SK group was lower than pre ( $P<0.05$ ). The average output power in SK group was significantly higher than group C and S ( $P<0.05$ ), the  $vVO_{2max}$  and  $VO_{2max}$  of S and SK groups were significantly increased ( $P<0.05$ ), ROR in SK group was significantly higher than group C and S ( $P<0.05$ ). **Conclusion:** 4 weeks of SSG combined with KAATSU training can improve RSA by improving the aerobic capacity, anaerobic power and muscle strength in young football players.

**Key words:** Small Sided Games, KAATSU, Repeated Sprint Ability

### Introduction

Elite football players possess the good aerobic capacity and sprints speed, direction change ability, acceleration, deceleration and confrontation capabilities, which can be indicated by RSA. RSA refers to capability of completing more than 2 consecutive sprints ( $<10s$ ) without complete recovery (interval  $<60s$ ) (Cai et al., 2017), which includes RSAbest, RSAMEAN, and RSADEC. High-intensity interval and repeated sprints training is commonly conducted in football players to enhance RSA (Bishop, Girard & Mendez, 2011). SSG is used as a professional training for physical characteristics of football players to improve aerobic capacity (Moran, et al., 2019). However, it mainly runs at low and medium speeds, lacking high-intensity sprints and it's hard to increase muscle content and muscle strength, which leads to its defects in improving RSAbest. As a result, it's necessary to combine the SSG with other intervention to improve RSAbest (Eniseler, et al., 2017). KAATSU refers to blood flow restriction training (BFR). It can restrict the blood flow of skeletal muscle and provide a hypoxia condition by applying compression at the proximal extremities, which can achieve the similar effects of high-load training on muscle growth as the light-load training (Liang, Ruiyuan & Xiaoping, 2016). In this study it is hypothesized SSG and KAATSU can enhance RSAbest.

### Methodology

#### Subjects

34 male U17 football players from China Football College were randomly into SSG group (S,  $n=12, 171.92\pm 5.31cm, 61.28\pm 9.22kg$ ), SSG combined with KAATSU group (SK,  $n=12, 171.27\pm 3.85cm, 66.23\pm 6.44kg$ ), control group (C,  $n=10, 172.29\pm 4.72cm, 60.62\pm 7.06kg$ ). The participants were (1) no cardiovascular and neurological diseases; (2) professional football training experience at least 4 years; (3) no sports injuries one month before study. Training program and content is presented in Table 1.

Table 1. Intervention Program

Group	Time/Frequency	Time Point	Training Content
<b>C</b>	4weeks/12 times	Week (Monday, Wednesday, Friday)	Functional injury prevention training
<b>S</b>	4 weeks/12 times	Week (Monday, Wednesday, Friday)	3v3: 4 quarters x3min (1.5min);
<b>SK</b>	4 weeks/12 times	Week (Monday, Wednesday, Friday)	3v3: 4 quarters x3min (1.5min) Pressure band: length 5cm; pressure 210mmHg (Abe, et al., 2010)

## Measurement

### RSAMean, RSABest, and RSAdec

RSA was measured by six 20m back runs (6×40m), with a 20s interval (Rampinini, et al., 2007). Rest for 5 minutes between each test. The measurements were stopped if the repeated sprints greater than the basic value up to 2.5%. The calculation formula of RSAdec is presented below:

$$RSAdec = \frac{RSAMean - RSABest}{RSABest} \times 100$$

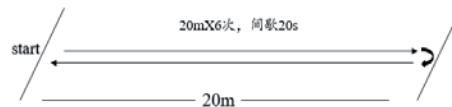


Figure 1. Repeated Sprints Illustration

### Skeletal Muscle Content

A bioimpedance body composition analyzer (InBody770, South Korea) was used to measure body skeletal muscle content and lower limb skeletal muscle content.

### Maximal Strength

Squat maximum strength (1RM) test with a Smith Rack for maximal strength.

### Anaerobic Power

30s average power, 5s maximum power and fatigue index were calculated.

### Tissue saturation index (TSI)

MBSX Insight (USA) was used to measure the TSI of 30 seconds prior to the sprint, prior to the 1<sup>st</sup> to 6<sup>th</sup> repeated sprints, and 0s, 20s, 40s, 60s, 80s, 100s, 120s following the 6<sup>th</sup> repeated sprints.

$$ROR = \left( \frac{TSI_{1_1} - TSI_{2_0}}{20s} + \frac{TSI_{2_1} - TSI_{3_0}}{20s} + \frac{TSI_{3_1} - TSI_{4_0}}{20s} + \frac{TSI_{4_1} - TSI_{5_0}}{20s} + \frac{TSI_{5_1} - TSI_{6_0}}{20s} + \frac{TSI_{6_1} - TSI_{20s}}{20s} \right) \times \frac{1}{6}$$

TSI: Tissue Saturation Index; 1-6: The number of the repeated sprints; 0: Pre- repeated sprints; 1: Post-repeated sprints

## Data Analysis

Statistical analyses were performed with SPSS.24 and presented as Mean±SD. Using Kolmogorov-Smirnov to assess data normality. The training effects between different groups were analysed with one-way ANOVA. Paired sample T test was used to compare the pre and post tests.

## Results

### Changes in RSA following 4 weeks of intervention.

After 4 weeks training, the SK group RSABest (0.17s), RSAMean (0.27s) and RSAdec (1.42%) had statistically significant increases (P<0.05) (Table 2). Pairwise comparison results showed RSABest, RSAMean, and RSAdec in group SK were significantly lower than those in group C (P<0.05). RSAdec in group S was lower than that in group C (P<0.05).



Table 2. Within-group and between group comparisons of participants' RSA before and after 4 weeks

Indicators	C		S		SK	
	Pre	Post	Pre	Post	Pre	Post
RSAbest	7.51±0.21	7.56±0.29	7.49±0.31	7.42±0.36	7.33±0.22	7.16±0.30ab
RSAmean	7.80±0.23	7.86±0.29	7.78±0.30	7.63±0.34a	7.64±0.22	7.37±0.29ab
RSAdec	3.90±3.00	4.11±1.39	3.81±1.26	2.87±0.75b	4.30±1.69	2.88±0.86ab

a: Compared with the pre test; b: Compared with the post test

### Changes in skeletal muscle content and maximum strength after 4 weeks

The body skeletal muscle content and lower limb skeletal muscle content of group S and SK were significantly increased ( $P<0.05$ ). The difference between the total skeletal muscle content of group S and group SK was significantly higher than that of group C ( $P<0.05$ ). The difference in skeletal muscle content of lower limbs was significantly higher than that in group C and S ( $P<0.05$ ). The squat 1RM in SK group was 11kg heavier than the pre-test ( $P<0.05$ ). After the intervention, the squat 1RM in SK group was significantly higher than group C and group S ( $P<0.05$ ).

Table 3. Within and between group comparisons of skeletal muscle content

Group	Time	Skeletal muscle content(kg)	Lower limb skeletal muscle content(kg)	1RM of Lower limb skeletal muscle(kg)
C	Pre	29.67±2.98	17.35±1.27	108.21±16.64
	Post	29.92±2.89	17.44±1.41	107.96±16.85
	Difference	0.25±0.38	0.10±0.31	-0.24±1.26
S	Pre	30.03±4.95	16.76±2.01	107.1±16.85
	Post	30.68±4.94a	17.06±2.15a	108.86±16.66
	Difference	0.65±0.25b	0.30±0.22	1.70±2.88
SK	Pre	32.01±3.47	17.92±1.66	112.86±14.82
	Post	32.91±3.37a	18.57±1.54a	124.13±14.81abc
	Difference	0.90±0.54b	0.65±0.31bc	11.26±3.17

a: Compared with the pre test  $P<0.05$ ; b: Compared with the C group  $P<0.05$ ; c: Compared with the S group  $P<0.05$ ;

### Changes in anaerobic capacity and power following 4 weeks of intervention

The 5 seconds maximum power in group C and SK were 1.35w/kg and 1.20w/kg higher than pre intervention ( $P<0.05$ ). Mean anaerobic power in SK group was significantly higher than group C and S 4 weeks later. Fatigue index of each group increased after the experiment ( $P>0.05$ ).

The  $vVO_{2max}$  of group S and SK were 0.45km h<sup>-1</sup> ( $P<0.05$ ) and 0.44km h<sup>-1</sup> ( $P<0.05$ ) higher than the pre test.  $VO_{2max}$  of group S and group SK were increased by 4.56% ( $P<0.05$ ) and 4.58% ( $P<0.05$ ) respectively 4 weeks later. After the experiment, the muscle ROR increased significantly ( $P<0.05$ ) in SK group, it was significantly higher than group C and S ( $P<0.05$ ).

Table 4. Comparison of participants' anaerobic capacity and power before and after the four weeks training

Indicator	C		S		SK	
	Pre	Post	Pre	Post	Pre	Post
5s maximum power (w/kg)	10.31±1.14	11.66±1.40a	11.17±2.25	12.00±1.68	11.53±1.69	12.73±1.17a
Mean power (w/kg)	7.81±0.66	8.02±0.51	7.92±1.20	8.01±0.88	8.31±0.75	8.85±0.61abc
Fatigue index (%)	0.48±0.06	0.52±0.08	0.50±0.09	0.61±0.03	0.51±0.08	0.57±0.05
$vVO_{2max}$ (km h <sup>-1</sup> )	13.20±0.42	13.50±0.52	13.16±0.43	13.61±0.48a	13.22±0.66	13.66±0.66a
$VO_{2max}$ (ml/kg/min)	55.08±2.59	55.75±3.22	54.73±2.37	57.23±2.64a	54.79±3.47	57.30±3.47a
ROR (%/s);	0.18±0.16	0.27±0.11	0.22±0.16	0.36±0.24	0.31±0.22	0.63±0.24abc

a: Compared with the pre test  $P<0.05$ ; b: Compared with the C group  $P<0.05$ ; c: Compared with the S group  $P<0.05$ ;



## Discussion

### Short-term SSG mode combined with KAATSU can improve RSA.

SSG can improve the physical fitness of football players. However, whether it can improve RSA is still controversial. So we explore whether KAATSU with SSG has combined effects on RSA compared with SSG method. The results showed SSG can't improve player's RSAbest, which is consistent with Eniseler's research that SSG can't enhance RSAbest in adolescent after 6 weeks' 3v3 SSG (Takarada, et al., 2000). In our study, the RSAbest was improved significantly in SK group ( $P<0.05$ ). Compared with group C, the performance in RSAmean and RSAdec were enhanced in S and SK groups ( $P<0.05$ ). Compared with S group (1.9%, 24%), the RSAmean and RSAdec were enhanced in SK group (3.5%, 30%). Therefore, it's suggested SK can improve RSAbest to a greater extent.

### Short-term SSG combined with KAATSU can increase the skeletal muscle strength.

RSA has 2 influential factors (stride length and stride frequency), stride length and stride frequency are related to lower limb muscle strength, nerve excitability, and flexibility (Madarame, et al., 2011). This study found the lower limbs was 0.65kg in SK group following 4 weeks', which was significantly higher than S group (0.30kg) and C group (0.10kg). Moreover, the maximum strength in SK group was significantly improved following the intervention ( $P<0.05$ ), which was consistent with the previous results. Abe found 8 weeks' cycling with 40%  $VO_{2max}$  combines 210mmHg compression can increase the muscle strength (0.6%) and cross-sectional area (1.4%) (Abe, et al., 2010). KAATSU combined with SSG can increase the lower limb muscle content and maximum strength which may related to KAATSU restricts venous blood return, resulting in hypoxia and accumulation of lactic acid in the compression site, and induces muscle swelling stimulations of skeletal muscle growth (Aguiar et al., 2013).

### Short-term SSG combined with KAATSU can increase anaerobic capacity.

The increase in skeletal muscle strength may be one of reasons of the improvement in RSAbest, while from the perspective of energy metabolism and neuromuscular control, RSAbest mainly depends on anaerobic capacity. In this study, 30s-watt bike sprint was measured. The results of 5 seconds maximum output power and average output power indicated that the improved RSAbest may be associated with the enhanced anaerobic capacity. Behringer found that 70% intensity exercise combined with KAATSU had similar benefits as 100% intensity exercise (Behringer, et al., 2017). However, Madarame, et al. (2011), found there was no significant change ( $P>0.05$ ) in the jumping performance in the KAATSU group and a control group following a 10 weeks' KAATSU intervention with 250mmHg pressure. In conclusion, whether KAATSU intervention can improve short-term explosive action needs to be further confirmed.

4 weeks' SSG combined with KAATSU can improve  $VO_{2max}$  in S and SK groups ( $P<0.05$ ), while no statistically significant difference within the two groups. It was inconsistent with previous studies. Paton, Addis & Taylor (2017) found significant increases in  $VO_{2max}$  and running economy ( $P<0.05$ ) following 4 weeks KAATSU with an intensity of 80%HRmax. There are two reasons that may explain the inconsistent results: (1) The intensity of SSG is 80% HRmax, which can improve  $VO_{2max}$  itself; (2) The stability and accuracy of the field test will affect the  $VO_{2max}$  results.

## Conclusion

SSG and KAATSU can not only improve the aerobic capacity and RSAdec but increase the anaerobic power and the skeletal muscle strength to achieve improving RSAbest.

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**9<sup>th</sup> INTERNATIONAL  
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# **Adapted Physical Activity and Kinesitherapy**

**Editors:**  
**Assist. Prof. Tatjana Trošt Bobić, PhD**  
**Assoc. Prof. Lidija Petrinović, PhD**



## EFFECTS OF ECCENTRIC AND HEAVY-SLOW RESISTANCE TRAINING ON LATERAL EPICONDYLITIS REHABILITATION

Petar Čuljak, Šime Mijić, Grgur Bulović

*Polyclinic Faktor Zdravlje, Zagreb, Croatia*

**Introduction:** The inflammation of the proximal muscle of the forearm is of common occurrence (Vaquero-Picard i sur., 2016). Like most tendon inflammation, it is conservatively often treated by eccentric contraction. Recent studies indicate possible positive effects activity of heavy slow resistance training (Kongsgaard i sur., 2009; Beyer i sur., 2015).

**Purpose:** The aim of this paper was to determine the difference in the effect of eccentric contractions and slow isotonic contractions with submaximal load in the rehabilitation of persons with lateral epicondylitis.

**Methods:** The sample consisted of 16 participants randomly divided into 2 groups. The control group carried out eccentric out an eccentric training, and the experimental group conducted heavy slow resistance (HSR) training. During the planning of kinesitherapy protocols, findings from previous studies were used, and subjects from both groups conducted exercise 3 times a day in a 10-day period. Range of motion variables (angle of dorsal flexion, palmar flexion, flexion and elbow extension, as well as pronation and supination), subjective pain assessment (VAS / NAS), and strength of the hand were measured. Based on the results given by t-test for dependent samples, both groups achieved statistically significant results compared to the starting point of measurement. Difference in mean score between groups from initial to final testing, were tested through a repeated measures anova.

**Results:** This results shows that both exercise methods are useful in treating overuse syndrome of the forearm. Statistically significant differences were obtained in SUPINATION variables ( $p = 0.03$ ) and NAS scales of pain (0.0456). The experimental group performing HSR achieves statistically significantly better results in comparison to the control group that scores statistically significantly better in the NAS variables.

**Conclusions:** The main conclusion of the study is that both groups achieve approximately equal results with respect to initial measurement, although the experimental group spent less time in performing the exercises. Also, subjects of the experimental group achieved significantly better results in the test SUPINATION. It is especially important to take into account the fact that in people with lateral epicondylitis the supine movement is extremely painful.

**Key words:** *lateral epicondylitis, tennis elbow, eccentric exercises, isotonic exercises, heavy slow resistance*

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## BOBATH CONCEPT VS CONVENTIONAL MEDICAL GYMNASTICS IN MILD MOTOR DEFICIT HABILITATION OF CHILDREN

Zrinka Djukić Koroljević<sup>1</sup>, Valentina Matijević<sup>2</sup>, Branka Matković<sup>3</sup>

<sup>1</sup>Specialty Hospital St. Catherine, Zagreb, Croatia

<sup>2</sup>Children Rehabilitation Department, University Hospital Centre "Sisters of Mercy", Croatia

<sup>3</sup>University of Zagreb Faculty of Kinesiology, Croatia

**Introduction:** Nowadays, the number of children diagnosed with mild motor deficit is significantly increasing. Those children should be promptly included in habilitation programs. Out of different habilitation programs, conventional medical gymnastics and the Bobath neurodevelopmental concept are the most commonly used. However, only a few methodologically relevant studies favour one method over the other. The aim of this study is to determine whether different outcomes exist in these two habilitation concepts.

**Methods:** This study included 30 children three months old, verified with mild variations of gross motor skills. Children were classified into two equal groups by computerised random selection, of which one was habilitated according to the Bobath concept and the other by classical medical gymnastics exercises, with a frequency 1x per week in the clinic, and daily for 2 hours at home, depending on the needs and rhythms of the child. After 3 months of treatment, at the age of 6 months, children's gross motor skills were assessed by the Ages and Stages questionnaire, and the results were analysed with standard statistical methods.

**Results:** Initially, children in the Bobath group average age was  $92.4 \pm$  days and in the conventionally habilitated group  $94.3 \pm$  days. Analysing the obtained values, by assuming unequal variance, a two-sided t-test was used, wherein  $p\text{-value}=0.6889$ . Since  $p > 0.05$ , we conclude that there is no statistically significant difference in efficiency between the tested methods in improving the gross motor skills of children at the age of 6 months, which were included in habilitation program at the age of 3 months, and were habilitated for 3 months in total.

**Conclusion:** According to this study, there is no statistically significant difference in the effectiveness of the two habilitation programs. The appropriate initiation of any of the two habilitation programs, with regular kinesitherapy exercises leads to the reduction of gross motor skills deviations in both cases. Limitation of this study is a small sample, hence examining the hypothesis on a bigger sample is necessary.

**Key words:** *psychomotor development, milestones, child exercise therapy*

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## COMBINATION OF MANUAL YUMEIHO THERAPY AND EXERCISE TO REDUCE DEPRESSION AND NEUROPATHIC PAIN IN PATIENTS WITH CHRONIC NONSPECIFIC LOW BACK PAIN

Neven Gladović<sup>1</sup>, Tatjana Trošt Bobić<sup>2</sup>, Dino Bartoluci<sup>3</sup>, Irena Vuglovečki<sup>4</sup>

<sup>1</sup>Primary school Josip Juraj Strossmayer, Zagreb, Croatia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>3</sup>Edward Bernays, Zagreb, Croatia

<sup>4</sup>Faculty of Economics & Business, University of Zagreb, Croatia

### Abstract

Psychosocial factors (depression, kinesiphobia and somatization) may have an important role in the appearance and duration of chronic nonspecific low back pain. Recent studies suggest that a rehabilitation model which combine manual therapy and exercise, provide better results compared to individual (separate) applications. The aim of this research was to examine the effects of the rehabilitation program, which includes manual yumeiho therapy and exercise, on depression in people suffering from chronic nonspecific low back pain. The study included 25 participants, aged 40 to 60 (M=51.76, sd=5.87) who suffer from chronic nonspecific low back pain. Initial and final tests to evaluate depression and neuropathic pain were performed. Between the initial and the final testing, a three-week therapeutic procedure of yumeiho manual therapy and exercise was performed (15 treatments). Repeated estimates of depression and neuropathic pain were tested 30, 60 and 90 days after the implementation of the rehabilitation protocol. Statistically significant improvements were noted between the initial and the final test in both observed variables. Significant improvements (lower depression and neuropathic pain) have also been noted 30, 60 and 90 days after the implementation of the rehabilitation protocol (in relation to the initial state). The findings indicate that the rehabilitation protocol, involving manual yumeiho therapy and exercise, is an effective method for treating depression and neuropathic pain in people suffering from chronic nonspecific low back pain. Considering the lack of research on the effects of manual therapy by yumeiho technique, the results contribute to a better understanding of technique which, although used in practice, has not been sufficiently explored. Further research is required, on comparing this rehabilitation model to other methods, as well as longer follow-up in the post-rehabilitation period.

*Key words: rehabilitation program, spine, movement, quality of life*

### Introduction

During a lifetime period, about 84% of people experience at least one episode of low back pain, which represents 11-12% of the population's disability (Airaksinen et al., 2006). In case of acute low back pain, 75-90% of people recover within six weeks regardless of medical intervention, while about 25% of people develop chronic low back pain. Chronic lumbar pain can occur without specific anamnestic causes and it is then called nonspecific back pain. Psychosocial factors may have an important role in developing and duration of chronic nonspecific low back pain. Burke et al. (2015) indicate that depression and chronic pain may occur in up to 80% of patients suffering from these disorders. Based on that, in designing a rehabilitation model, these factors should be taken into account. This assumption is supported by insights suggesting an association between depression and low back pain, and emphasizing that their association may have a more significant biological link than simple cause and effect relation (Elman et al., 2011). Likewise, it is estimated that about 35% of patients with chronic pain syndromes suffer from neuropathic pain also (Bouhassira et al., 2008). Despite the development of modern technology in the diagnosis and treatment of low back pain, functional disability due to back pain has risen in recent decades (Deyo et al., 2014). Due to the complexity of treating chronic diseases, patients often use complementary-alternative medicine as an adjunct or instead the usual medical treatment. One of the complementary-alternative methods is the manual therapy by yumeiho technique, in which the therapist's hands are the basic tool for the treatment. The main advantage of this technique is comprehensiveness because it combines methods of crushing, pressing and techniques of manipulation and mobilization of bone-joint structures (Saionji, 1990). After the literature overview, it is concluded that no study has been found examining the impact of manual yumeiho therapy and exercise on depression and neuropathic pain in people suffering from chronic nonspecific low back pain. The aim of this research was



to examine the effects of the rehabilitation program, which includes manual yumeiho therapy and exercise, on depression and neuropathic pain in people suffering from chronic nonspecific low back pain.

## Methods

A sample of 25 participants aged 40 to 60 ( $M=51,76$ ;  $sd=\pm 5,87$ ) was used. Sample size estimation was made by G\*Power 3.1.9.2. The criteria for inclusion in the study were as follows: diagnosed low back pain syndrome for at least 3 months and pain intensity equal or higher than 4 according to the Visual Analogue Scale (VAS). Exclusion criteria: malignancies 5 years backwards, inflammatory rheumatic diseases, inability to control stool and urine, more severe cardiovascular disease, more severe neurological diseases, applied physical therapy in the lumbar spine 3 months backwards, disc extrusion and pregnancy. Prior to joining the survey, all participants received an explanation notice and signed consent of willing participation. The study included initial and final testing of depression level and neuropathic pain. Between initial and final testing, a three-week treatment procedure was performed (15 treatments in total). Depression levels were tested by the revised Beck Depression Scale (BDI-II). The questionnaire is consisted of 21 questions (rated 0 to 3). The minimum score is 0, the maximum is 63. Average results show that subjects with up to 9 points do not have depression; 14-19 points indicate mild depression, while 20-28 points indicate moderate depression. Severe depression is estimated when a score is equal or higher than 29. Neuropathic pain was determined by the LANSS-The Leeds assessment of neuropathic symptoms and signs. The highest possible sum is 24 (higher value means stronger pain intensity), while values equal or higher than 12 indicate that neuropathic mechanisms contribute to the feeling of pain. Chronical pain syndrome is characterized by a combination of nociceptive and neuropathic pain (low back pain, radicular pain, carpal tunnel syndrome). The duration of the quality of rehabilitation program was monitored after the end of therapy, as well as one, two and three months after the end of the program by re-measurement of depression and neuropathic pain. Participants underwent 15 treatments over a 3-week period. The combination of yumeiho manual therapy and exercise was performed 3 times a week for 45 minutes (Monday-Wednesday-Friday), while separate training sessions were performed 2 times a week for 15 minutes (Tuesday-Thursday). Yumeiho therapy consists interchangeable and complementary components (methods of kneading and pressure). Their purpose is to soften and relax soft tissues. The third component involves techniques of manipulating bone-joint structures. Yumeiho therapy and exercise were conducted by an educated yumeiho therapist (master of kinesiology). The treatment is performed on the mat in kneeling position, with some interventions done in sitting or lying position. The exercise program included 30 exercises for improving neuromuscular control and increasing the mobility of the lumbar-gluteal region. The exercise program included specific exercises to strengthen *m. multifidus* and *m. transversus abdominis* and specific stretching exercises for *m. piriformis* and *m. quadratus lumborum*. Data were presented by arithmetic mean, standard deviation, minimum and maximum values. Non-parametric statistical methods were used, depending on the distribution of the data. The Friedman's test was used to examine the difference between the initial condition and the observed measuring points (final condition, 30, 60 and 90 days after the rehabilitation program).

## Results

### BECK scale for depression.

The differences between the first and other measuring points (final, 30 60 and 90 days after therapy), for depression is shown in table 1 and figure 1. The significance of p test is less than 0.05. Statistically significant differences in the BECK indicators were observed between the initial and other measuring points.

Table 1. Friedman's test

N	25
Chi-Square	24,96
df	4
Asymp. Sig.	,000

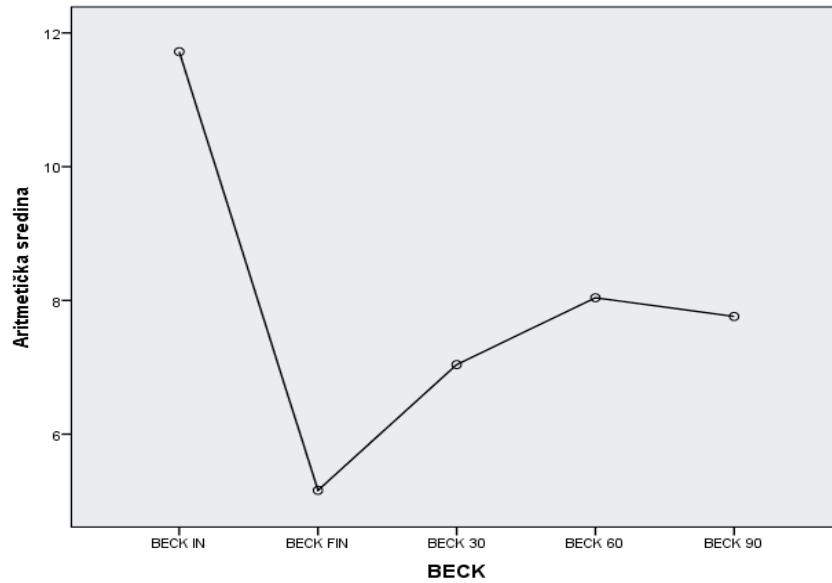


Figure 1. Differences in depression in people suffering from chronic nonspecific low back pain between the observation points (initial, final, 30, 60 and 90 days after the therapy)

### LANSS scale for neuropathic pain

The differences between the first and other measuring points (final, 30, 60 and 90 days after therapy), for neuropathic pain is shown in table 1 and figure 1. The significance of p test is less than 0.05. Statistically significant differences in the LANSS indicators were observed between the initial and other measuring points.

Table 2. Friedman's test

N	25
Chi-Square	32,81
df	4
Asymp. Sig.	,000

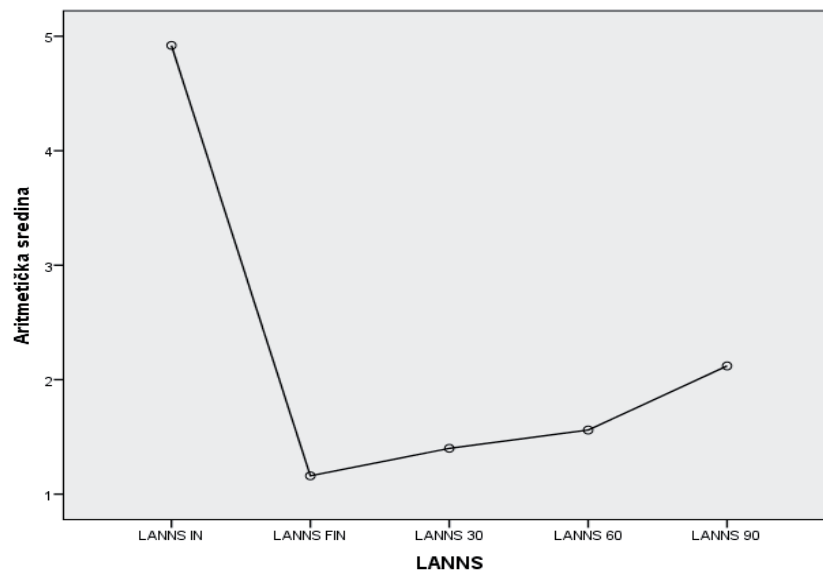


Figure 2. Differences in neuropathic pain in people suffering from chronic nonspecific low back pain between the observation points (initial, final, 30, 60 and 90 days after the therapy)

## Discussion

Participants who underwent rehabilitation program that included yumeiho manual therapy and exercise, reported a statistically significant reduction in depression and neuropathic pain at all observation points (final, 30 and 60 days after the rehabilitation program), compared to the initial measuring. Study suggests the quality of the used model. The data obtained, in addition to acute improvement, also indicate longer-lasting effect retention, which suggest the importance of continuity in care after the program. According to literature, only one study has compared the effects of manual therapy and exercise to physiotherapy program, in the treatment of depression (Niemistö et al., 2003). That study showed no statistically significant differences. Potential reasons may be caused by the mean age in used sample (24 to 46 years), and only 4 therapies performed in 4 weeks, unlike this study which included the active population of 40–60 years who performed 15 therapies in 3 weeks. In mentioned study, the effects of the therapeutic protocol were measured after 5 and 12 months. This indicates that the high volume of therapies over a short period may significantly reduce depression in people suffering from chronic nonspecific low back pain. A review of the available literature did not identify any research that examined the impact of manual therapy and exercise on neuropathic pain in people suffering from chronic nonspecific low back pain. The potential mechanisms on a decrease of paravertebral muscles which are in that case adequately activated while the burden is appropriately distributed along the spine. Thereby the passive stabilizers are unburdened and consequently decreasing the pressure on the nerves. These mechanisms should be expended within the future researches. This research suggests that this combined model should be considered in the future, given the results that indicate significantly reduced neuropathic pain after a rehabilitation program. The effects were retained after 30 and 60 days. The gained data, apart from acute improvement, suggest on long term preservation of effects and in that way don't advocate the negligence after the implemetation of the programme, moreover, they stress the quality of the applied model. Taking into account that there is no control group in this research, it is necessary to highlight the limitations at the conclusion. Relatively small sample is the limitation of the study and further research is needed to get a clearer picture. Authors recommend comparing this rehabilitation model to other methods, longer follow-up in the post-rehabilitation period and analysing the effects on a larger number of subjects.

## Conclusion

The results indicate that a rehabilitation protocol involving manual yumeiho therapy and exercise is an effective method of reducing depression and neuropathic pain in patients with chronic nonspecific low back pain. These results are valid only for this sample and do not allow generalization. Nevertheless, since the results showed positive effects, they may represent a valuable basis for planning further research on a larger sample of respondents.

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## DYNAMIC AND STATIC BALANCE PERFORMANCE AND LOWER EXTREMITY ASYMMETRIES IN HIGH SCHOOL STUDENTS

**Matija Jandrić**

*Petar Preradović High School Virovitica, Croatia*

### Abstract

It is very important to assess the dynamic and static balance and to recognize the risk of injury as well as the postural stability of the core and extremities. The purpose of the study was to assess differences in dynamic and static balance in high school students as well as asymmetries in Lower Quarter Y-Balance test. Fifty-nine female and fifty-five male students performed the Y-Balance test and the Stork Balance test to determine differences and potential risk of lower extremity injuries. The students were divided into subsamples: girls physically active and girls physically inactive then boys physically active and boys physically inactive. The following parameters were analyzed: age, body height, body weight, leg length, BMI, asymmetries in anterior, posteromedial and posterolateral reaches, scores in the Y-Balance test and Stork balance test. The analysis of descriptive parameters showed that there was no significant difference between the age of the students, asymmetries in the anterior, posteromedial and posterolateral reach in YBT-LQ but students who are not physically active have the highest risk of lower extremity injury. However, a significant difference was found with respect to leg length, body height, body weight and BMI of the students. A significant difference between groups of subjects was found in all variables of dynamic and static balance. It can be concluded that the best scores in 6 out of 9 variables of dynamic and static balance are performed by female physically active students and worst scores by male physically inactive students.

*Key words: Y-Balance test, Stork Balance test, physical activity, high school*

### Introduction

Physical activity require adequate musculoskeletal strength and power, as well as motor coordination and control that positively affect athletic performance and help reduce the risk of injury (Lockie et al., 2015). One of the important motor skills that affects athletic performance is balance (Lockie et al., 2015). Many participants in sports such as basketball, football, and volleyball have an increased risk of lower extremity injuries (Miller et al., 2017). The incidence of injuries in young athletes is usually in the range of 1-10 injuries/1000 hours of exposure to physical activity and approximately one-fifth of all injuries are severe, meaning withdrawal from normal sports activity for at least 4 weeks, while up to 20% of all injuries are the occurrence of the same injury that was seemingly cured (Theisen et al., 2014). Lower Quarter Y - Balance test (YBT-LQ) and Stork balance test (SBT) are clinical tests that are widely used to diagnose dynamic and static balance deficits of young participants in various sports (Benis et al., 2016; Oshima et al., 2018; Negra et al., 2017; Bouteera et al., 2018). Smith et al. (2017) conducted a study on high school students regarding the characteristics and reliability of YBT-LQ. They concluded that YBT-LQ may be useful in assessing the recovery of an injured limb relative to an uninjured one. The study found that out of 110 participants, 79% of them had asymmetry of the lower extremities in at least one of the directions in which the subjects were tested. Miller et al. (2017) conducted research related to the effects of sports specialization and gender on outcome in YBT-LQ (only anterior reach). The results showed that boys have greater anterior asymmetry and reduced anterior reach than girls. In a study by Plisky et al. (2006) composite score (overall score) in YBT less than 94% in female basketball players proved to be a significant predictor of lower extremity injuries and asymmetries in the anterior reach in all subjects (male and female) greater than 4 cm meant 2.7 times higher risk of lower extremity injury. Oshima et al. (2018) found in a sample of 276 high school girls that insufficient static balance is a risk factor for non-contact injuries, especially anterior cruciate ligaments. YBT-LQ is a proven good diagnostic tool for diagnosing lower extremity injury risk and also showing accuracy in measuring lower extremity joint mobility and knee extensor strength performance (Plisky et al., 2006; Hammami et al., 2016). According to the author of this study, there is lack of evidence about differences in dynamic and static balance and asymmetry between the extremities in the secondary school population with respect to gender and physical activity in order to diagnose the potential risk of lower extremity injuries. The differences in the YBT-LQ and SBT scores and the asymmetries in YBT-LQ of male and female students are not clearly understood. Gender is known to be a key biological variable that should be considered in all basic physiological and biological research as well as in research of this type (Torgrimson & Minson, 2005). The aims of this

study were: 1. to determine the differences in the tests of dynamic and static balance between female and male students who regularly engage in physical activity and those whose only physical activity is in the Physical Education class; 2. to determine asymmetries in three directions in YBT-LQ.

## Methods

### Participants

The sample consist of 59 female and 55 male students (N=114; average age  $16.86 \pm 1.5$  years) who attend the high school in Virovitica, Croatia. Parents of participants signed an informed consent form. The research was approved by the Ethics Committee of the Faculty of Kinesiology, University of Zagreb. The sample of students was divided into four groups. The first (N=39; females; FPIA=females physicaly inactive) and third (N=26; males; MPIA= males physicaly inactive) groups are students who are not physically active and their only physical activity is in Physical Education classes. The second (N=20; females; FPA=females physicaly active) and fourth groups (N=29; males; MPA=males physicaly active) consist of students who are physically active and currently under a training regime at various sports clubs. FPA: handball (N=8), basketball (N=4), tennis (N=2), karate (N=2), gymnastics (N=2) and athletics (N=2) and MPA: football (N=10), handball (N=10), basketball (N=7) and swimming (N=2). Participants have no previous experience in performing YBT-LQ and SBT. Prior to testing, subjects reported the presence of any lower extremity injury, vision problems, vestibular problems or concussions (in the past 6 months). None of the participants had the above problems. Measurements of YBT-LQ and SBT were conducted during Physical Education classes. First, YBT-LQ measurements were performed, then SBT with a day off between measurements. Prior to the measurement, the participants were explained and demonstrated the tests that were performed. After the explanation and demonstration, a warm-up (15 minutes) was performed which included: light running, stretching, various dynamic stretching exercises and imitation of movements used in the tests (anterior reach, posteromedial reach, posterolateral reach and body and leg position as in SBT). To avoid the stability provided by the sneakers, all tests were performed barefoot (Robbins et al., 1994). YBT-LQ and SBT have shown good reliability in previous studies (Schwartz et al., 2018; Zumana et al., 2019) and are therefore used in this study as well.

### Procedures

The sample of variables consists of: age, body height, body weight, leg length, BMI, and two tests to assess dynamic and static balance. Age was calculated by the formula: age (years) + age (months)/12. Measurement of anthropometric dimensions is described in detail in the literature (Mišigoj-Duraković, 1995). BMI was calculated by the formula  $\text{kg/m}^2$ . Leg length was measured with a centimeter tape from the anterior superior spine of the iliac to the farthest part of the medial malleolus (Butler et al., 2012). Both balance tests were performed by experienced kinesiologists. Measurement procedures for YBT – LQ are described in the literature (Gribble & Hertel, 2003; Coughlan et al., 2012; Fusco et al., 2020). For the anterior reach the toes were placed in the marked spot on the anterior tape (0 on the tape) and for the posterior reaches the heel was placed in the marked spot on the anterior tape (0 on the tape) (Figure 1). When processing the data, the best result of 3 attempts was taken. Asymmetries in all directions (anterior, posteromedial, posterolateral) were calculated as the difference between the absolute reaches of the right and left legs. Absolute reach in each direction was normalized ( $\text{absolute reach} / \text{leg length} \times 100$ ) with respect to leg length. Composite (total) score was also calculated by summing three normalized reaches divided by three leg lengths and multiplied by 100 (Butler et al., 2012).

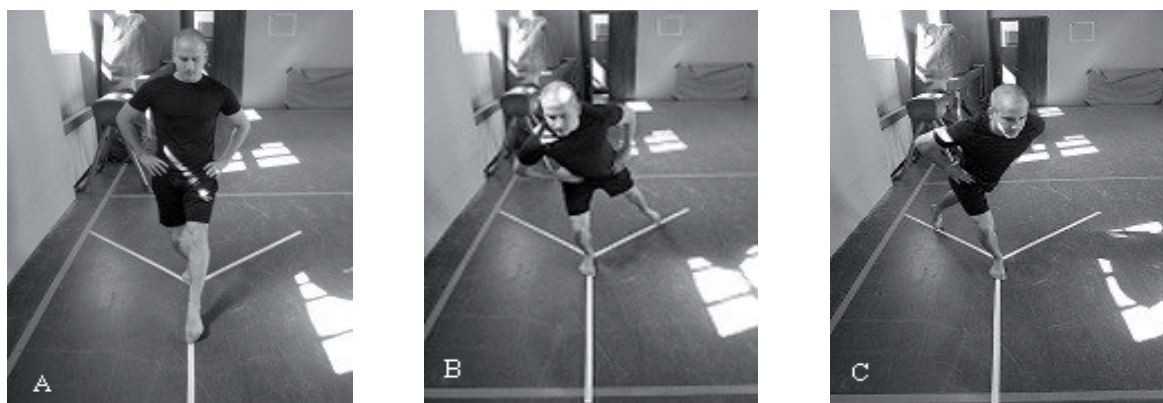


Figure 1. YBT-LQ reach directions (A – anterior, B – posteromedial, C – posterolateral)



SBT was performed on the dominant leg while the foot of the other leg was on the knee of the dominant leg (Figure 2). The dominant leg is determined by the type of action and the task. In this case, the dominant leg was the one with which the participants would kick the ball (Velotta, 2011). Measurement procedures for SBT are described in the literature (Negra et al., 2017).



Figure 2. Stork balance test

### Statistical analysis

Data were processed using the Statistica for Windows software package (Version 13; Copyright 1984 - 2018 TIBCO Software Inc). Basic descriptive parameters were calculated: arithmetic mean, standard deviation. The Shapiro - Wilk test was used to check the normality of the distribution. Since the normality of the distribution was confirmed, one - way analysis of variance (ANOVA) determined the differences in the arithmetic means of the groups of subjects and after that the results were analyzed by the Tukey post - hoc test. The magnitude of the effect between groups of subjects was tested by partial eta squared ( $\eta^2 p$ ); 0.01 = small effect, 0.06 = medium effect and 0.14 = large effect (Cohen, 1988). The level of statistical significance was set at  $p < 0.05$ .

### Results

The analysis of descriptive parameters (Table 1) showed that there was no significant difference between the age of the students, asymmetries in the anterior, posteromedial and posterolateral reach in YBT-LQ of FPA and MPA compared to FPIA and MPIA. However, a significant difference was found with respect to leg length, body height, body weight and BMI of the students. MPIA and MPA have significantly longer legs than FPA and FPIA, but when the result was normalized with respect to leg length MPIA demonstrated worse scores than FPIA and MPA than FPA. The only significant difference in BMI is between FPA and MPIA. The average differences in anterior asymmetry between active and inactive students are not significant, but when we consider the number of students who show an asymmetry greater than 4 cm in the anterior reach then we can find that 1.9 times more FPIA than FPA and 2.5 times more MPIA than MPA with an asymmetry in the anterior reach greater than 4 cm.

Table 1. Descriptive parameters of anthropometric variables and asymmetries (arithmetic mean  $\pm$  standard deviation)

	FPIA (N=39)	FPA (N=20)	MPIA (N=26)	MPA (N=29)	ALL (N=114)
Age (years)	16.79 $\pm$ 0.88	16.87 $\pm$ 0.80	17.05 $\pm$ 0.80	16.80 $\pm$ 0.96	16.86 $\pm$ 0.87
Body height (cm)	164.36 $\pm$ 6.46 <b>b,c,d</b>	170.00 $\pm$ 7.82 <b>a,c,d</b>	180.27 $\pm$ 8.11 <b>a,b</b>	179.31 $\pm$ 7.13 <b>a,b</b>	172.86 $\pm$ 10.06
Body mass (kg)	60.00 $\pm$ 12.82 <b>c,d</b>	58.80 $\pm$ 6.91 <b>c,d</b>	76.62 $\pm$ 17.59 <b>a,b</b>	69.76 $\pm$ 15.41 <b>a,b</b>	65.96 $\pm$ 15.59
BMI (kg/m <sup>2</sup> )	22.07 $\pm$ 4.26	20.34 $\pm$ 1.62 <b>c</b>	23.69 $\pm$ 6.10 <b>b</b>	21.55 $\pm$ 3.61	22.00 $\pm$ 4.38
LL (cm)	89.01 $\pm$ 4.61	91.36 $\pm$ 5.13	98.12 $\pm$ 5.92 <b>a,b</b>	96.91 $\pm$ 4.85 <b>a,b</b>	93.51 $\pm$ 6.39
AA (cm)	3.10 $\pm$ 3.01	2.43 $\pm$ 2.58	3.62 $\pm$ 2.88	2.53 $\pm$ 2.46	2.96 $\pm$ 2.77
PMA (cm)	4.25 $\pm$ 3.32	3.98 $\pm$ 4.56	3.95 $\pm$ 3.55	4.13 $\pm$ 3.20	4.10 $\pm$ 3.54
PLA (cm)	4.73 $\pm$ 4.38	4.51 $\pm$ 3.67	3.49 $\pm$ 3.09	5.37 $\pm$ 4.13	4.57 $\pm$ 3.94
AA > 4 cm (N)	11 (28.21 %)	3 (15 %)	11 (42.31 %)	5 (17.24 %)	30 (26.32 %)

Note. FPIA=females physically inactive; FPA=females physically active; MPIA=males physically inactive; MPA=males physically active. LL=leg length; AA=anterior asymmetry; PMA=posteromedial asymmetry; PLA=posterolateral asymmetry; AA>4 cm=number of subjects with an asymmetry greater than 4 cm. a=significantly different from FPIA ( $p < 0.05$ ). b=significantly different from FPA ( $p < 0.05$ ). c= significantly different from MPIA ( $p < 0.05$ ). d=significantly different from MPA ( $p < 0.05$ ).

After determining the descriptive parameters, statistical procedures were applied to determine the differences between groups of subjects in the tests of dynamic and static balance (Table 2). A significant difference between groups of subjects was found in all variables of dynamic and static balance: COMPR-R ( $F=9.84$ ;  $p<.001$ ;  $E=0.21$ ), COMPR-L ( $F=9.83$ ;  $p<.001$ ;  $ES=0.21$ ), RELR-AR ( $F=6.71$ ;  $p<.001$ ;  $ES=0.15$ ), RELR-AL ( $F=7.98$ ;  $p<.001$ ;  $ES=0.18$ ), RELR-PMR ( $F=10.18$ ;  $p<.001$ ;  $ES=0.22$ ), RELR-PML ( $F=8.95$ ;  $p<.001$ ;  $ES=0.20$ ), RELR-PLR ( $F=12.19$ ;  $p<.001$ ;  $ES=0.25$ ), RELR-PLL ( $F=10.32$ ;  $p<.001$ ;  $ES=0.22$ ) and SBT ( $F=24.15$ ;  $p<.001$ ;  $ES=0.22$ ). There is no significant difference between FPA and MPA in all variables, but they differ significantly in all reaches relative to MPIA. In SBT, MPA and FPA performed best, while MPIA demonstrated worst scores. FPA and MPA in SBT are significantly different from FPIA and MPIA. It can be concluded that the best scores in 6 out of 9 variables are performed by FPA. Overall, the best scores in static and dynamic balance tests are demonstrated by FPA, then MPA and FPIA, and the worst scores by MPIA. Accordingly, as previously noted, the lowest risk of injury with respect to asymmetries in the three directions of YBT-LQ was demonstrated by FPA and MPA, followed by FPIA and MPIA.

Table 2. YBT-LQ and SBT scores of four groups of high school students (arithmetic mean  $\pm$  standard deviation)

	FPIA	FPA	MPIA	MPA	ALL
COMPR-R (%)	79,29 $\pm$ 9,15 <b>b,c</b>	85,43 $\pm$ 8,14 <b>a,c</b>	71,86 $\pm$ 7,44 <b>a,b,d</b>	79,62 $\pm$ 8,84 <b>c</b>	78,76 $\pm$ 9,49
COMPR-L (%)	80,31 $\pm$ 10,15 <b>c</b>	85,85 $\pm$ 7,01 <b>c</b>	71,87 $\pm$ 7,84 <b>a,b,d</b>	80,67 $\pm$ 9,47 <b>c</b>	79,45 $\pm$ 9,99
RELR-AR (%)	70,52 $\pm$ 6,48	74,56 $\pm$ 5,37 <b>c</b>	67,93 $\pm$ 5,04 <b>b,d</b>	73,58 $\pm$ 7,03 <b>c</b>	71,42 $\pm$ 6,55
RELR-AL (%)	71,18 $\pm$ 6,37	74,24 $\pm$ 5,55 <b>c</b>	67,10 $\pm$ 5,92 <b>b,d</b>	74,51 $\pm$ 6,57 <b>c</b>	71,63 $\pm$ 6,74
RELR-PMR (%)	73,73 $\pm$ 8,60 <b>b,d</b>	82,12 $\pm$ 4,75 <b>a,c</b>	75,76 $\pm$ 5,92 <b>b,d</b>	81,59 $\pm$ 7,16 <b>c</b>	77,66 $\pm$ 7,92
RELR-PML (%)	75,80 $\pm$ 8,80 <b>b,d</b>	84,29 $\pm$ 6,66 <b>a,c</b>	75,48 $\pm$ 6,81 <b>b,d</b>	82,61 $\pm$ 8,12 <b>c</b>	78,95 $\pm$ 8,65
RELR-PLR (%)	66,72 $\pm$ 7,55 <b>b,d</b>	76,52 $\pm$ 7,28 <b>a,c</b>	67,00 $\pm$ 7,25 <b>b,d</b>	75,41 $\pm$ 9,28 <b>a,c</b>	70,71 $\pm$ 9,02
RELR-PLL (%)	66,59 $\pm$ 9,14 <b>b,d</b>	76,17 $\pm$ 6,68 <b>a,c</b>	68,05 $\pm$ 8,14 <b>b,d</b>	76,40 $\pm$ 9,85 <b>a,c</b>	71,10 $\pm$ 9,76
SBT (sec)	17,74 $\pm$ 9,02 <b>b,d</b>	36,70 $\pm$ 19,57 <b>a,c</b>	12,38 $\pm$ 8,80 <b>b,d</b>	36,83 $\pm$ 16,25 <b>a,c</b>	24,70 $\pm$ 17,00

Note. FPIA=females physically inactive; FPA=females physically active; MPIA=males physically inactive; MPA=males physically active. COMPR-R=composite score (right leg); COMPR-L=composite score (left leg); RELR=relative (normalized) reach; AR=anterior right leg; AL=anterior left leg; PMR=posteromedial right leg; PML=posteromedial left leg; PLR=posterolateral right leg; PLL=posterolateral left leg; SBT=Stork balance test. a=significantly different from FPIA ( $p<.05$ ). b= significantly different from FPA ( $p<.05$ ). c= significantly different from MPIA ( $p<.05$ ). d= significantly different from MPA ( $p<.05$ ).

## Discussion and conclusions

The purpose of this study was to determine the differences in dynamic and static balance tests with respect to gender and physical activity between FPA, MPA, FPIA, and MPIA. Then determining differences in asymmetries in three directions in YBT-LQ. The main finding of this study is that FPA demonstrated the best scores in 6 of 9 variables and that overall the best scores in dynamic and static balance tests are performed by FPA, then MPA and FPIA, and the worst scores by MPIA. Apart from the differences in YBT-LQ and SBT, the lowest asymmetries in the anterior direction are performed by FPA and MPA, then FPIA and the greatest by MPIA. According to the results of this study, the students who demonstrated the worst scores in YBT-LQ and SBT have the greatest asymmetries in the anterior reach and thus the highest risk of injury to the lower extremities. According to some studies (Plisky et al., 2006; Smith et al., 2015), the risk of injury is 2.7 times higher in subjects with an asymmetry in the anterior reach of YBT-LQ greater than 4 cm. Plantar and dorsiflexion of the ankle appear to make a major contribution with respect to asymmetries in the anterior, posteromedial, and posterolateral directions (Kang et al., 2015; Overmoyer et al., 2015). The results of this study are understandable with respect to AA and the students with the best scores in YBT-LQ and SBT have the lowest asymmetries and the lowest risk of injury. However, with respect to PMA and PLA the results of this study show that the best scores in PMA are performed by MPIA and in PLA by MPIA then FPIA. This may mean that the ability to direct the toe while performing the test can be a significant factor in asymmetry scores (Overmoyer et al., 2015). Contrary to current study Fusco et al. (2019) found that there was no significant difference in YBT-LQ between females and males in posteromedial and posterolateral reaches with respect to the extremities. The only significant difference was found in the anterior reach where females showed better balance than males. However, the average age of the subjects in that study was 23.8 years. According to current study, Miller et al. (2017) studied the effects of specialization and gender on the result in the anterior reach of YBT-LQ. The sample consisted of high school students (117 boys and 178 girls) aged 15.6 years. The results showed that male students have a greater asymmetry in the anterior direction and a reduced reach compared to female students. Differences in YBT-LQ and SBT scores between females and males are possible due to the influence of factors not assessed in this study, such as ankle dorsiflexion, knee flexion, hip flexion (Fusco et al., 2019). As previously mentioned, FPA and MPA demonstrated the best scores in all variables, including YBT-LQ in the anterior reach. An explanation can be found in the research of Kang et al. (2015) in which the results showed that ankle dorsiflexion explains 50% of the variance in RELR-AR and RELR-AL. In addition to ankle dorsiflexion being a good predictor of normalized anterior reaches, it may be a good indicator of chronic ankle instability associated with limited ankle dorsiflexion (Hoch et al., 2012; Terada



et al., 2014). Greater dorsiflexion of the ankle allows further reach of the opposite leg, so reduced performance during YBT-LQ in the anterior direction may indicate ankle deficits in dorsiflexion that may help clinicians when examining individuals at increased risk of ankle injuries (Kang et al., 2015). In male students the increased risk of ankle injuries is also significantly associated with BMI, which may mean that young men with higher BMI have a significantly higher risk of ankle injuries (Hartley et al., 2017). In this study, MPIA has the highest BMI and is only significant compared to FPA. One possible explanation for the differences between male and female in YBT-LQ is also the optimal flexibility or range of movement (ROM) of the lower leg muscles. Ankle dorsiflexion and 0° and 90° knee flexion appear to be the most significant factors when talking about the influence of flexibility on the score in YBT-LQ and this is most emphasized in the measurement protocol where the heel of the standing leg must be in contact with the ground during anterior reach (Overmoyer et al., 2015). Apparently FPA and MPA perform better than FPIA and MPIA in YBT-LQ in the anterior reach and thus this may indicate that they have better ankle stability and optimal lower extremity flexibility. In contrast, FPIA and MPIA are potentially at risk of lower extremity injuries as they have ankle deficits in dorsiflexion and thus limited abilities. Also, knee flexion has been shown to be moderately correlated with anterior normalized reach in YBT-LQ, but not as a predictor that could significantly contribute to the predictive value of anterior reach (Kang et al., 2015). In a study by Kang et al. (2015) hip flexion proved to be the best single kinematic predictor of performance in the posteromedial and posterolateral direction of YBT-LQ. But reach in the posterolateral direction appears to be moderately correlated with ankle dorsiflexion and knee flexion of 90° while reach in the posteromedial direction is correlated with hip flexion which may mean ROM is an important factor during reach in that direction (Overmoyer, 2015). In addition to ankle dorsiflexion, knee flexion, hip flexion, lower extremity flexibility core strength, core endurance, core proprioception, and neuromuscular control can also significantly affect outcome in YBT-LQ (Granacher et al., 2014; De Blaiser et al., 2017). Granacher et al. (2014) reported that 6-week core strength training can significantly improve results in YBT-LQ (2-3%). Thus, this may indicate that FPA and MPA have better ankle stability, greater ROM (hip, knee, ankle), better proprioception, and greater core strength compared to FPIA and MPIA and therefore achieve greater scores in YBT-LQ. In SBT the best scores were demonstrated by MPA and significantly different from MPIA and FPIA. Hammami et al. (2016) reported that the score in SBT was significantly moderately to highly correlated with back extensor muscle strength and highly correlated with power tested by horizontal and vertical jumps. This is one of the possible reasons, together with proprioception and neuromuscular control, why MPA and FPA perform better on in SBT and thus have a better ability of the pelvis to remain stable when transferring loads between the spine and lower extremities (Hungerford et al., 2007). Thus, in both YBT-LQ and SBT, core stability is important, which can be achieved with core strength exercises. Those subjects who have greater strength, proprioception and neuromuscular control of the core have a lower risk of injury to the lower extremities. This study also has some limitations. Future studies should analyze possible differences in balance tests on larger samples to establish normative values to determine injury risk cutoffs. Also, future studies should take into account more parameters (ROM of hip, knee, ankle and strength of core, hip, lower extremities) when analyzing the differences between YBT-LQ and SBT. Further research related to asymmetries in the posteromedial and posterolateral directions of YBT-LQ needs to be conducted because it is unclear why MPIA and FPIA perform better than MPA and FPA and vice versa. Certainly, future studies should analyze and specify why female students score better in dynamic and static balance tests than male students.

The results of this study found that FPA and MPA demonstrated the best scores in YBT-LQ and SBT compared to FPIA and MPIA. Given the scores in AA in YBT-LQ, FPA and MPA have the lowest risk, while FPIA and MPIA have an increased risk of lower extremity injury. This research and evidence from the literature suggest the need to conduct balance exercises for young athletes and those young people who are not physically active. The balance tests used in this study are excellent tools for diagnosing dynamic and static balance and its deficits in participants in various sports and those who are not physically active. These tests can quickly, efficiently, economically and reliably assess the control of dynamic and static balance of subjects stability of the lower extremities, the progress of rehabilitation and understand the shortcomings after injury and identify athletes at high risk of injury of the lower extremities. Coaches and teachers of physical education should be aware of how, how and to what extent they should adapt the training and teaching of physical education according to the age and needs of those who are physically active and inactive with the aim of optimal development of abilities and reduction of risk of injuries.

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## THE EFFECTS OF MITOCHONDRIAL ENERGY METABOLISM INDUCED BY HIIT IN SKELETAL MUSCLES DEGENERATION CAUSED BY AGE DEVELOPMENT

Zhong-Ye Jiang, Hao Su, Guo-Huan Cao, Tian-Hao Wen, Jia Shao

Beijing Sports University, China

**Objective:** Ageing degeneration of skeletal muscle can lead to degenerative symptoms such as decreased mass of skeletal muscle, decreased muscle strength, decreased muscle endurance and metabolic capacity, disorders of innervation, increased connective tissue and fat. It is an important reason for the decline of the elderly's ability to move. Therefore, the aging of skeletal muscle has attracted increasing attention. At present, there are many researches on the improvement of skeletal muscle ageing degeneration by exercise, but it mainly focuses on skeletal muscle mass and strength, and lacks a combing of energy metabolism changes in ageing degeneration. High intensity interval training (HIIT) as a new sports training method, it has attracted the attention of many Chinese and foreign scholars, but the current related research lacks the influence of HIIT on the mitochondrial oxidative capacity of rats during aging. Therefore, this study intends to construct a rat model of skeletal muscle ageing degeneration, observe the timing and change of mitochondrial oxidative capacity of skeletal muscle in rats during aging, and perform HIIT intervention on the rat model, to study the effect of HIIT on delaying the decline of oxidative capacity of skeletal muscle.

**Method:** A total of 58 seven-month-old male Wistar rats (average weight 631 g) were randomly divided into a control group (C) and a HIIT intervention group (H). All rats entered the animal room for one week of adaptive feeding and exercise, and then group H began to exercise for four months and group C had four months of static feeding. In group H, a training program was developed by testing the maximum oxygen uptake of rats. HIIT exercise rats were alternately exercised at 50%, 70%, and 90% VO<sub>2</sub>max. Group H exercise for 50 minutes every day for 5 days / week. Rats in each group were selected after training for a specified number of weeks (8 weeks, 16 weeks), and the VO<sub>2</sub>max test was performed before the selection. 24 hours after the end of the VO<sub>2</sub>max test, the soleus muscles were stripped from the dead animal and the mitochondria were extracted to test the mitochondrial oxidase activity and mitochondrial ATP production ability. The time points and changes of cardiopulmonary endurance, skeletal muscle mitochondrial oxidative capacity, and mitochondrial synthesis capacity caused by natural ageing in animal models were observed.

**Result:** 1. During the aging of 16 weeks, the maximum oxygen uptake of rats in group C and group H both showed a downward trend, but group H decreased more slowly than that in group C. 2. After 8 weeks of intervention, there was no change in the mitochondrial ATP concentration of soleus muscle in group H compared with group C rats. After 16 weeks of intervention, the mitochondrial ATP concentration of soleus muscle in group H was higher than that in group C ( $P < 0.05$ ). 3. The concentration of pyruvate dehydrogenase in the mitochondria of soleus muscle of group H rats was not significantly changed after 16 weeks of HIIT intervention. It can be seen that the increase of ATP in mitochondria of soleus muscle of group H rats originated from mitochondrial fat metabolism rather than glucose metabolism.

**Conclusion:** 1. HIIT can delay the aging of skeletal muscle mitochondria and the body's cardiopulmonary endurance. 2. The delay effect of HIIT training at 16 weeks is better than that at 8 weeks.

**Key words:** High intensity interval training, skeletal muscles degeneration, mitochondria, energy metabolism

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## LUMBAR EXTENSION STRENGTH TRAINING AND CHRONIC LOW BACK PAIN

**Andelka Knezović Svetec**

*Centre for Diagnosis and Therapy-Marianowicz, München, Germany*

**Purpose:** Low back pain is one of the most significant public health problems in the World and one of the most common causes of seeking medical attention. Therapeutic exercises play an important role in the treatment of chronic low back pain (Grazio et al., 2012). The MedX device plays an exceptional role in strengthening the extensor muscles of the lower back. The aim of the study was to determine the effectiveness of a strength training program carried out on the MedX medical device on the strength of the lumbar spine extensor muscles.

**Methods:** 10 participants took part in the study. They were randomly selected from a pool of patients of the Centre for Diagnosis and Therapy-Marianowicz in München, Germany. The mean age of the five male participants was  $57 \pm 8.46$  years, while the five women were  $57 \pm 8.26$  years old. Each of the respondents gave their written consent to participate in this pilot study. The strength of the lumbar spine extensor muscle was measured using a MedX device. A series of isometric tests were performed in order to assess maximal isometric strength of the extensor muscles of the lower back in the positions of 0°, 12°, 24°, 36°, 48°, 60° i 72° angles of dorsal extension. Subsequently, 18 isometric strength training sessions of the lumbar spine extensor muscles were performed on the MedX device in the same positions. A final test equal to the initial one followed.

**Results:** The difference in maximal isometric strength of the lumbar spine extensor muscles at the beginning and after 18 training sessions was evaluated by means of a t-test for dependent samples. A significant development of isometric strength of the interested muscles was determined ( $p=0,000273$ ).

**Conclusions:** Since the strength of the extensor muscles of the lower back increased, based on the obtained results, the effectiveness of the strength training program performed on the MedX device was confirmed.

**Key words:** *Chronic low back pain, MedX, strength training, lumbar extensor muscles*

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## EFFECTS OF TAI CHI COMBINED WITH ZHAN ZHUANG GONG ON THE BALANCE CAPABILITY OF AMATEUR FOOTBALL PLAYERS WITH FUNCTIONAL ANKLE INSTABILITY

Yingkui Li, Youhua Li

*Beijing Sports University, China*

**Objective:** To observe the effects of Tai Chi (TC) or Zhan Zhuang Gong (ZZG) on the functional ankle instability (FAI) evaluated through balance, of amateur football players.

**Methods:** 57 amateur football players with FAI were randomly assigned to three groups: TC + ZZG (n = 21), TC (n = 18), and ZZG (n = 18). The TC + ZZG group performed TC and Tai Chi pile movement intervention, the TC group performed TC movement intervention, and the ZZG group performed Tai Chi pile movement intervention. The three groups each performed 60 minutes each time, 3 times a week for 14 weeks of intervention training. Star Excursion Balance Test (SEBT), UniPedal Stance Test (UST), for the ankle were evaluated at baseline (front), 10 weeks (middle) and 14 weeks (post) of baseline. Ankle joint position perception (AJPP) was also evaluated.

**Results:** The TC, TC + ZZG group had significant improvements in SEBT (front, middle, front, rear), UST (front, back, middle, rear) and AJPP (front, back, middle, and rear) ( $P < 0.05$ ); ZZG group UST (back, middle, and rear) And AJPP (before, after, and after) have significant improvements ( $P < 0.05$ ). In terms of SEBT, the TC and TC + ZZG groups were better than the ZZG group ( $P < 0.05$ ); in the UST, the ZZG and TC + ZZG groups were better than the TC group ( $P < 0.05$ ); in the AJPP, the three groups were not significantly different ( $P > 0.05$ ).

**Conclusion:** 10 weeks of Tai Chi combined with Zhan Zhuang Gong exercises can significantly improve the balance ability of amateur football players with FAI, and the effect is better than Tai Chi or Zhan Zhuang Gong exercises alone, and it can be used as a long-term effective training method for rehabilitation.

**Key words:** *ankle rehabilitation, ankle instability, balance*



## EFFECT OF TAI CHI COMBINED WITH KINESIO TAPING ON POSTURE CONTROL OF COLLEGE FOOTBALL PLAYERS WITH FUNCTIONAL ANKLE INSTABILITY

Youhua Li, Yingkui Li

*Beijing Sports University, China*

**Objective:** To observe the effects of Tai Chi (TC) or Kinesio Taping (KT) on posture control such as dynamic balance, static balance and flexibility, in football players with functional ankle instability (FAI).

**Methods:** 53 college football players with FAI were randomly assigned to 3 groups: TC+KT (n=20); TC+KTp (Placebo Kinesio taping, KTp, intramuscular effect placebo) (n=17), KT(n =16). The TC+KT group was treated with TC and KT functional correction techniques, the TC+KTp group was treated with TC and placebo KT, the KT group was treated with KT functional correction technique. Each of the 3 groups received their intervention for 30 minutes each time, 3 times a week for a total of 6 weeks of intervention training. At baseline (before), 4 weeks after intervention (middle) and 6 weeks after intervention (after), Star Excursion Balance Test (SEBT), UniPedal Stance Test (UST) and The standing body flex test (Toe Touch Test, TTT) was used for evaluation.

**Results:** The TC+KT group showed significant improvement in SEBT (pre-neutralization) and UST (pre- and post-middle) ( $P<0.05$ ); TC+KTp group in SEBT (pre-neutralization), UST (before and after) and TTT there was a significant improvement ( $P<0.05$ ). Compared with the KT group, SEBT (TC+KT and TC+KTp) was significantly improved in the middle of the intervention ( $P<0.05$ ); late in the intervention, SEBT (TC+KT and TC+KTp), UST(TC+KT) and TTT (TC+KT and TC+KTp) showed significant improvement ( $P<0.05$ ).

**Conclusion:** 6-week Tai Chi intervention can significantly improve posture control evaluated through dynamic balance, static balance and flexibility, in football players with FAI. Compared with KT alone, Tai Chi or combined KT improves FAI posture control. Therefore, Tai Chi can be used as a long-term training method for FAI rehabilitation.

**Key words:** *ankle sprain, balance, postural training*

## THE ROLE OF STABILOMETRY IN THE FUNCTIONAL RE-EDUCATION OF PATIENT WITH STROKE

Marius Neculăeș<sup>1</sup>, Paul Lucaci<sup>2</sup>

<sup>1</sup>Alexandru Ioan Cuza University of Iasi, Romania

<sup>2</sup>Faculty of Physical Education and Sport, Romania

### Abstract

Nowadays, stroke represents a burden for the society and it is assumed that, due to population ageing, this burden is increasing. Experts in the field of neuromotor rehabilitation look for solutions for the effective and rapid recovery of post-stroke patients, the ultimate purpose being their socio-professional integration. We have carried out a prospective study on a sample of 23 subjects (11 females and 12 males), who had suffered an ischaemic stroke. The functional assessment method consisted in the testing of balance parameters using the stabilometric platform. The means used for the medical recovery of the subjects included within the research were the training of weight distribution at the level of the lower limbs, using the GPS 400 stabilometric platform, associated with the individualised physiotherapy programs. The findings of the study highlight the efficiency of the rehabilitation methods used.

**Key words:** cerebral ischaemic lesions, balance, recovery, physiotherapy

### Introduction

Worldwide, stroke represents the second mortality causes. The main risk factors for this disease are high blood pressure, genetic predisposition, high cholesterol, diabetes mellitus, metabolic syndrome, chronic renal disorder (Mozaffarian et al., 2016). Stroke prevention involves an efficient management of the risk factors, as well as major changes in lifestyle, such as exercising and changing the diet (Guzik et al., 2017).

The five main signs and symptoms of stroke consist in sudden weakness or numbness of the face, of the upper or lower limb, confusion or problems uttering words or understanding them, sudden vision issues in one or both eyes, strong and sudden dizziness also associated with string headaches, gait issues or loss of balance and coordination (Randolph 2016).

Despite the continuous progresses made in terms of treatment and management of stroke, it still remains an important cause of disability and of economic burden worldwide; it is predicted to grow, due to population ageing, as mentioned above (Winters et al., 2018).

Rehabilitation services represent the main mechanism through which functional recovery and independence are possible among the patients with acute stroke (Winstein et al., 2016). The prevention of sequelae onset is very important in this stage because the emergence of retractions and the faulty postures of the hemiparetic limbs has negative effects in what concerns the possibility of the patient to perform daily living activities.

The national health institutes have underlined the need for clinical investigations to assess the efficacy, optimisation and dosing of recovery therapies in order to gain postural control, meant to reduce the risk of falling (Lee et al., 2018).

For the functional assessment, testing methods have been developed throughout time including the dysfunction of the higher and lower limb, the postural control, the possibility of the patient to perform daily living activities (Lin et al., 2018). In order to assess body balance, commonly impaired post-stroke, several tests were developed, such as Berg Balance Scale, Romberg test, Four Step Square Test, Timed Up and Go test (Goljar et al., 2019).

Stabilometry has been used in clinical practice to assess balance; the importance of this method is renowned throughout the world< a standardisation of the stabilometric platform parameters has been proposed at the international meeting of the Society for Posture and Gait Research in 2009, 2013, 2014, 2015 (Yamamoto et al., 2018).

The stabilometric platform represents a modern method of balance evaluation, which may be used for patients with stroke, in both the acute and the subacute stage, as well as in the chronic stage. It provides information concerning the loading of the lower limbs, weight distribution at plantar level, variation and speed of barycentre oscillations in the support polygon and length of the curve described by the barycentre. The evaluation of gravity centre values provides information about body stability, which is then stored and processed using special software programs that make up a stabilogram.

Postural control and stability represent the main components for maintaining the upright stance and the balance during daily living activities, with significant implications in rehabilitation (Baldini et al., 2013). The stabilometre may be used to re-educate weight distribution at the level of the lower limbs and the barycentre projection, given that the patient monitors the barycentre and the loading degree on the display of the device.

## Methods

The research study has included 23 hemiparetic subjects (11 females and 12 males), who had suffered an ischaemic stroke, all of them within the first five months post-stroke. After signing the informed consent form, they benefitted from two balance assessment sessions using the GPS 400 stabilometric platform, providing information concerning weight distribution at the level of the lower limbs, speed of barycentre oscillations, anterior-posterior and lateral imbalances, as well barycentre curve length.

We have excluded from the study the patients with severe physical and mental disabilities, unable to stand, as well as the subjects with balance disturbances provided by associated pathologies or by severe biomechanical alterations of the leg.

The stabilometric assessment was conducted with eyes open; the subjects were explained the testing method, which involved maintaining the upright stance on the stabilometric platform without support, the legs parallel, slightly apart; the test lasted for 20 seconds (Lucaci et al., 2019).

The first balance assessment took place at the beginning of the study, while the second one after five months; all the subjects benefitted from physiotherapy programs associated with sessions of weight distribution re-education at the level of the lower limbs using the stabilometric platform.

Stabilometric re-education was conducted using the GPS 400 platform, which enabled the patient to watch of the display of the device weight distribution at the level of the lower limbs and barycentre position; hence, the patient could correct the loading degree through an intentional effort, with help from the feedback shown on the monitor.

The stabilometric re-education programs were conducted with a frequency of 3 sessions a week, with a duration of 5 minutes in the first 2 weeks to avoid fatigue, increasing afterwards to 15 minutes (weeks 4-6) and then 20 minutes after the first 6 weeks.

Stabilometric re-education was associated with the physiotherapeutic program underwent by the patients to re-education joint mobility, muscle strength, balance and body stability.

## Results

The 23 subjects included in the study, who benefitted from stabilometric assessment and balance re-education using the GPS 400 stabilometric platform have obtained the results featured below. Figure 1 shows the comparison between the initial and the final evaluation for mean loading of the lower limbs in stabilometric evaluation.

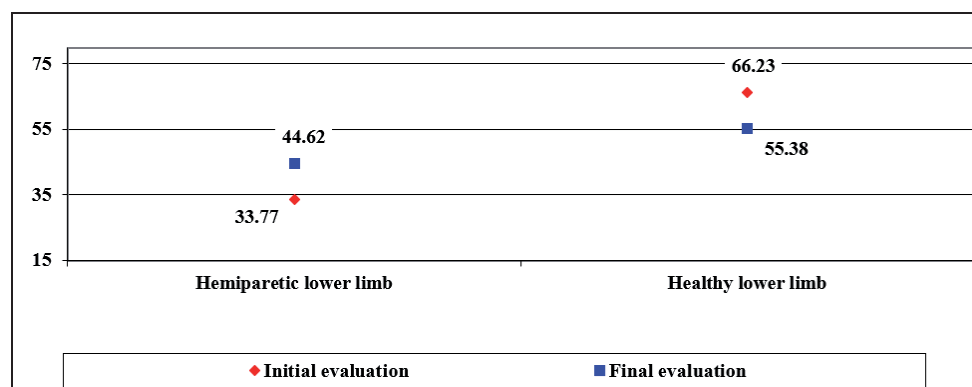


Figure 1. Differences between the initial and the final evaluation, concerning the mean loading of the lower limbs, during eyes open assessment

In the stabilometric evaluation of weight distribution at the level of the lower limbs, statistically significant differences were found between the two evaluations; the mean percentage of loading at the level of the paretic lower limb is significantly higher at the final evaluation (44.62% compared to 33.77% at the initial evaluation,  $p < 0.0000001$ ), which highlights an improvement of weight distribution at the level of the impaired lower limb. The same was found at the level of the healthy lower limb, where the mean percentage of the loading was significantly higher at the initial evaluation (66.23% compared to 55.38% at the final evaluation,  $p < 0.0000001$ ).

Figure 2 illustrates the comparison between the initial and the final evaluation concerning imbalance direction, in the stabilometric evaluation.

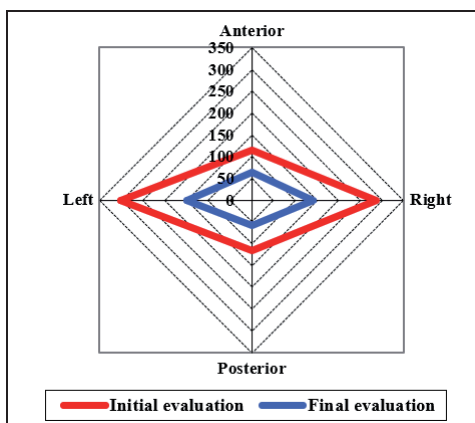


Figure 2. Imbalance direction

In the stabilometric evaluation of imbalances, the mean direction of imbalance seemed to be significantly higher at the initial evaluation, both leftwards for the right hemiplaegic subjects (301.54 mm compared to 150.14 mm at the final evaluation,  $p < 0.0000001$ ), and rightwards for the left hemiplaegic subjects (285.83 mm compared to 140.66 mm at the final evaluation,  $p < 0.0000001$ ), anterior (114.93 mm compared to 63.43 mm at the final evaluation,  $p = 0.000002$ ) and posterior (116.61 mm compared to 59.16 mm at the final evaluation,  $p < 0.0000001$ ). The descriptive statistics of the results obtained in what concerns the speed of barycentre oscillations and the barycentre curve length are depicted in Table 1 and Table 2.

Table 1. Comparisons between the initial and final evaluation concerning the speed of barycentre oscillations, in stabilometric evaluation.

Compared variable	Initial average	Initial Std. dev.	Final average	Final Std. dev.	N	t	p
Speed of barycentre oscillations	750.86	309.28	409.00	308.71	66	20.369	<0.0000001

In stabilometric evaluation, the mean speed of barycentre oscillations was significantly higher at the initial evaluation (750.86 mm/s compared to 409 mm/s at the final evaluation,  $p < 0.0000001$ ).

Table 2. Comparisons between the initial and final evaluation regarding barycentre curve length, in stabilometric evaluation.

Compared variable	Initial average	Initial Std. dev.	Final average	Final Std. dev.	N	t	p
Length of curve	3.741	1.205	1.490	0.387	66	16.726	<0.0000001

In stabilometric evaluation, the mean barycentre curve length was significantly higher at the initial evaluation (3.741 mm compared to 1.490 mm at the final evaluation,  $p < 0.0000001$ ).

## Discussion

In order to quantify objectively the functional status of a patient post-stroke, several tests have been developed in order to have accurate measurements; nowadays, however, computer-based measurements prevail (Lin et al., 2018).

Thus, through the stabilometric assessment applied to our sample of subjects and by applying the stabilometric re-education program using the GPS 400 platform, we have been able to point out that weight distribution at the level of the lower limbs, direction of imbalances, speed of oscillations and barycentre curve length have improved from the initial evaluation to the final evaluation, which stands to prove an effective re-education of balance for the patients with ischaemic stroke.

Our research pinpoints that the association of stabilometric re-education and physiotherapy protocols may lead to optimised balance parameters. This improvement of balance parameter is also due to the fact that training on the stabilometric platform provides the possibility of increasing muscle coordination capacity through bio-feedback and participated in joint stabilisation through practice and proprioceptive re-education.

Other studies that have focused on balance re-education on healthy subjects and on patients with stroke underline the feasibility of stabilometric platforms as a clinically useful tool (Llorens et al., 2016; Mazumder et al., 2017).

## Conclusion

Our research highlights the utility of stabilometric platforms as an assessment means and as a mean or re-educating weight distribution at the level of the lower limbs and the balance of patients with cerebral ischaemic lesions.

Regular functional evaluation is necessary to monitor the recovery process and to adapt the rehabilitation programs to the functional remain of the patient.

Physiotherapy protocols associated with training on the stabilometric platform contribute to an increase in the quality of life for patients with stroke, by improving balance parameters and by enhancing their capacity of performing activities of daily living.

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## EARLY ONSET OF INTERVENTIONAL TREATMENT AS A PREDICTOR OF SUCCESSFUL MOTOR DEVELOPMENT

Sanja Novak Orlić<sup>1</sup>, Ivana Jurković<sup>2</sup>, Andrea Miškulin<sup>1</sup>

<sup>1</sup>*Institution for Home Care, Zagreb, Croatia*

<sup>2</sup>*Primary school Horvati, Zagreb, Croatia*

### Abstract

There are certain medical situations that indicate early interventional treatment of a child. In some other cases, parents notice “that there is something wrong” with their child. That is the right time to get the first assessment. Early intervention means identifying and providing effective early support for children who are at risk of poor outcomes. *Early intervention* helps children to improve their abilities and learn new skills. One of the most successful and recognized approaches is the Bobath approach. It is used to facilitate motor activities for getting (more) normal neuromotor development, which will affect other areas of child development. The aim of early treatment is to establish normal developmental patterns and not to allow pathological patterns to form tight neurological connections. If pathological patterns are not identified early, and if the damage of the central nervous system (CNS) is extensive, it will be more difficult to correct them - sometimes impossible. Neuroplasticity allows babies to develop the neural connections that they need. Connections that are not used will fail. The aim of this paper is to examine whether an early neurodevelopmental treatment can be a predictor of the successful motor development of a child. Thirty-seven (37) children were included in the longitudinal study. All of them were assessed by the Bobath approach and were treated by the Bobath treatment. Children were divided into three groups:

Group I: low-risk children (8); Group II: premature children with extensive damages of CNS (16); Group III: high-risk children (13). The results of this longitudinal research shows that the earlier the intervention, the better the result.

**Key words:** *Neuromotor development, child, milestones, neurodevelopmental treatment, physiotherapist*

### Introduction

The goal of the normal motor development of a child is to achieve functional independence through independent walking and hand manipulation. If everything runs smoothly, a child will achieve normal neuromotor development through play and positive stimulation from the environment, without problems or major delays. But if a child's motor development is delayed or disrupted, physiotherapeutic guidance is of crucial importance. Some children are born prematurely. In some children, intrauterine development was impaired. Because of that, their development may be disturbed. Motor development influences all other spheres of development, such as: tactile, sensory, motor, visual, auditory, psychological, neurological, cognitive, emotional and social. According to experts, there are multiple benefits to establishing a diagnosis in a timely manner (Noritz and Murphy, 2013). Literature and practice confirm that there are multiple benefits to start an early neurodevelopmental treatment with children. By the Bobath approach, it is possible to facilitate motor activities for getting (more) normal neuromotor development, which will affect other areas of child development. Therapy performed as a home-based early intervention have many benefits (Scrutton, 2012). The aim of this paper is to examine whether an early neurodevelopmental treatment can be a predictor of the successful motor development of a child. The hypothesis is that the earlier the intervention begin, the better will the outcome be.

### Importance of early diagnosis

It is of a great importance to pursue diagnostic tests by a pediatrician or neurophysiologist and concurrently refer patients to early intervention programs (Noritz and Murphy, 2013, Robards, 2004).

### Treatment approach

The multidisciplinary therapy approach developed by Bertha and Karel Bobath (in early 1965) for cerebral palsy (CP), became the main approach to the management of CP. It was also applied to early intervention of high-risk infants, which was unusual at that time (Mayston, 2016).



## Bobath neurodevelopmental treatment (NDT)

An educated and licensed physiotherapist will initially evaluate the status of a child. Initial Bobath approach assesses general picture and spontaneously initiated movements of a child, quality of muscle tone and its distribution, patterns of posture and movement, quality of movement, abilities and main problems. It takes more than one treatment to take a quality assessment. After assessing, it is time to make treatment planning and proceed with therapy.

### Why early years matter

Neuroplasticity allows babies to develop the neural connections that they need. Building massive connections, using and strengthening them through life experiences and pruning unused traits is an extraordinary feature of the human brain. Or shorter: "Use it or lose it" (Graham, 2013).

### A fine line between disrupted development and normal neuromotor development

The process of intensive motor and overall development lasts at least 18 months, while in that period, intensive development of neural connections takes place in CNS. Sometimes there is a fine line between normal neuromotor development and disrupted development. The process of diagnosing involves monitoring the child's development and watching for possible signs of impairment. If experts in medical practice meet a child with impaired development very early i.e. in first 6 months of life, the result of the child's development could not be immediately apparent.

## Methods

In the period from 1997 to 2019, a longitudinal research study was conducted within the framework of the Institution for Home Care, Zagreb, Croatia (Ustanova za zdravstvenu njegu u kući, Zagreb). Thirty-seven (37) children were involved, divided into three groups. There were thirteen (13) girls and twenty-four (24) boys.

### Group I: Low-risk children (8)

In the first group there were 8 low-risk healthy children, born on the term, and children whose development was delayed (Table 1). Their muscle tone was around normal.

Table 1. Low-risk children (8)

	Patient, sex	Year of birth	Muscle tone	Status	Exercise started/ months	Walks	Walking/ months of age
1.	A.O. - f	1999	normal	risk of a mother (DM I)	4	✓	12.5
2.	L.O. - f	2002	normal	risk of a mother (DM I)	3	✓	11.5
3.	L.H. - f	2007	- to normal	delayed head control	3	✓	16.5
4.	H.B. - f	2007	-/+ changing	delayed rolling	9	✓	15
5.	J.G. - m	2008	-/+ changing	delayed rolling	6	✓	14
6.	S.B. - f	2009	+	delayed rolling	10	✓	14
7.	M.H. - m	2009	+	delayed head control	3	✓	12
8.	N.B. - m	2009	normal	risk of a mother (MS)	2	✓	12

Table 1 index:

m - male  
f - female

DM I = diabetes mellitus type I  
MS = multiple sclerosis

### Group II: Premature children with extensive damages of CNS (16)

In the second group, there were sixteen (16) children, born 2 - 11 weeks preterm. Their CNS was damaged. Children were treated by the Bobath approach. The aim was to stimulate the motor development of children (Table 2).

Table 2. Premature children with extensive damages of CNS (16)

	Patient, sex	Year of birth	Gest. week	Muscle tone	Dg	Exercise started/ months of age	Walking	Walking pattern
1.	M.S. - f	1991	34	+	CP - para	9		with help
2.	L.G. - f	1991	33	+++	CP - quadri	4	NO	
3.	I.B. - m	1992	38	++	CP - quadri	12		with help
4.	M.K. - m	1993	29	++	CP - hemi	7	✓	Independently
5.	M.T. - f	1993	36	+	CP - para	10	✓	Independently
6.	D.I. - m	1993	34	+	CP - quadri	7	✓	Independently
7.	B.I. - m	1993	34	++	CP - para	7		with help
8.	D.U. - m	1993	34	+	CP - quadri	5		with help
9.	S.N. - f	1994	32	+++	CP - quadri	3	NO	
10.	M.R. - f	1995	33	++	CP - quadri	2		with help
11.	M.M. - m	1999	34	++	CP - quadri	1		With help
12.	J.J. - m	2002	32	+++	CP - quadri	2		with help
13.	I.V. - m	2002	32	+++	CP - quadri	1	NO	
14.	M.K. - m	2003	29	+++	CP - quadri	2	NO	
15.	S.S. - m	2004	33	++	CP - quadri	7		with help
16.	L.V. - m	2007	38	+	CP - hemi	5	✓	Independently

Table 2 index:

m - male  
f - femaleCP - para = Cerebral palsy - paraparesis  
CP - quadri = Cerebral palsy - quadripareisis  
CP - hemi = Cerebral palsy - hemiparesis**Group III: High-risk children with delayed development (13)**

In the third group, there were thirteen (13) high-risk children whose development was delayed or disrupted (Table 3). They suffered from hemorrhage or/and hypoxia. Children had an early, regular treatment based on the Bobath concept. The aim was to stimulate the motor development of children (table 3).

Table 3. Children with delayed development

	Patient, sex	Year of birth	Muscle tone	Status	Dg	Exercise started/ months	Walks	Walking/ months
1.	V.L. - f	2005	++		HE II	5	✓	10.5
2.	B.S. - m	2006	+++		HE III, HY III	4	✓	11.5
3.	M.R. - f	2007	+	delay		3	✓	11.5
4.	K.K. - m	2007	+		HY II	6	✓	13.5
5.	L.C. - f	2008	++		HE II, HY II	3	✓	12
6.	I.J. - m	2008	++	delay		3.5	✓	12
7.	B.G. - m	2011	++	delay		5	✓	15
8.	T.V. - m	2012	++	delay		5.5	✓	11.5
9.	T.G. - m	2012	+	delay	HE II	8.5	✓	13.5
10.	M.M. - m	2012	++	delay	HE III	6	✓	12.5
11.	B.J. - m	2014	++	pathological patterns	ventricle expansion	3	✓	11.5
12.	I.M. - m	2016.	+++	pathological patterns	HE II	3	✓	13
13.	M.K. - m	2017	+	delay		7	✓	15

Table 3 index:

m - male  
f - femaleHE - hemorrhage  
HY - hypoxia

## Results

Tables 1, 2 and 3, in the methods, section of the paper describe the characteristics of the children who took part in this longitudinal study, but also present the results of the conducted Boath therapy. Results had shown that in:

Group I: All children mastered normal neuromotor development.

Group II: The whole group of thirteen children was born very prematurely (2 - 11 weeks), with excessive CNS damages. Their muscle tone was initially significantly higher than normal: five out of sixteen had mild increased tone (+), six out of sixteen had moderately increased tone (++) and five out of sixteen had severely increased tone (+++). CP was diagnosed at the age of three to five (3 - 5).

Group III: In nine out of thirteen children muscle tone was initially higher than normal and damages of CNS were initially significant. After the treatment, no child had a diagnosis. All children mastered normal neuromotor development.

## Discussion

Early intervention means identifying and providing effective early treatment and support to children who are at risk of poor outcomes. In physiotherapy, early intervention means treatment which is undertaken in the first 6 months of life. The results show that it is optimal to start an early neurodevelopmental treatment at the age of three months if a child can breathe and eat without problems. Neurodevelopmental treatment is in practice a successful approach but we should not think that we can cure a brain lesion or cerebral palsy (Dolenc Veličkovič, Veličkovič Perat, 2005).

## Conclusion

The hypothesis of this research has been confirmed. Early neurodevelopmental treatment can be a predictor of successful motor development of a child. The earlier started intervention, the better the results. Exceptions exist, usually in severe cases when the child is born very prematurely and suffers from severe brain damages.

## Acknowledgments

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## POSSIBLE EFFECT OF PHYSIOTHERAPY ON REDUCING THE INCIDENCE OF INJURIES IN TAEKWONDO COMPETITORS

Snježana Schuster<sup>1</sup>, Goran Bobić<sup>2</sup>, Monika Talan Mihaljević<sup>1</sup>

<sup>1</sup>University of Applied Health Sciences, Croatia

<sup>2</sup>College Ivanić-Grad, Ivanić-Grad, Croatia

### Abstract

**Introduction:** Injuries in taekwondo cannot be entirely prevented, but by implementing quality prevention and rehabilitation procedures, it is possible to improve the quality of training, reduce the severity and frequency of injuries and return to full activity faster.

**Aim.** The aim of this study was to determine the number of injuries as well as the level of selected motor abilities in a suitable sample of taekwondo fighters of different ages and to assess whether the presence of a physiotherapist reduces the number of injuries.

**Methods:** The study was performed on a sample of 35 taekwondo trainees of significantly different ages (3-18 years). A retrospective injury questionnaire was filled out by the parents. Flexibility, anaerobic endurance and repetitive strength were measured using standardised motor tests. Differences between the groups were tested using the analysis of variance, and a post-hoc test was used for further multiple comparisons of groups.

**Results:** The obtained results showed the presence of injuries, mostly on the lower and upper extremities (hematomas, sprains, fractures) with a higher presence in girls (25%). A lower frequency of injuries was observed in the older group, which was made of competitors and had a physiotherapist. ANOVA showed the expected differences between the groups in flexibility and anaerobic endurance ( $p=0,00$ ), and an almost significant difference for repetitive strength ( $p=0,057$ ).

**Conclusion:** Injuries are more common in girls aged 7 to 9 who are not competing. Factors in preventing and reducing the occurrence of injuries in a group of taekwondo competitors are related to physiotherapy intervention.

**Key words:** *physiotherapy, sports injury, taekwondo*

### Introduction

In addition to all other risk factors for the occurrence of injuries in sports, both due to the complex structure and motor requirements and due to the contact characteristics of taekwondo, injuries are common and in fact inevitable (Milinković, 2014). Taekwondo is an Olympic sport, and its rapid expansion and increasing popularity requires a greater interest in studying, researching, and finding ways to effectively prevent injuries in this sport (Vučenik and Rebac, 1989).

For this reason, it is extremely important to take preventive measures, and in case of an injury enable the athlete to return to full training load and competitive activity as quickly and efficiently as possible by use of rehabilitation procedures and by educating the coach and the athlete, while also reducing the possibility of reinjury (Milinković, 2014).

Most children begin their taekwondo training at school age, even though there are clubs that enroll preschool children as well. Even at that age the children start working on their motor skills, strength, power, endurance and flexibility (Lee et al., 2007). Clubs that have a system of cooperation between coaches and physiotherapists have much more success and better results in competitions because they implement injury prevention (e.g. system of proprioception exercises) that improves the dexterity of athletes and reduces the risk of possible injuries (Grba, 2010). In one tournament, the competitors have several fights, and there are breaks between them, so the structures of the locomotor system cool down and reheat. The problem occurs when an injury occurs in the middle of a competition and the fighter does not have time to fully recover and continues the competition and increases the risk of a serious injury (Milinović, 2014; Grba, 2010). Generally, in taekwondo, competitors do not have enough time between fights to fully repair the injury.

The use of physiotherapy is important in the prevention and rehabilitation of injuries (Rössler et al., 2014). Recently, in addition to classical approaches, various customized protocols have been applied that make use of rehabilitation vibrations, stabilization, vibration therapy, neuromuscular electrical stimulation, and laser to improve sports-specific healing outcomes (Edgar and Kazemi, 2020).

Prevention of sports injuries is a set of measures that try to preserve the health of athletes, especially in professional sports where the requirements on the athletes' organism far exceed the physiological capacity of the human body starting from an early age, as well as in the sensitive reproductive period. Prevention of sports injuries is carried out on several levels and includes a primary, secondary and tertiary level. In the protection of athletes' health, primary prevention procedures are a significant factor, especially when assessing their health. It is necessary to properly teach future athletes from an early age, even if they have not yet started primary school. With a teamwork involving all participants in sports (e.g., kinesiologists, doctors, physiotherapists) it is possible to carry out effective primary prevention of sports injuries and damage, or as far as it is possible in high performance sport today, to preserve the health of athletes.

The aim of this study was to determine the number of injuries as well as the level of selected motor abilities in a suitable sample of taekwondo fighters of different ages and to assess whether the presence of a physiotherapist reduces the number of injuries.

## Methods

The study was conducted in the taekwondo club Tigar Zagreb. A total of 35 trainees (12 girls and 23 boys) aged 3 to 18 years were examined. Respondents were divided into 3 groups. The first group (3-6 years), the second group (7-12 years) and the third group (13-18 years). The third group of respondents were also competitors who had the use of physiotherapy at their disposal during training, in preparation for the competitions. For underage respondents, parental consent was obtained. Flexibility, anaerobic endurance and repetitive strength were tested. Posterior thigh muscle flexibility was assessed with the forward bend test (Prskalo,2004). The test was performed three times and the arithmetic mean of three repetitions, in centimetres, was taken for further processing. The subjects' anaerobic endurance was assessed using the one-minute running test at maximum speed. The task was performed once, and the used criterion variable was the running distance in one minute, in meters. Repetitive strength was assessed by the repeated abdominal curl in one minute test. Respondents performed the task once, and the criterion variable was the number of correctly performed curls in one minute. An open-ended questionnaire with 18 questions was sent to the parents. For the purpose of this paper, data related to their injuries will be presented. The obtained results were processed by the statistical program SPSS version 17.0 and are presented in the tables and figure. Possible differences between groups were tested with the analysis of variance, and a post-hoc test was used for further multiple comparisons of the groups.

## Results

Figure 1 shows the total number of respondents and the distribution of injuries according to their gender. ANOVA results for between groups differences in flexibility, anaerobic endurance and repetitive strength are shown in Tables 1, 2 and 3, while post-hoc test results are discussed in the text below.

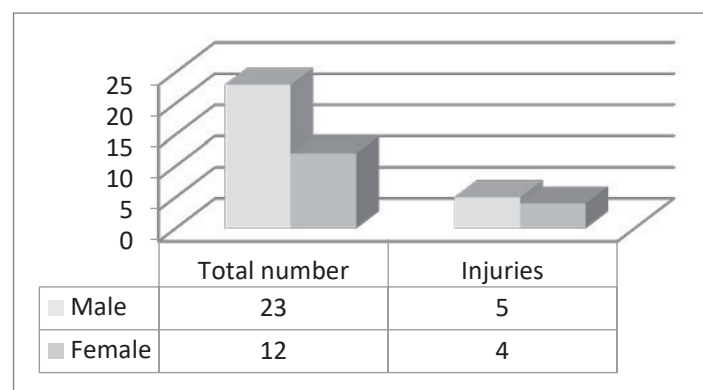


Figure 1. Distribution of injuries by gender

Table 1. Between groups differences (ANOVA) for flexibility

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4915,330609	2	2457,67	49,73	0,0000000002	3,294537
Within Groups	1581,320808	32	49,42			
Total	6496,651417	34				

Table 2. Between groups differences (ANOVA) for anaerobic endurance

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	17425,79	2	8712,89	41,68	0,0000000012	3,294537
Within Groups	6689,76	32	209,05			
Total	24115,54	34				

Table 3. Between groups differences (ANOVA) for repetitive strength

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	376,706494	2	188,35325	3,127063	0,05748403	3,294537
Within Groups	1927,46494	32	60,233279			
Total	2304,17143	34				

The results of the analysis of variance confirm the expected significant differences in motor abilities of taekwondo trainees of different ages. Significant differences were present for flexibility ( $p=0,00$ ) and anaerobic endurance ( $p=0,00$ ), while for repetitive strength the differences were near to significant ( $p=0,057$ ). Post-hoc test for multiple comparisons between groups revealed a significant difference between all the groups in the variables measuring flexibility and anaerobic endurance ( $p<0,05$ ). Such results emphasize the importance of a different approach to individual groups of athletes, taking into account their individual characteristics, both in training and in physiotherapy procedures.

## Discussion

The results of the study indicate a total of 9 injuries per 35 respondents (25%). Two injured respondents belonged to the competitors' group (13-17 years), six respondents to the group of 7-12 years and one respondent to the group of 3-6 years. The relatively small number of injuries of older athletes, to whom a physiotherapist was available, can be partly explained by the possible positive effect of periodic physiotherapy procedures on the health of the athletes. The obtained results, as well as the assumption are in line with previous findings. A study conducted by Grba (2010) suggests a higher frequency of injuries in athletes in clubs without a physiotherapist. In this paper, for example, of the 50 respondents, 88% were injured between the ages of 16 and 20 (Grba, 2010). The results on injuries by gender in this study shows a higher presence of injuries in female respondents ( $N = 4, 30\%$ ) compared to male respondents (21.7%), although some previous studies have shown that there are no significant differences concerning gender (Pieter and Zemper, 1997). The obtained results of the motor skills test indicate that both the female and male population in the taekwondo club Tigar Zagreb are equal in the conducted motor tests and no significant effects on the increased risk of injuries were observed. Respondents who trained for longer show better coordination and starting speed and are more skilful in performing tasks. The youngest group of respondents (aged 3 to 6 years) completed the tasks with some difficulties in understanding the task itself. Fatigue was more pronounced because they ran at full speed from the beginning to the end of the stopwatch countdown. It was observed that previous continuous competitions in the competitors' group resulted in significant exhaustion and loss of strength probably due to muscle inflammation or sprains. Greater flexibility is observed in the group of competitors aged 8-17 years and there is a partial correlation with the previous research showing that flexibility is greatest in early childhood, after that it slowly decreases till 10 or 12 years of age and improves till early maturity, but does not reach the level present in childhood. In relation to gender, flexibility is more pronounced in women than in men (Findak and Milanović, 1997). Taking into account the results of previous research by other authors (Trajkovski Višić, 2004; Dietz and Gortmaker, 1985), it is evident that children who play sports, either taekwondo or some other sport, are in much better physical and mental condition. The results of the questionnaire showed that 9 out of 35 children were injured (25%) but it is important to note that the club does not employ a licensed physiotherapist who could, based on physiotherapy assessment and in agreement with the coach, suggest a preventive exercise program to reduce injuries and improve performance or perform kinesiotherapy procedures in case of an injury. The physiotherapist participates in training, preparations and competitions only for a group of competitors periodically, so the probability of reducing the number of injuries is observed in that group. By increasing general and specific endurance, concentration, accuracy, reaction speed, and by optimizing rest and tactical training, it is possible to reduce the possibility of injury. Educating both athletes and coaches about the importance of working with a physiotherapist before an injury, the presence and reduction of risk factors, the importance of implementing quality warm up and stretching, fatigue control, and modelling training according to the needs of athletes with emphasis on proprioception is of great importance (Jukić, 2013; HKF, 2010). Recent research shows a high incidence of dental injuries in taekwondo ( $n = 57; 3.5\%; P = .035$ ) (Galić, 2018) and the problem of head and neck punches (Koh, 2020), which will require greater responsibility and complexity in a holistic approach to therapy and training components in case of an injury.



## Conclusion

A higher presence of injuries was observed in girls in taekwondo in the examined group aged 7 - 9 years who are not competitors. The number of injuries in the group of competitors is lower, which is associated with the presence of a physiotherapist. The presence of a physiotherapist is significant in the prevention and reduction of injuries in taekwondo.

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## CONCERNS OF CONFLICT SITUATIONS OF PERSONS USING A WHEELCHAIR BEFORE AND AFTER A SELF-DEFENSE COURSE

Alena Skotáková, Zdenko Reguli, Petr Vajda

Masaryk University, Faculty of Sports Studies, Brno, Czech Republic

### Abstract

People with physical impairment could be an easy target of aggressors. Many studies confirm that they become victims twice as often. This paper analyses concerns of conflict situations and their main determinants of persons using a wheelchair who participated in the self-defense course. The second aim is to evaluate the influence of self-defense courses on concerns of the attack on participants of the course. There were five subjects - four women, one man, 31±11 years old. Semi-structured individual interviews were used, analyzed by coding open methods based on grounded theory. The results show that self-defense courses could bring a positive influence on the condition, social, and psychological level. Despite a possible increase in the frequency of perception of fears, participants agree that after completing the self-defense course, there was increased self-confidence and a proactive approach to prevention, as well as the improved perception of self-safety.

**Key words:** *people with physical impairment, victimize, concerns*

### Introduction

The safety and concerns of people with disabilities are becoming current issues. According to WHO (2011), there is 15 % of adults of the world population who have a certain type of disability. There is a connection between this group of people and tendencies to become a victim (Hughes et al., 2012; Bones, 2013). Perreault (2009) finds out that people with various disability have twice more experience with a situation to become a victim of a crime and 2,5 times more of a chance to be attacked. One-third of violent crimes, such as rape or robbery, happen to people with a disability (Rand & Erika, 2009). People with a disability could be an easy and attractive target for aggressors, mainly because it is generally believed that they are not able to defend themselves sufficiently (Bones, 2013). Vulnerability is increasing according to their health condition and often reliant on the activity of another person. The research of people using a wheelchair is insufficient. Occasionally, only an effort to apply competitive, combat sports for self-defense can be found (Serban, Anghelescu, Constantin & Onose, 2019, Madorsky, Scanlon, & Smith, 1989). Research on visually impaired people shows (Kohoutková, Čihounková, Skotáková, & Reguli, 2015) that disabled people generally fear of an attack, they do not feel completely safe on the streets or even in their own houses. A higher risk of social isolation is one of the important consequences of this fear (Kane, 2008). Due to these facts, it seems worth training disabled people in self-defense and building up their confidence and courage (Wong, 1991). Self-defense courses could influence physical, mental, and social health, except the influence of the victimity of people using a wheelchair. There is a strong connection between regular physical activity and various variables of life and functional independence (Stuifbergen, 2010). Despite these benefits, the participation of people with disabilities in physical activities is lower, with a comparison of the non-impaired population (Kawanishi et al. 2013). The motivation of the involvement in physical activity could be increased by expected social interaction and a level of fun during the event (Jaarsma et al., 2014).

### Methods

The purpose of this study is to describe concerns of conflict situations and their main determinants in selected wheelchair users, who participated in a self-defense course. The second aim is to evaluate the influence of self-defense course on concerns of an-attack on participants of the course. There were five subjects (4 women, 1 man, 31±11 years old) participating in the course of self- defense who underwent quality interviews. Each participant is a manual wheelchair user. They are employed; except for one disability pensioner. One of them would partially use assistance service. Intervention program *Self-defence course for wheelchair users* was built on the evidence-based self-defense training approach (Reguli, 2018). The experimental group had ten practical double sessions in total. The course gradually dealt with all three phases of conflict (with an emphasis on pre-conflict), and the participants learned how to behave in these situations. The course also included teaching of strategic solution of self-defense situations and verbal self-defense, the development of technical skills needed for self-defense per se (e.g., parrying, punching, etc.), training of falling techniques including combat in a

disadvantaged position on the ground and the final stabilization of a conflict situation (getting assistance, moving away to safe distance). The last part of a teaching session was always devoted to conditioning and compensatory exercise. At the end of each session, there was a direct feedback slot from the participants. At the end of the course, all the techniques and skills were applied in model situations. The evaluation was based on the methodology used for a specific target group in self-defense (Čihounková, Skotáková, & Kohoutková, 2016). Semi-structured individual interviews for collecting data were used, which takes from 25 to 35 minutes. The place for the interviews was determined by the participants, so they feel comfortable and safe. The interview was structured to areas – a) perceives risks, b) active decreasing of victimity, c) awareness of self-defense, d) experience with conflict situations, e) evaluation of benefits of the course, and influence on the quality of life. The participants were encouraged to express any other thoughts, opinions, or feelings. We used software Atlas with coding open methods based on the grounded theory for analysis (Corbin & Strauss, 1990). There were created four basic patterns by sorting codes into thematic units. The relationships were graphically shown between them.

## Results

Basic aspects, which influence on feelings of concerns of participating wheelchair users by semi-structured interviews were defined - Figure 1. The essential designation is concerned, which increase with limitations and previous negative experience with conflicts. Concerns decrease after a self-defense course completion and with making a personal saving strategy.

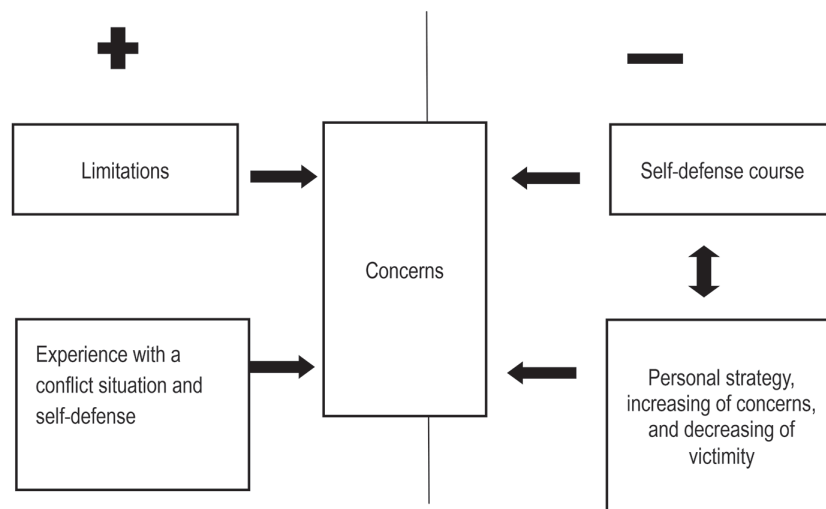


Figure 1. Representation of relationships between 4 patterns which influence concerns of the course participants

**Concerns.** Despite a handicap, the respondents feel current concerns according to the situation, rather than the whole life. Each of the participants has their vigilance scale, where the main motivation is intuition. Except for the intuition, the experience of fear and vigilance increases as well contact with potential risk situations such as “dangerous” places, late time, or a specific group of people (homeless, addicted people). They report that financially motivated crimes, such as robbery or pick-pocketing, are the main motive of attacks because it is challenging to intervene and defend your belongings, such as handbags or cellphones. The primary complication is a location of a rucksack on a rear handrail of a wheelchair, where it is difficult to check the content regularly. Despite all of these concerns and limitations, there is a big will in respondents to be active in case of conflicts and not to underestimate prevention in the pre-conflict phase. Even though there are some concerns about the mismanagement of the self-defense situation, which were supported by the experience of model situations and exercises from the course. The course, on the one hand, increased participants’ confidence, but on the other, raised the perception of conflict concerns

**Limitations.** Limitations, which are created by a life in a wheelchair, screen a lot on concerns of the participants. There is a direct connection between a specific restriction and its concern. The wheelchair users perceive the possibility of falling down or out of a wheelchair as their most significant limitation. The limitation of mobility and speed of movement is perceived very sensitively as well. The experience of the participants suggests that it is effortless to restrict movements to wheelchair users even in verbal conflicts, e. g., catching the wheelchair or blocking the road.

**Experience with a conflict situation and self-defense.** Neither of the participants in the self-defense course had experience with a physical attack that would lead to more severe injury or a post-conflict trauma. Even without much emotional background, everyone was able to talk about their experiences. They describe concerns from the following activities as the most often: various forms of begging from apparently unkempt people or homeless people, disruption of the intimate zone, travel by public transport, unsolicited and unexpected help from other people. Respondents describe

that their attitude and alertness correspond to the situation. They emphasize their intuition and don't want to be limited by these concerns in their lives.

**Self-defense course.** Participants express positively about the course. They say that it was funny, action, dynamic, and complex. Socialization, during the session, had strong responses.

Wheelchair users got to know each other and established relationships with trainers and assistant instructors. The friendly atmosphere and judgeless approach created an overall feeling which encouraged the wheelchair persons to join in actively, ask, and try anything. There were positive asses of the compensation section in the final part of the course. Participants would welcome more practical training in dealing with physical confrontation, instead of de-escalation and communication. The benefits include the increase of self-confidence, feeling that wheelchair users could resist actively, the knowledge of risky behavior, and methods of preventive behavior. The negative influences include the increase of concerns and perceive dangerous situations, the knowledge that some situations are not able to be dealt with due to their limitations.

**Personal strategy, increasing of concerns, and decreasing of victimity.** Participants gain information about potentially dangerous places actively, and they think about that. We found out the effort to avoid hazardous situations and times and being accompanied by friends, relatives, or dogs. Wheelchair users ask actively for help from other people. Participants realize that the quality of life may be impaired if concerns surrender them. They perceive it very important not to show their concerns to the public and act self-confident and certainly not to attract potential attackers. They use their own strategies and rituals, for example, singing or active asking the potential attackers to step back. Checking the surroundings and evaluation of their security has increased in the participants. Among personal strategies are found: self-development and education, active physical exercises, setting personal and security rules, the imagination of positively managing conflict situations, and evaluation acquired experience to common everyday life. Very important is the self-evaluation of their abilities, which could help with the definition of borders of mastered and to create a plan of self-development.

## Discussion

The promptness of the participating of the course may be seen as the most significant limitation of this study. There is commonly lower participation in physical activity of people with disabilities (Kawanishi & Greguol, 2013). Participating in a self-defence course is usually more often in very active persons with a tendency to face problems and concerns. This fact could influence the validity of the results, which may be perceived only with a relationship to similar active wheelchair users. At the same time, it may be assumed that in addition to the relationship between fear and isolation or frequent homestay (Kane, 2018), there may be an opposite relationship in which, due to low activity and homestay, there may be a reduced perception of a concern than wheelchair users move independently without assistants or friends. The social contact could be motivation for participating (Jaarsma et al., 2014). On the one hand, the process of the course is evaluated positively and its acquisition as a benefit. On the other hand, it intensifies feelings of concern. Especially in difficult situations as a folding out of the wheelchair, a group attack, the participants notice after each scenario, that these situations are almost unsolvable. The concerns of wheelchair users confirm previous research Čihounková, Skotáková, Kohoutková (2016). They admit recognizing more potential risk situations because they have more information about a possible threat. Despite awareness of risk, there is a noticeable increase in self-confidence and willingness to resist and approach prevention actively. Practicing in a safe environment could potentiate the feelings of self-confidence and effort to deal with issues independent and actively. There is a strong perceiving of insufficient possibilities of education in self-defense. The course of self- defense for wheelchair users was unique in the environment but it also was a time-limited project. Based on the obtained results, there is space for improvement and specific focus on a similar type of course is needed. Participants of the course have a feeling of insufficient automatization of movement and quickly forget the subject matter. Wheelchair users expect that the course should last from 6 months to 1 year with 1-2 times a week frequency. The alternative was regular repetitions once a year, according to respondents. In terms of the course layout, the participants feel a lack of practicing in practical parts and physical conflicts, especially. On the opposite, the participants assume that in communications and deescalate techniques were considered either as interesting or time-consuming. These opinions could be influenced by the fact that drills of techniques and scenarios are considered as the funniest by the participants.

## Conclusion

The testimonies of the research participants indicate the recency of the topic. The research shows that the course of self-defense for wheelchair users could bring a positive influence on the condition, social, and physic level. The patterns which influence the concerns of conflict situations were set (created). Despite the possible increase in the frequency of perception of danger and concern, participants agree that after completing the self-defense course, there was increased self-esteem and a proactive approach to prevention, as well as an improved perception of self-safety. Participants realize that self-defense competencies require regular training. The possibilities of accessing a self-defense course for specific groups are very limited, and there is a great need to raise awareness of this issue.

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## INCLUSIVE SPORTING AREA

**Nikola Stračárová**

*Masaryk University, Faculty of Sports Studies, Brno, Czech Republic*

### Abstract

The number of persons with disability, elderly and obese people is ever growing, so we are proposing a sporting area, a gym, for people with disability. It is a multifunctional gym, which could be visited by healthy and people with disability alike, or people who do not feel well in the normal gym environment (obese, seniors), who are afraid of disrespect from other visitors and this prevents them from doing sports. Using the PESTE analysis, the political, economic, sociological and technological aspects of the macro-environment that would affect the implementation of this project was investigated which led to the conclusion that the sporting area is feasible.

**Key words:** *Sport, disability, PEST, gym, sport for people with disability, sport of seniors, inclusion, integration, health lifestyle, overweight, obesity, Brno*

### Introduction

For an individual to be considered disabled, they have to have bodily, sensory or mental disability that limits them for a period longer than one year. More than 10% of Czech population fits these criteria, which means a million Czech citizens have some kind of disability. In the age group 60+ more than 3/5 of the populace suffers from some kind of disability. In recent years, the numbers are increasing in the age groups under 19 and over 75 years of age. The number of people who are born with disability also increases, now at nearly 14 percent. As per the data from Czech Statistical Office (ČSÚ, 2019), the percentage of people with disability in the population, as well as congenital disability has increased since the year 2007, when the data were first collected.

Masaryk University is a pioneer in making studies accessible to people with disability. In the last twenty years, their number is still growing and currently 450 people with special needs study at the university, which is the highest number of all Czech universities and more than a third of all college students with disability in the country.

The number of people with disabilities are increasing (ČSÚ, 2019). This is due to advances in medicine in general. Two fifths of people with disabilities are self-sufficient. Better medical care, medication and patient care reduce mortality and increase life expectancy, but the populace is aging. As a result of improving the standard of life and implementing technologies and mechanisms that make life easier, the numbers of obese people are increasing (ČT24, 2015).

These groups often have difficulty integrating into everyday life, they are different from the majority population, they are afraid of being ridiculed and of social ostracization. As a result, their health problems, often linked to lack of movement, may be getting worse. An earlier survey was conducted by the author, that showed that people with disability would like to visit some sports facilities. Sports facilities for people with disability actually exist, but they are focused on individual types of disabilities and they are relatively narrowly specialized and designed for top parasporters. According to (Jelínek, Fikesová, & Synková, 2018) there is no facility of this type in the city of Brno for the general population of people with disability who just wants to maintain or improve their health. If athletes want to use such a gym, they must go to Olomouc, which is 80 kilometers away.

### Purpose of the study

The aim of the study is to design an inclusive sports facility, primarily aimed at people with some disabilities, and then analyze the situation in Brno and see if the project is feasible.



## Methods

### Peste Analysis

PEST is an abbreviation that stands for Political, Economic, Social and Technological. Analysis like this one is used to approximate how these four external factors will affect your business.

PEST analysis helps to tell how these factors will interfere in the performance of a business in the long-term. (Pestle analiza, 2015)

Political - Here government regulations and legal factors are evaluated in terms of their ability to affect the business environment and trade markets.

Economic - Through this factor, businesses examine the economic issues that are bound to have an impact on the company.

Social - With the social factor, a business can understand how consumer needs are shaped and what brings them to the market for a purchase.

Technological - How technology can either positively or negatively impact the introduction of a product or service into a marketplace is assessed here (Understanding Pest Analysis with Definitions and Examples, 2013).

## Results

### Politically-legislative influences

In Brno, the development of organizations dedicated to seniors or people with disability is rather lagging behind the growth of the city and its population. This is pointed out by the SWOT analysis of sport for everyone in Brno (Jelínek, Fikesová, & Synková, 2018). The city is aware of this, and in its 2030 concept of sport, it presents an opportunity to “complete the recreational sport infrastructure in order to ensure quality and affordable leisure time for citizens, seniors and the disabled.” At the same time, they state that there is a “developed network of sports organizations and associations offering sport for everyone” in Brno.

This includes also people with disabilities, the same document states that the Czech Paralympic Committee, covering six sports associations of disabled athletes, supports specific sports clubs in Brno. Among the sports clubs for people with disability in Brno the Kociánka Sports Club Brno, the Sports Club Moravia Brno, Brněnský plázivec, the AVOY MU Brno, the SK Deaf Brno, the SK Orbita Brno, the Sports Club HOBIT Brno and the Czech Wheelchair Tennis Association can be mentioned. A total of 1,400 athletes are engaged in sport clubs in Brno (Jelínek, Fikesová, & Synková, 2018).

The concept of sport until 2030 also mentions the intention to “support the activities of athletes and inhabitants of the city with disabilities”. The aim is to support twenty such projects per year, according to the attached table (Výroční zpráva o rozvoji obecního školství ve městě Brno za školní rok 2017/2018, 2018).

The Faculty of Sports Studies of the Masaryk University in Brno is also active in this respect. They plan to open a new field of study - Coach for people with disability. By opening a new field of study, the excess of applicants for study in the field of rehabilitation worker will be reduced and its connection with the field of trainer will be reduced (extension of scope). This combination of responsibilities complies with the current requirements of promoting sports for disadvantaged athletes. Rehabilitation workers only heal pathology and trainers' work is dedicated entirely to the healthy populace. These newly trained trainers for people with disability would combine their knowledge of both disciplines and, within the health limits, would be able to lead a person with disability or otherwise disadvantaged exerciser in exercise and help him to improve fitness. As part of their studies, students would go to practice in this special gym, which could be built with the support of the university and would also be used for teaching purposes. The current gym is insufficient for such teaching purposes.

### Economic factors

From an economic point of view, the gym project has to deal with two fundamental issues. First, how it will finance the initial costs, in particular the acquisition of fitness equipment and gym equipment. Secondly, how it will cover its ongoing costs, in the first place wages, and then energy.

One of the goals set out in the Brno City Sport Concept for 2018-2030, issued in March 2018, is to support the activities of athletes and citizens of the city of Brno with health disadvantages. The Concept states that the target value of the indicator of supported projects is twenty per year. Initial expenditure could therefore be financed by and within the framework of this objective. Initial expenditures include the acquisition of fitness machines, as well as the installation of new floors and air conditioning (Jelínek, Fikesová, & Synková, 2018).

When answering the second question, it is necessary to start from the current situation of gyms for people with disability. In other Czech cities, such as Prague and Olomouc, such gyms already exist for some time. Since there is no

such gym in Brno so far, based on the experience from other cities it can be expected of it to support itself on the market, there is no need to worry about the competitive environment. At the same time, it is possible to assume that ongoing costs can be financed from revenues on admission. These include sales from both, people with disability and other visitors, such as students from the nearby faculty. The ongoing costs in this case include mainly coach wages and energy costs. Last but not least, it should be noted that because the space will be owned by the city, there will not be the need to pay the rent.

As mentioned above, the concept is primarily built on the expected support of the city and gym's unique position. Overall, the project of a gym for people with disability seems economically feasible.

### Socio-cultural factors

Life expectancy is increasing. Thanks to advanced health care, people with disabilities survive and people live to be older. Their number is steadily increasing because modern medicine is able to cure illnesses and bodily defects, but it cannot completely remove them. The development of medicine goes hand in hand with the development of technologies that make life easier, help people with disability as well as healthy individuals in their everyday life, facilitate daily activities and in many cases do not force a person to leave the apartment. It is comfortable, but sometimes also disadvantageous for health and manifests by reduced fitness and health of the overall population. This is especially true in the case of people with disability, as opposed to the healthy population, it is necessary for them to exercise physical activity in order to not only rehabilitate but also to stay fit (ČSÚ, Lidé a bydlení, 2018).

Childhood obesity is a growing problem. According to WHO data, 27.5% of children in the Czech Republic are overweight and 9.7% are obese. While in 1994 GPs registered 3.7% of obese children in their offices, in 2000 13% of children were registered with excessive weight. Every seventh child in the Czech Republic is obese and 4% of them even suffer from monstrous obesity. According to data of the leading child obesitologist MUDr. Zlatko Marinova, when children leave primary school, 25% of them are overweight and 14% obese (Žára, 2020).

Mobility - accessibility - public transport, wheelchair access, better in a new building, eg near the Faculty of Medicine and FSpS, the possibility of applying students in practice.

### Technological influences

Rooms will have 20 machines, all available to use for people with disabilities and healthy alike. Most machines (15) will operate using compressed air, 3 will be used for warming up (bicycle both classic and for hands, a rowing machine, cross trainer). The other two machines will be a bench with sets of dumbbells.

The size of the gym will be an area of 350-450 m<sup>2</sup>.

Special instruments HUR SmartTouch are modern machines controlled via computer, which significantly increases the self-service of the trainees. The first session would be with a trainer, who would set the individual input parameters, estimate the development and benefits of each exercise and configure the exercise program. The trainer then comes with a programmed chip that will set up the individual machines and allow the exercise load to be achieved and adjusted to the current state of the trainee.

The machines operate using air pressure resistance, a combination of air force training equipment and operating software is specially designed for senior exercise, rehabilitation and inclusive wellness markets. Regulated air pressure resistance is gentle to the joints, so exercise, training and subsequent recovery after exercise is less painful compared to ordinary weight weights. The unique system also allows resistance training and using HUR machines muscles work both in concentric and eccentric phases (Arto Hautala, 2020).

All machines have an integrated computer with software. So each coach can track the progress of workouts at distance and can possibly even modify the data and doses of exercise from almost zero load to an automatic increase in resistance that can be automatically set. Individual machine arms and seat are electronically adjustable and adjusted for each trainee according to their chip (identifier), which significantly reduces personnel requirements for the operation of the entire gym.

Personal online customer profile visualizes the progress of the education program and provides the messaging function between the user and instructor, and automatically reports on the client progress, state of equipment, use of facilities, etc. (Arto Hautala, 2020)

### Discussion

The Olomouc Center confirmed the suitability of HUR machines for the needs of people with disability and otherwise disadvantaged athletes (Baluo, 2020). Everything has worked for several years and athletes commute to Olomouc from a wide area. A similar facility has been operating in Prague for several years. The health benefits of the sports grounds are indisputable, in accordance with the current trend of healthy lifestyle and support of physical activities among exercisers of all ages and health categories, therefore communication with health insurance companies regarding their involvement in prevention and treatment programs in the new facility is also discussed.

## Conclusion

The PEST analysis was used in order to find out whether it is realistic to realize a sports project. The political and economic point of view is clear, the political will is to open the gym and the representatives of the Brno City Hall promised to support the project, so the project is economically viable. Those social groups for which the gym is designed do not have the appropriate facilities to do sports, and research shows that interest in this form of exercise is significant. There are fitness machines that would be suitable for the equipment in the gym in Olomouc, where they have been running for several years and exactly meet the requirements of athletes with disability.

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## BODY MASS INDEX IN CHILDREN WITH AND WITHOUT INTELLECTUAL DISABILITY: DISTRIBUTION AND IMPLICATIONS

Bogdan-Constantin Ungurean<sup>1</sup>, Adrian Cojocariu<sup>2</sup>

<sup>1</sup>"Alexandru Ioan Cuza" University of IASI, Romania

<sup>2</sup>Faculty of Physical Education and Sports, Romania

### Abstract

The aim of this study was to determine whether intellectual disability had a direct influence on the BMI. The study included 40 children aged  $14 \pm 3$  years old, from 4 education units from Romania. The participants in this study were distributed into four groups as follows: group 1 - children without intellectual disabilities, group 2 - children with mild intellectual disability group 3 - children with severe intellectual disability and group 4 - children with Down's syndrome. The measurements for the subjects within the four groups were carried out in the morning, from 10 to 12. Each participant's BMI was calculated using weight and height and then categorised into healthy, underweight, overweight or obese according to Body Mass Index Classifications. After calculating the t tests and the values of the significance threshold for ( $p > 0.05$ ), it may be stated that there are no statistically significant differences between the four groups. We have also appraised the values of BMI for the four groups. It may be mentioned that the groups of children with ID have close values to the ones of children without ID, thus ranging within the limits of WHO (18.5–24.9); however, the group of children with Down's syndrome exceeds these limits, as it borderlines obesity (25.4).

**Key words:** *intellectual disability, Down syndrome, BMI*

### Introduction

Intellectual disability (ID) is a disorder characterized by impaired cognitive and adaptive skills, caused by multiple gene overexpression, single-gene mutations, different non-syndromic genes, as well as environmental factors (Chiurazzi & Oostra, 2000). A growing literature documents the health inequalities experienced by people with Intellectual Disability (ID) compared to the general population (Allerton, Welch, & Emerson, 2011; Emerson, Baines, Allerton, & Welch, 2010). These disparities have been shown in both mortality and morbidity rates (Ouellette-Kuntz, 2005). One particular area of concern is the number of people with ID who are overweight or obese. Prevalence rates vary depending on country but range between 8.5% and 36%, which is consistently higher than rates reported in the general population for the same countries (Grondhuis & Aman, 2013; Rimmer et al. 2010).

It is suggested that higher rates of overweight or obesity in people with ID are caused by several biological / genetic factors, such as a higher prevalence of low metabolic rate and hypothyroidism, especially in people with Down's syndrome (Bhaumik, Watson, Thorp and McGrother, 2008), increased likelihood that they take antipsychotic drugs (Newcomer, 2005) and barriers to maintaining a healthy lifestyle, such as limited access to recreational facilities due to transportation problems, staff shortages and limited incomes (Eden & Randle-Phillips, 2017).

Body mass index (BMI) is a ratio of weight to height used to assess degree of fatness or adiposity of an individual. The measurement is obtained from the calculation of weight in kilograms divided by height in meters squared. BMI is an assessment tool used to estimate degree of overweight or obesity. In the general population, a BMI of  $30 \text{ kg/m}^2$  or above indicates obesity. A BMI below  $19 \text{ kg/m}^2$  indicates a risk of malnutrition. However, BMI is only one component of nutrition assessment and, like body weight, it should not be the only data used to assess nutritional status especially in diseases like AIDS, which can greatly alter body composition (Gerrior & Wanke, 2001)

The BMI ranges are based on the effect excessive body fat has on disease and death and are reasonably well related to adiposity. BMI was developed as a risk indicator of disease; as BMI increases, so does the risk for some diseases (WHO, 2017). Some common conditions related to overweight and obesity include: premature death, cardiovascular diseases, high blood pressure, osteoarthritis, some cancers and diabetes.

## Methods

The purpose of this research study was to determine whether ID had a direct influence on the BMI. The study included 40 children aged  $14 \pm 3$  years old, from 4 education units as follows: “St. Andrei “Gura Humorului, Foster care centre” Laurenția Ulici “Gura Humorului,” Constantin Păunescu “School Centre Iași and” G. Ibraileanu “Iasi, Romania. The participants in this study were distributed into four groups as follows: group 1 - children without ID, group 2 - children with mild ID group 3 - children with severe ID and group 4 - children with Down’s syndrome. It should be noted that at the beginning of the study, we obtained the consent of parents or legal guardians because some subjects came from foster care centres. The measurements for the subjects within the four groups were carried out in the morning, from 10 to 12. Each participant’s BMI was calculated using weight and height and then categorised into healthy, underweight, overweight or obese according to Body Mass Index Classifications (WHO, 2015;)

## Results

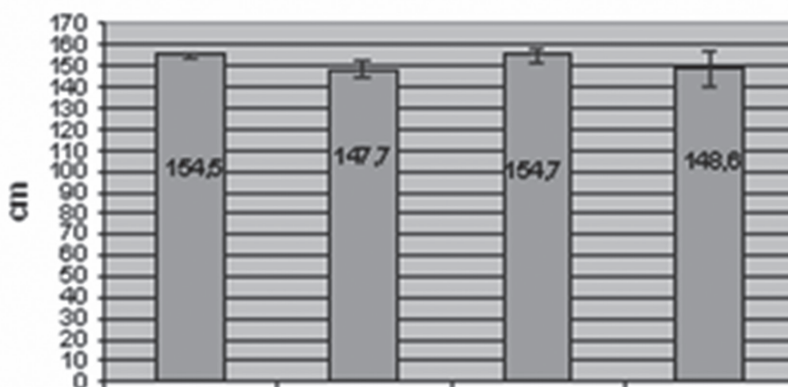
Table 1. Height characteristics in normal children and in disabled children

Group	N	M	M%	E.Std.	C.V.%	t	p
Group 1	10	154.5	100%	1.51	3.1	1.662	0.114
Group 2	10	147.7	95.59%	3.76	8.06		
Group 1	10	154.5	100%	1.51	3.1	0.051	0.96
Group 3	10	154.7	100.12	3.62	7.41		
Group 1	10	154.5	100%	1.51	3.1	0.682	0.531
Group 4	10	148.6	96.18%	8.51	12.82		
Group 2	10	147.7	95.59%	3.76	8.06	1.329	0.2
Group 3	10	154.7	100.12%	3.62	7.41		
Group 2	10	147.7	95.59%	3.76	8.06	0.107	0.916
Group 4	10	148.6	96.18%	8.51	12.82		
Group 3	10	154.7	100.12%	3.62	7.41	0.659	0.537
Group 4	10	148.6	96.18%	8.51	12.82		

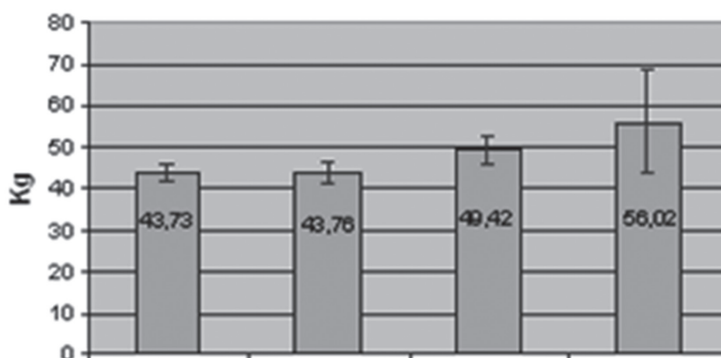
Legend: N – number of subjects; M – arithmetic mean; M% - percentage mean; E.Std. – mean standard error; C.V.% - variation coefficient; t – student test; p – significance threshold

Table 2. Characteristics regarding weight in normal children and in disabled children

Group	N	M	M%	E.Std.	C.V.%	t	p
Group 1	10	43.73	100%	1.91	13.85	0.027	0.979
Group 2	10	43.76	100.92%	2.79	21.45		
Group 1	10	43.73	100%	1.91	13.85	1.468	0.159
Group 3	10	49.42	113.01%	3.36	21.56		
Group 1	10	43.73	100%	1.91	13.85	0.981	0.38
Group 4	10	56.02	128.10%	12.37	49.41		
Group 2	10	43.76	100.92%	2.79	21.45	1.278	0.217
Group 3	10	49.42	113.01%	3.36	21.56		
Group 2	10	43.76	100.92%	2.79	21.45	0.961	0.386
Group 4	10	56.02	128.10%	12.37	49.41		
Group 3	10	49.42	113.01%	3.36	21.56	0.514	0.631
Group 4	10	56.02	128.10%	12.37	49.41		



Graph 1. Height: mean and standard error



Graph 2. Weight and standard error

Table 3. BMI values for the four groups

Group	Height	Weight	BMI
Group 1	154.5	43.73	18.3
Group 2	147.7	43.76	20.1
Group 3	154.7	49.42	20.71
Group 4	148.6	56.02	25.4

## Discussion

Upon calculating the means for *height*, it may be highlighted that the group of children without ID and of children with severe ID have recorded very close values: 154.5 cm and 154.7 cm, respectively (according to Graph 1). The greatest difference has been found between the group of normal children (154.5cm) and the group of children with mild ID (147.7cm), namely 6.8 cm. Close values have also been found between the group of children with mild ID (147.7cm) and the group of children with Down’s syndrome (148.6).

The value of the variation coefficient (*Table 1*) shows that all the four groups are homogeneous. The most homogeneous group is the one of normal children (CV = 3.1%), while the highest variation coefficient is recorded within the group of children with Down’s syndrome, with a value of 12.82 %.

Upon analysing the t test and the values of the significance threshold ( $p > 0.05$ ) (according to *Table 1*), it may be stated that no statistically significant differences between the four groups.

After analysing *Graph 2*, concerning *weight*, it may be noted that groups 1 and 2 have recorded very close values: 43.73 kg for the group of children without ID and 43.76 kg for the group of children with mild ID. The greatest difference was recorded between group of children without ID (43.73 kg) and the group of children with Down’s syndrome (56.02 kg), the latter with a value of 12.29 kg, but the difference is statistically insignificant, for  $p = 0.38$ .

The variation coefficient was analysed and then illustrated in *Table 2*. It may be stated that the most homogeneous one is group 1, with a VC value of 13.85%. Groups 2 and 3 are relatively homogeneous, with very close values of the variation coefficient: 21.45% for group 2 and 21.56% for group 3. Group 4 is heterogeneous from this point of view, thus recording a value of the variation coefficient of 49.41%.



After calculating the t tests and the values of the significance threshold for ( $p > 0.05$ ), it may be stated that there are no statistically significant differences between the four groups.

We have assessed the values of weight within *Graph 2*, showing that the group of children without ID and the group of children with mild ID record lower values than the two other groups featured in *Graph 2*.

We have also appraised the values of BMI (Table 3) for the four groups. It may be mentioned that the groups of children with ID have close values to the ones of children without ID, thus ranging within the limits of WHO (18.5–24.9); however, the group of children with Down's syndrome exceeds these limits, as it borderlines obesity (25.4). Whereas several research studies (Allison et al., 1998; Eden & Randle-Phillips, 2017) feature increased values of the BMI, the results obtained in our measurements determine us to state that, at this age, ID does not entail significant differences in the BMI. This may be explained by the fact that our subjects live in foster care centres, and access to fast-food or other calorie-rich foods is very limited or even absent.

## Conclusion

- Concerning height, the highest values are recorded in the group of children with severe ID; they are also the oldest within the sample.
- Whereas the group of children with severe ID is the oldest, they have an age-specific mean of 14-15 years old; hence, it may be stated that ID has a negative influence on the growth process.
- Upon analysing the values of the weight parameter, the main conclusion to be drawn is that the group of normal children, the group of children with mild ID and the group of children with severe ID have close values, ranging between 43.73 Kg and 49.42 Kg, the highest value being recorded by the group of children with Down's syndrome; actually, they are characterised by mild to average obesity.

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## EFFECT OF WALKING AND KINESITHERAPY ON LOW BACK PAIN

Goran Vasić<sup>1</sup>, Siniša Nikolić<sup>2</sup>

<sup>1</sup>*Faculty of Sport and Physical Education, University of Novi Sad, Serbia*

<sup>2</sup>*Institute for Physical Medicine and Rehabilitation "Dr Miroslav Zotovic", Banja Luka, Bosnia and Herzegovina*

**Introduction/Purpose:** Lumbar syndrome is a set of symptoms dominated by unilateral or bilateral pain in the region from the 12th rib to the infragluteal furrow; it can also be accompanied by pain in the lower extremities. It is often caused by imbalance of the lumbar and abdominal muscles, as a result of sedentary lifestyle and obesity. The aim of the study was to determine the effects of separate and combined effect of kinesitherapy and walking on the ultimate outcome of rehabilitation of persons with chronic lumbar syndrome, and on the mobility of the lumbosacral part of the spinal column.

**Methods:** The study included 60 individuals of both genders, aged 45-65 years, divided into two groups of 30 subjects (experimental and control), consisting of two sub-samples of 15 male and 15 female subjects with chronic lumbar syndrome. All subjects were patients, treated at the Institute for Physical Medicine and Rehabilitation "Dr Miroslav Zotovic" in Banja Luka, where they were included in a three-week study. Diagnoses were made by physiatrists and neurologists: Dorsalgia, Dolor lumbosacralis - Low Back pain, and Dorsalgia non specificata, with no significant comorbidities associated with the study. Also, patients were not operated, nor indicated surgical treatment, had no neurological deficits. They have a neat RTG image of the lumbosacral spine and hips (no advanced degenerative changes of the vertebral body, no protrusion or extrusion of the disc), basic laboratory diagnostics neat, internal medicine specialist's finding neat. The Visual Analogue Pain Scale (VAS) was used to assess the subjective feeling of pain, and for the spinal motility, the Schober test (SCH). During rehabilitation treatment, both groups underwent standard kinesitherapy treatment, and experimental walking. Testing of the effects of the applied treatments was done using the Repeated measure ANOVA, at a significance level  $p \leq 0.05$ .

**Results:** Differences in the final measurement in both sub-samples were statistically significant in both variables in favor of the experimental group: male sub-sample, in the variable VAS-F1,28 = 30.1;  $p = .001$  and SCH- F1.28 = .27.9;  $p = .001$ ; female sub-sample in the variable VAS-F1,28=75.2;  $p = .001$  and variables SCH-F1,28=20.73;  $p = .001$ .

**Conclusion:** The pedestrian-related kinesitherapy program significantly improves the ultimate outcome of rehabilitation in people with chronic lumbar syndrome, both in the functional and subjective domains.

**Key words:** *chronic lumbar syndrome, daily walk, lumbosacral pain*

## THE FIRST 1,000 DAYS OF LIFE- AN OPPORTUNITY FOR MUSIC AND DANCE MOVEMENT. A REVIEW

Jadranka Vlašić<sup>1</sup>, Neda Aleksić<sup>1</sup>, Marina Đelić<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Faculty of Medicine, University of Belgrade, Serbia

### Abstract

Healthy early child development, which includes the physical, social/emotional, and language/cognitive domains of development, each equally important, strongly influences well-being, obesity/stunting, mental health, heart disease, competence in literacy and numeracy, criminality, and economic participation throughout life. Providing support to children in early childhood to reach their full potential is one of 17 Sustainable Developmental Goals in the world brought up by United Nations in 2015. (goal 4; target 2). Families, practitioners in early childhood development and doctors confront with raising number of developmental disorders and development delay in infancy. They are in constant search for different interventions aimed to prevention and early intervention. During last two decades, significant role of arts has been promoted as non-invasive intervention in fields of child development and public health. Numerous researches in different fields: medicine, psychology, child development, sociology, music education showed that infants perceive music, attend to music, respond to music and engage in social music interactions (Arrasmith,2019). Movement and dance are most common and natural reactions to music both in children and adults in all cultures worldwide. This paper discusses the music intervention on developmental movement milestones in infants. We argue that positive early music experience is essential for early motor brain maturation and may be a contributing factor for healthy movement development. Therefore, the aim of this review is to provide an overview about 1. how infants perceive music 2. interaction between music stimuli and infants' movement and 3. how that interaction can be enhanced by an adult/carer toward developmental goals.

**Key words:** *infant, music and movement, child development, early intervention*

### Introduction

The first 1,000 days of life - the time spanning roughly between conception and one's second birthday - is a unique period of opportunity when the foundations of optimum health, growth, and neurodevelopment across the lifespan are established (unicef: <https://www.unicef-irc.org/article/958-the-first-1000-days-of-life-the-brains-window-of-opportunity.html>). Prenatal development is largely driven by genetic processes, but in postnatal development the environment plays a crucial role in fostering development, and the interactions between genetics and experiences account for most developmental outcomes. Experience is defined as the interaction between the individual and his or her environment (Tierney and Nelson, 2009). Through music and movement, meaningful interaction between babies and adults can be established and enhanced toward developmental goals (Phillips-Silver, 2009; Vlismas, Malloch and Burnham, 2013; Parncutt, 2019). Music, as enrichment to environment, is powerful stimuli for newborns and infants to arouse movement. Therefore, the aim of this review is to provide an overview about 1. how infants perceive music 2. interaction between music stimuli and infants' movement and 3. how that interaction can be enhanced by an adult/carer toward developmental goals.

### The development of auditory system in newborn and early infants

To better understand the need for early music intervention on movement milestones development, it is necessary to point out some of the most important developmental milestones of auditory system in newborn and early infants. It is well known that, the development of the auditory system begins very early in gestation, and all major structure of the ear finished development between 23- and 25-weeks gestational age (Hall, 2000). At this point, human fetus can perceive and react to music interaction starting at approximately 26 weeks gestational age. At the same time, specific auditory cells, hair cells in the cochlea are fine tuned for specific frequencies and can translate vibratory acoustic stimuli into an electrical signal which transport to the auditory centre. Finally, by 35 weeks GA, the auditory system is mature enough to determine and distinguish complex sounds (McMahon, Wintermark & Lahav, 2012). This development of auditory cortex is intimately linked with early sensory experience. It is well known that after birth, neonates seem to prefer their mother's voice over an unknown voice. Several studies showed that newborns selectively respond to their mother's speech with

various changes in heart rate and movements toward the source of the mother sound (McMahon et al., 2012; Kisilevsky, et al. 2009). This could suggest that auditory learning, and memory begin during pregnancy and that the stimulation during about 3 months before birth could have positive impact on auditory development. At the other side, the auditory cortex continues to mature in the weeks leading up to birth and continues to develop through the first years of life. (Moore and Guan, 2001) In fact, many aspects of basic auditory expression appear to be adult-like by the middle of the first year of life. However, processes such as attention and sound source determination take much longer to develop (Werner, 2007). Following this, the second critical period for the cerebral cortex and the auditory system development is the first years of infants. It has been estimated that a frequency resolution is mature by 6 months of age, and that high frequency mature later than low frequency. Thus, it would seem that exposure to high-frequency sounds early in infancy is quite important to the normal development of auditory system, as well as, predicts better speech and language outcomes (Yoshinaga-Itano, Coulter & Thomson, 2001). After the 6 months, the infant has difficulty extracting the tone from the noise that remains, and this auditory development extends into the early school years (Werner & Boike, 2001). Because of those investigations, the development of the auditory cortex is heavily dependent on the acoustic environment.

## Music as a stimuli

Music is one of auditory domains that most compellingly attracts infant listeners (Saffran Loman & Robertson 2000). It is present in all cultures as a complex structure of three main elements melody, rhythm and harmony and their related terms like pitch, tempo, beat, meter, timbre. Each one of these elements play its role in one piece of music and they were studied through different research both separately and according to each other. In this review we will focus on research related to musical rhythm and its' following terms of beat, tempo and meter because they are fundamentals in organizing structure of music in time and provide essential elements for eliciting movement.

## Interaction between music stimuli and movement of babies

According to developmental stages, infants can react to music with different motor behavior such as kicking, waving, banging, rocking, bouncing, swaying, scratching, and twirling (Thelen, 1979). In addition to this, very first motor behavior in infants is following with a look, moving muscles of an eye, and head turning towards auditory stimuli. All these behaviors were used as indicator in different studies to show whether some stimuli arouse infants' movement or not. Knowing how to recognize movement as response to music stimuli gives adults opportunity to establish playful interaction and provide opportunities for learning and motor skill development through enhancing duration of interactive play and repetition of movements.

Infants 5 to 24 months old engage spontaneously more with rhythmic movement to musical and other metrically regular stimuli than to speech (Zentner & Eerola, 2010). In this study, researchers also compared whether rhythmic movement increases over the course of infancy. Somewhat less-consistent behavior occurred at younger infants, but no significant difference was present. One more thing that showed when infants were divided by age, was that the youngest infants (5 to 7 months) move to infant directed speech as much as to musical and other metrically regular stimuli. Although infants also exhibited a certain degree of tempo flexibility, no evidence for movement-to-music synchronization was found since that requires a degree of motor control that may not be achieved until preschool age. In later replication and extension of this study (Ilari, 2014) with Brazilian infants 5, 11 and 19-months findings were consistent with original research, except that Brazilian babies reacted with more spontaneous rhythmic movement to music than those in original study. This suggest that culture play significant role in spontaneous rhythmic engagement to music and rhythmic entrainment. Infants 7 and 9 months old can categorize auditory patterns along two critical temporal dimensions, rhythm and tempo (Trehub & Thorpe, 1989). In later studies with 9 months old, Bergeson and Trehub (2006) found consistency with processing predispositions for auditory temporal sequences that induce a metric framework, particularly those in duple meter. Findings of Hannon and Trehub (2005) in experiments with infants 6 and 12 months old, showed that musical rhythm perception undergoes a process of experience-dependent tuning and that transition from culture-general to culture specific responding could occur early in life. Besides proprioceptive (perception of body position), visual and auditory system, there is also vestibular system included in body movement (perception of movement and balance). In study with 7 months old infants, Phillips-Silver and Trainor (2005) trained infants with listening and bouncing on every second beat in duple meter. After experiment with trained infants, they concluded that there is strong multisensory connection between body movement and auditory rhythm processing. In comparing amount of limb movement and vocalization when listening to music and in silent, 3 and 4 months old infants didn't show significant increase in amount of movement around the musical tempo. However, in the same study (Fujii et al, 2013) two infants demonstrated striking increases in the rhythmic movements via kicking or arm waving around the musical tempo. Although reaction was individually, the result suggests that infants already at age 3 and 4 months old are possible to interact with music via limb movements and vocalizations. This study underlines importance of considering individual behavior patterns even in group studies. Infants between 10 and 18 months of age showed no synchronous movement, but 18-months-old showed tempo flexibility and more associated behaviors such as bouncing and rocking in the absence (rather than presence) of social partner (Rocha

& Mareschal, 2017) Very few studies have been done in home environment, although infants react more positively and with movement in safe and familiar surroundings. One case study with infant 19 months old (Cirelli & Trehub, 2019) has shown that in home environment, comparing with laboratory context (Zentner & Eerola, 2010), infant was spontaneously dancing 9% of time at home comparing to 4% in laboratory context. Her movements were more dance-specific and motorically complex than the rhythmic limb movements in previous study with younger infants. Duration of dance was greater and tempo faster for familiar than for unfamiliar music and duration was positively related to smiling, highlighting the links between dance and pleasure.

### How interaction with infant can be enhanced by an adult/carer toward developmental goals

Taking into consideration results of research presented in this review, there is no doubt that music provides stimulating environment for establishing and nurturing playful interaction with infants through movement and dance. In order to maintain infants' attention, adults should answer to potential interplay and communication that is aroused with music stimuli because encouragement is nothing without control. Examining how the nature and context of social interactions affect infants' engagement in motor activity, Scola, Bourjade & Jover (2015) concluded that the presence of a partner (stranger or mother) can modulate motor activity of infant. Adding music and movement to interaction, Vlismas, Malloch and Burnham (2012) showed that music and movement programme increased interaction between 2-6 months old infants and their mothers. Mothers were given written instructions followed with audio-disc with music and recorded instructions of how to use rhythmical movements and gestures to accompany the activities. Mothers' engagement included increased using of gestures and change of tone in speech. The infant's engagement resulted with prolonged visual contact, smiling, vocalizing and using motor actions of hand/arms and foot/leg movements.

### Conclusion

Music is valuable mean in connecting with infants since it supports and facilitate infant-adult interaction through music and movement activities. Results presented in this review showed that infants have innate reactions to music stimuli and with adequate movement response from adults, they can improve and learn motor behavior through repeated music activities. Therefore, we conclude that further research could take into consideration music intervention in fostering stimulative surrounding for enhancing movement activities toward development of motor behavior.

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## TRAINING LOAD MONITORING FOR ATHLETES OF CHINA PARA-TAEKWONDO TEAM

Jianzhong Wu, Junqiang Qiu, Guoqiang Geng, Ziyi Xia

*Beijing Sports University, China*

**Purpose:** Taekwondo is the official competition event of the Tokyo 2020 Paralympic games. The training load of para-taekwondo athletes of the Chinese national team was regarded as the research object in this paper. The collected data may provide the theoretical basis for the formulation of the training plan and help para-taekwondo athletes to improve athletic performance.

**Methods:** Literature Review Method, Mathematical statistics, Experimental Method. Three para-taekwondo athletes (2 males and 1 female) of the Chinese national team took part in the study. Their oxygen saturation, maximal heart rate, level of urine protein, urine PH value, Hb values, lactate levels, Creatine Kinase and testosterone levels were measured before and after each training session, for a training period of one month, altogether 16 training sessions.

**Results:** No significant change in oxygen saturation was found. The athletes' heart rate increased significantly after training. The blood lactate concentration of the three athletes was between 3 and 6mmol/L. The morning urine gallbladder was basically normal, but the urine protein of some athletes was higher than (+1). Urine has a higher PH than normal, athletes lack water and urine was acidic. Hb values of all male athletes were higher than 120g/L, while those of all female athletes were higher than 110g/L. The athletes' blood urea value was higher at the beginning of the exercise. In the middle and later stages, all athletes' blood urea was within the normal range. The overall change trend of Creatine Kinase value in the training period of athletes was in stable decline, in which the measured value of Creatine Kinase of athletes on May 8 and June 5 was higher. It was found that athletes' testosterone levels generally showed a rising trend.

**Conclusion:** The results showed that the training intensity was moderate, but dehydration was common. Athletes gradually began to adapt to the training load, the overall functional level of athletes of China para-taekwondo team was in a good state.

**Key words:** *biochemical markers, adaptation to training, fitness level, Paralympic games*

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# Biomechanics and Motor Control

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## DIFFERENCES IN THE PERFORMANCE OF THE UHCJ20M TEST BY THE DOMINANT AND NON-DOMINANT LEG

Vesna Babić<sup>1</sup>, Ivan Milinović<sup>2</sup>, Aleš Dolenc<sup>3</sup>, Maja Babić<sup>4</sup>, Marko Čule<sup>5</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>University of Zagreb, Faculty of Economics & Business, Croatia

<sup>3</sup>University of Ljubljana, Faculty of Sport, Croatia

<sup>4</sup>Srebrnjak Children's hospital, Croatia

<sup>5</sup>University of Zagreb, Faculty of Economics & Business, Croatia

### Abstract

The purpose of this research study was to determine differences between the performance of the UHCJ20m test with the dominant and non-dominant leg and the final test result, as well as certain kinematic parameters of the test, and to determine the symmetry index for the final result and kinematic parameters in the UHCJ20m test. A sample of 118 kinesiology students aged  $20.5 \pm 1.2$  years, with an average height of  $179.7 \pm 6.4$  cm and body weight of  $75.6 \pm 7.3$  kg was used for this research study. Independent samples t-test was used to determine the statistically significant difference for UHCJ20m test performance with dominant and non-dominant leg in the final test result and kinematic parameters T ( $4.41 \pm 0.32$ ,  $4.72 \pm 0.34$ ;  $p < 0.00$ ), v ( $4.56 \pm 0.33$ ,  $4.26 \pm 0.30$ ;  $p < 0.00$ ), JF ( $2.26 \pm 0.41$ ,  $2.15 \pm 0.15$ ;  $p < 0.00$ ), JL ( $2.06 \pm 0.28$ ,  $1.99 \pm 0.18$ ;  $p = 0.02$ ), CT ( $193.39 \pm 25.01$ ,  $203.89 \pm 19.22$ ;  $p < 0.00$ ) and JN ( $9.14 \pm 0.87$ ,  $9.44 \pm 0.95$ ;  $p < 0.00$ ) were determined. The symmetry index of the average speed and test performance result was  $SI = 93.56$ , suggesting an acceptable difference between performing this test with the dominant and non-dominant leg in the student athletes. For the other kinematic parameters, the value of the symmetry index was even higher ( $SI = 95.21 - 98.96$ ).

**Key words:** unilateral horizontal jumps, symmetry index, dominant and non-dominant leg

### Introduction

In sport, the concept of symmetry is related to competitive performance, injury prevention, and to diagnostic procedure in post-injury rehabilitation. Symmetry can be defined as the quality of indication of the exact correspondence of size, shape and form across its two halves when divided along given axis (Maloney, 2019). Symmetry in sports can be observed in different ways: directional asymmetry, antisymmetry, and fluctuating asymmetry (Van Valen, 1962; Maloney, 2019). Šarabon et al. (2020) propose few methods to quantify inter-limb asymmetry: back squat and isokinetic dynamometry for strength, bilateral and lateral countermovement and depth jumps for jumps, and the "505" test for speed of change in direction of movement. Although there are symmetry differences in athletes and non-athletes, this difference should be as small as possible. Of course, athletes from unilaterally dominated sports, such as soccer, will have a greater asymmetry of results in certain tests between dominant and non-dominant leg than, for example, sprinters. The recommendation for strength is that limb similarity should be between 85-95% (Armstrong & Oldham 1999; Lanshammar & Ribom 2011; Gara, 2018). It is suggested that prior to return to training process, athletes' symmetrical bilateral power between injured and healthy leg should be less than 15% (Barber et al., 1990; Creighton et al., 2010; Munro & Herrington, 2011). Furthermore, determining asymmetry in sport is not only important for injury prevention, but also an important factor in athletic development and result improvement. It is necessary to determine the asymmetry in different sports in terms of population, disciplines, gender, and age so that the results can be more accurately interpreted and implemented considering a specific population. The unilateral horizontal cyclic 20m jump (UHCJ20m) test is commonly used by athletes in practice. Although the UHCJ20m test is classified as a test to assess leg explosive strength (power), the goal of the test is to achieve the maximum possible speed, i.e., to cover a 20 m distance in the shortest possible time. Due to this time component, it can be assumed that the goal of this test is not to produce the maximum muscular force in the unit of time, but rather for the tested athletes to successfully balance take-off strength, take-off direction, speed, frequency of jumps, and maintenance of coordination to achieve the most efficient and fast movement possible (Dolenc et al., 2020). The purpose of this research study is to determine differences in final result and kinematic parameters between UHCJ20m test performance with the dominant and non-dominant leg, as well as to determine the symmetry index in student athletes.



## Methods

### Subject sample

The sample consisted of 118 subjects with an average age of  $20.5 \pm 1.2$  years, an average height of  $179.7 \pm 6.4$  cm, and an average body mass of  $75.6 \pm 7.3$  kg. The subjects were positively selected for sport considering motor knowledge and health status, were active in different sports and did not belong to the population of sprinters. Convenience sampling was used in this research study. Only the subjects who met the predefined criterion regarding the correct performance of the motor test (average contact time  $\leq 250$  ms) with dominant leg were selected for the subject sample.

### Variable sample

The variable sample included performance of the UHCJ20m motor test (Dolenec et al., 2020) with the dominant (UHCJD20m) and non-dominant (UHCJN20m) leg, which is used to assess lower extremity explosive strength. In addition to the result in the test (T - time (s)), the following parameters were determined (time-related and kinematic): v - average movement speed (m/s), JL - average jump length (m), JF - average jump frequency (j/s), CT - average contact time (ms), FT - average flight time (ms), JN - number of jumps (n). Asymmetry/symmetry between dominant and non-dominant leg was determined by calculating the symmetry index (SI).

### Test

The test (Dolenec et al., 2020) was performed in sports hall on flat and hard surface, the distance of 20 m was marked by start and finish line. The results were registered electronically (Brower Timing System, Draper, USA). The OPTOJUMP optical system (Microgate, Bolzano, Italy) was adjusted along the measured distance (20 m). The subject was in a standing start position behind the start line. After the measurement signal "set" and the start signal, the task began with the lifting of the front leg and the swinging of the arms in countermovement. With unilateral horizontal countermovement jumps, the subject crossed the track in the shortest possible time. Timing began after the start signal of measurer who started the time manually. Basic criteria had to be met for the correct execution of the jumps: Start after the start signal and completion of the task to the finish line by jumping with only one leg with countermovement arm swing. The test was performed with the dominant and non-dominant leg. The task was repeated twice with the shortest rest interval of 15 min between test performances. The result was recorded in hundredths of a second and the better result was used for analysis.

### Data Processing Methods

Basic descriptive parameters were calculated for all variables and the normality of the distribution was tested using the Kolmogorov-Smirnov test at the significance level of  $p \leq 0.05$ . Differences between UHCJ20m test results obtained with the dominant and non-dominant leg were tested with the independent samples t-test, while for variables whose results differed significantly from the normal distribution, the difference was tested with the Sign test. The symmetry index (SI) between dominant and non-dominant leg in the test was determined in the following way: for time variables T, CT, FT and variable JN:  $SI = \text{dominant} / \text{non-dominant leg} \times 100$  and for variables v, JF, JL:  $SI = \text{non-dominant} / \text{dominant leg} \times 100$ . The results were obtained using Statistica 13.3 software package, TIBCO Software Inc, USA.

## Results

In the UHCJD20m test, subjects averaged  $T 4.41 \pm 0.32$  s with  $v 4.56 \pm 0.33$  m/s, with the slowest subject achieving 3.81 m/s and the fastest 5.41 m/s. The arithmetic mean of the JF was  $2.26 \pm 0.41$  jumps per second, with the lowest being 1.78 jumps and the highest being 4.49 jumps per second. The JL achieved during the test was  $2.06 \pm 0.28$  m, with the shortest average jump being 1 m and the longest being 2.87 m. During amortization and take-off, CT was  $193 \pm 25$  ms, the shortest average time was 90 ms and the longest was 243 ms. FT of the subjects in the test was  $259 \pm 34$  ms. The shortest flight time duration was 119 ms, whereas the longest was 335 ms. On average, the subjects required  $9.14 \pm 0.87$  jumps. The subject with 7 had the lowest and the subject with 11 had the highest number of jumps (Table 1).

On the other hand, in the UHCJN20m test, subjects achieved  $T = 4.72 \pm 0.32$  s with  $v$  of  $4.26 \pm 0.30$  m/s, with the slowest subject achieving 3.42 m/s and the fastest 5.09 m/s. The arithmetic mean of JF was  $2.15 \pm 0.15$  jumps per second and is slightly lower than in the previous test, with the smallest value being 1.81 and the largest being 2.46 jumps per second. JL was  $1.99 \pm 0.18$  with the shortest average jump of 1.51 m and the longest of 2.40 m. During amortization and take-off CT was  $203 \pm 19$  ms, the shortest average time was 168 ms, while the longest average time was 258 ms. JN was  $9.44 \pm 0.95$  jumps.

Table 1. Descriptive indicators of the kinematic parameters of the UHCJD20m and UHCJN20m tests

N=118	Variable	Mean	Min	Max	V	SD	Skew	Kurt	max D
UHCJD20m	T (s)	4.41	3.70	5.25	0.10	0.32	0.30	-0.01	0.05
	v (m/s)	4.56	3.81	5.41	0.11	0.33	0.10	-0.15	0.05
	JF (j/s)	2.26	1.78	4.49	0.16	0.41	3.84	17.04	0.05
	JL (m)	2.06	1.00	2.87	0.08	0.28	-1.14	4.17	0.06
	CT (ms)	193.39	90.89	243.63	625.45	25.01	-1.21	3.32	0.05
	FT (ms)	259.32	119.33	335.14	1171.3	34.23	-1.61	4.88	0.06
	JN (n)*	9.14	7.00	11.00	0.76	0.87	-0.21	-0.36	0.20
UHCJN20m	T (s)	4.72	3.93	5.84	0.12	0.34	0.34	0.47	0.07
	v (m/s)	4.26	3.42	5.09	0.09	0.30	0.13	0.23	0.06
	JF(j/s)	2.15	1.81	2.46	0.02	0.15	-0.07	-0.53	0.27
	JL (m)	1.99	1.51	2.40	0.03	0.18	0.17	-0.20	0.10
	CT (ms)	203.89	168.43	258.14	369.44	19.22	0.32	-0.36	0.08
	FT (ms)	265.58	230.09	341.43	519.99	22.80	0.69	0.22	0.13
	JN (n)	9.44	8.00	12.00	0.90	0.95	0.23	-0.31	0.20

K-S<sub>0,05</sub>=0,13. Legend: UHCJD20m- 20m unilateral horizontal cyclic jumps dominant leg, UHCJN20m-20m unilateral horizontal cyclic jumps non-dominant leg, T- test result, v- average speed, JF-average jump frequency, JL-average jump length, CT-average contact time, FT-average flight time, JN-number of jumps.

The determination of the differences in the results and kinematic parameters of the unilateral cyclic 20-m jump test with the dominant and non-dominant leg was analyzed with the t-test for independent samples, while the Sign test (Table 2) was used in the case of certain variables of the test performance with the non-dominant leg.

Independent samples t-test analysis showed a statistically significant difference in the performance of the UHCJ20m test with dominant and non-dominant leg and the result obtained in the test (T) ( $t = -13.94$ ,  $p < 0.001$ ). When looking at the other kinematic parameters analyzed in this study, it can be seen that there was a statistically significant difference in all parameters, except FT, when performing the test with dominant and non-dominant leg. Statistically significant differences were found in v ( $t = 13.73$ ,  $p < 0.001$ ), JF ( $Z = 3.41$ ,  $p < 0.001$ ), JL ( $t = 2.46$ ,  $p = 0.015$ ), CT ( $t = -4.66$ ,  $p < 0.001$ ) and JN ( $Z = 3.57$ ,  $p < 0.001$ ). SI of average v and UHCJ20m test performance results between dominant and non-dominant leg was  $93.56 \pm 4.81$ , while the differences in other parameters were smaller on average (JF =  $96.54 \pm 11.50$  and JL  $98.96 \pm 18.68$ , CT =  $95.21 \pm 11.63$ , FT =  $98.01 \pm 13.18$  and JN =  $97.30 \pm 9.08$ ). Effect size measures showed an importance effect from small to large ( $r = 0.10 - 0.67$ ; Table 2).

Table 2. Results of independent samples T-test and Sign test for achievements and kinematic parameters in UHCJD20m and UHCJN20m performances, SI

Variable	UHCJD20m	UHCJN20m	SI $\pm$ SD	t/Z <sup>#</sup>	p	Effect- size r
	Mean $\pm$ SD	Mean $\pm$ SD				
T (s)	4.41 $\pm$ 0.32	4.72 $\pm$ 0.34	93.56 $\pm$ 4.81	-13.94	<b>0.000*</b>	0.67
v (m/s)	4.56 $\pm$ 0.33	4.26 $\pm$ 0.30	93.56 $\pm$ 4.81	13.73	<b>0.000*</b>	0.67
JF (j/s)#	2.26 $\pm$ 0.41	2.15 $\pm$ 0.15	96.54 $\pm$ 11.50	3.41	<b>0.000*</b>	0.22
JL (m)	2.06 $\pm$ 0.28	1.99 $\pm$ 0.18	98.96 $\pm$ 18.68	2.46	<b>0.015*</b>	0.16
CT (ms)	193.39 $\pm$ 25.01	203.89 $\pm$ 19.22	95.21 $\pm$ 11.63	-4.66	<b>0.000*</b>	0.29
FT (ms)#	259.32 $\pm$ 34.23	265.58 $\pm$ 22.80	98.01 $\pm$ 13.18	1.57	0.118	0.10
JN (n)#	9.14 $\pm$ 0.87	9.44 $\pm$ 0.95	97.30 $\pm$ 9.08	3.57	<b>0.000*</b>	0.23

Legend: UHCJD20m- 20m unilateral horizontal cyclic jumps dominant leg, UHCJN20m-20m unilateral horizontal cyclic jumps non-dominant leg, T- test result, v- average speed, JF-average jump frequency, JL-average jump length, CT-average contact time, FT-average flight time, JN-number of jumps, SI-Symmetry index, Effect-size r – effect size value, #- Sign test, \*significant at  $p \leq 0.05$ .

## Discussion

Itoh et al. (1998) found a statistically significant difference in unilateral horizontal countermovement jump performance with the dominant and non-dominant leg (SI = 104.9) in healthy male subjects, which is similar to the results of this research study. Maulder and Cronin (2005), using a smaller sample of 18 subjects, found no statistically significant differences in horizontal and vertical jump performance with dominant and non-dominant leg, while some other authors (Bahamonde

et al., 2012) found statistically significant differences in unilateral jump performance with dominant and non-dominant leg, but at a much shorter distance (6 m).

Despite the difference in symmetry when performing the UHCJ20m test with the dominant and non-dominant leg, as found in this research study, SI is on average no greater than 10 % which is the threshold indicating normal muscular imbalance, i.e., asymmetry (Meylan et al, 2010; Noyes et al., 1989). The analyzes of this research study found a statistically significant difference between result (T) and speed (v) in UHCJ20m performance with dominant and non-dominant leg, as well as between all other kinematic parameters and test performances. Lower limb asymmetry (in the normal range) during unilateral jump performance is not statistically significantly correlated with results of start acceleration during running and maximum speed during running up to 30 m (Lockie et al. 2016; and Lockie et al., 2014). The aforementioned research studies found no statistically significant difference in the results of unilateral jumps with dominant and non-dominant leg, whereas the results of unilateral horizontal jumps with dominant and non-dominant leg in this research study showed statistically significant differences in T, v, and observed kinematic parameters, with the exception of the FT parameter. The reason or explanation for this finding may be sought in the more complex and demanding motor test, which potentiates more differences between dominant and non-dominant leg due to its cyclic nature, as well as in the specifics of the subject sample, their number and characteristics. In any case, it would be interesting to compare the results of the UHCJ20m test obtained on the population of sprinters with the results of this research study, in order to determine their relationship and the presence and magnitude of the differences in achievements and values of the kinematic parameters of the test performance with the dominant and non-dominant leg.

## Conclusion

This research study is one of the rare studies in the field of symmetry between dominant and non-dominant lower extremity in unilateral jumps performed on a larger sample (more than 100 subjects). We conclude that there are statistically significant differences between dominant and non-dominant leg in the observed variables, but these differences are acceptable (10%) according to the results of the available research studies. Nevertheless, the goal is to train in such a way that the difference between dominant and non-dominant leg is as small as possible in order to achieve top results and participate in the training of top athletes, which is very important in cyclic sports, especially in sprint running. Furthermore, for different sports and coaches, it would be useful to investigate the same questions with different age and gender groups, as well as with athletes from different sports and different training levels (Babić et al., 2021).

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## THE USE OF REACTIVE STRENGTH INDEX TO EVALUATE UNILATERAL HORIZONTAL DROP JUMP PERFORMANCE IN CHILDREN

Marijo Baković<sup>1</sup>, Ivan Brkljačić<sup>1</sup>, Josip Jularić<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Elementary School Sesvetska Sela, Croatia

### Abstract

Jumping is one of the most important abilities for success in many sports. Stretch-shortening cycle (SSC) is being used in order to perform jump. To measure jumping performance or to control effects of some program, scientists and practitioners usually use Standing long jump (SLJ), Squat jump (SJ), Countermovement jump (CMJ) or vertical Drop jump (DJ) and variations. Recently, the reactive strength index (RSI) in practical as well as in exercise science literature is used as a means to quantify plyometric or SSC. Therefore, the aim of this study was to investigate the relationship between RSI and unilateral drop jump performance (jump distance) in children (male and female). Secondary goal was to investigate correlations between other kinetic variables in SSC drop jump movement as the amount of force (eccentric and concentric) as well as the rate of force development (RFD) and overall performance measured in jump distance. Divided in three groups (male, female and both), results showed no significant difference between male and female children in all variables ( $p$  level from 0,11 to 0,62). Male children have greater jump distance than female (225,49 vs 213,76cm), but difference was not significant ( $p=0,23$ ). RSI (reactive strength index) is statistically significant (0,60), correlated to jump distance with both male and female, and maximum concentric force ( $F_{maxCON}$ ) is also significantly correlated to jump distance, but only in male participants. Inverse correlation was found between jump distance and contact time in male participants (-0,05). These findings can be useful in further investigations on SSC movement mechanism. The use of RSI during fast plyometric exercises is an effective application of the performance measure and can enhance the quality of training.

**Key words** *plyometrics, ground reaction force, rate of force development, stretch-shortening cycle*

### Introduction

During the physical education in school, children practice and learn new motor skills. In most of the sport disciplines (handball, football, volleyball, basketball, gymnastics, athletics, etc.) they run, accelerate, decelerate, change direction of movement and jump. Jumping is one of the most important abilities for success in many sports. Stretch-shortening cycle (SSC) is being used in order to perform jump. The SSC is a natural type of muscle function in which muscle is stretched immediately before being contracted (Komi, 1992). In comparison with purely concentric movements, the SSC allows greater force production at any given velocity during the concentric phase (Komi, 1986). SSC movements have been classified as slow (i.e., contact time > 250 ms) or fast (i.e., contact time < 250 ms) (Schmidtbleicher, 1992). With ground contact times for sprinting below 250 ms regardless of the duration of the sprint (Schmidtbleicher, 1992; Atwater, 1982; Hunter, Marshall and McNair, 2005; Čoh and Tomažin, 2006), fast SSC ability is generally considered as important for sprinting. Jumping exercises can be divided into unilateral or bilateral, vertical or horizontal (in front, back or lateral direction) and according to muscle contraction in concentric or SSC mode. Athletes combine these jumps during the practice or game. The most common training used to enhance athlete's SSC capabilities is plyometric training. Plyometric training is a commonly used term to describe quick, powerful movements using a pre-stretch, or countermovement, that involves SSC (Potach & Chu, 2000). To measure jumping performance or to control effects of training programs, scientists and practitioners usually use Standing long jump (SLJ), Squat jump (SJ), Countermovement jump (CMJ) or vertical Drop jump (DJ) and variations (Keiner, 2013; Tottori, 2019).

Recently, the reactive strength index (RSI) in practical as well as in exercise science literature is used as a means to quantify plyometric or SSC performance (Flanagan & Comyns, 2008; Flanagan, 2007; McClymont, 2008). The RSI was developed as one component of the Strength Qualities Assessment Test, which originated at the Australian Institute of Sport (Wilson, 1991). RSI is derived from the height jumped in a drop jump, and the time spent on the ground developing the forces required for that jump (McClymont, 2008). RSI was used to evaluate drop jump performance in horizontal drop jump, but with no significant relationship with short sprint performance (Schuster & Jones, 2016).

According to authors knowledge, there are no researches about horizontal unilateral drop jump performance in children. Therefore, the aim of this study was to investigate the relationship between RSI and unilateral drop jump performance (jump distance) in untrained children (male and female). Secondary goal was to investigate correlations between other kinetic variables in SSC drop jump movement as the amount of force ( $F_{max}$ : eccentric and concentric) as well as the rate of force development (RFD) and overall performance measured in jump distance. The third goal was to find is there any significant differences between male and female children during horizontal unilateral drop jump performance.

## Methods

### Participants

All participants were untrained children from elementary school in Zagreb (Croatia). Study included 33 participants ( $n=33$ , 16 boys and 17 girls), age ranged from 11-14 years ( $12.12 \pm 1.01$  years, height  $156.23 \pm 9.44$  cm and body mass  $52.10 \pm 13.19$  kg). All participants had a signed informed consent from their parents/guardians after receiving both, verbal and written explanation of the experimental protocol and its potential risks and benefits. All procedures were conducted in accordance with the Declaration of Helsinki and approved by the Ethic committee of Faculty of Kinesiology in Zagreb, and also Ethic committee of mentioned elementary school.

### Procedures

All tests were performed in the afternoon hours, in the school gym on wooden base surface. Subjects wore their normal sport shoes. Before testing, all subjects performed 10 min standardized warm-up, including running, dynamic stretching and vertical and horizontal jumping (bilateral and unilateral). Subjects performed unilateral horizontal drop jump (UHDJ) on force platform (Kistler Instrument Corporation, Sindelfingen, Germany). Participants performed drop jump from 20 cm height box to force platform on their preferred take-off leg and then using swing with hands performed unilateral horizontal long jump (figure 1). Force platform was used to measure force ( $F_{max}$ ), rate of force development (RFD $_{max}$ ) and ground contact time. Jump distance was measured with OPTOJUMP system (Microgate, SRL, Bolzano, Italy) set on the height of the platform. Drop box was 120 cm away from the center of the platform. 5 cm mat was used as a landing spot. All performance tests were completed in the same session (three trials in one session), and best results were used for further analyses. Measured variables in this study were Contact time (CT), Jump distance (JD), maximal ground reaction forces for eccentric ( $F_{maxECC}$ ) and concentric phase ( $F_{maxCON}$ ), maximal rate of force development for eccentric (RFD $_{maxECC}$ ) and concentric phase (RFD $_{maxCON}$ ). Using two measured variables, Reactive strength index (RSI) was calculated by dividing the jump distance (m) with the time of ground contact (s).



Figure 1. Unilateral horizontal drop jump in steps

### Statistical analyses

The data were analyzed using Statistica for windows 13.0. All variables were tested for normality using the Kolmogorov-Smirnov test procedure. T-test for independent samples was used to calculate difference between groups. Further, results were tested with correlation between jump distance and other variables, displaying significant by Pearsons coefficient of correlation.

## Results

Means and standard deviations for each performance variable are displayed in table 1. Divided in three groups (male, female and both), results were similar between male and female children in all variables. Male children had greater jump distance than female, but longer contact time with lower force in concentric phase (table 1).

Table 1. Descriptive statistics

Descriptive statistics: mean $\pm$ standard deviation			
VARIABLE (unit)	ALL (N=33)	Male (N=16)	Female (N=17)
Contact time (ms)	299,82 $\pm$ 41,79	306 $\pm$ 50,76	294 $\pm$ 31,68
RSI	7,52 $\pm$ 1,75	7,68 $\pm$ 2,22	7,37 $\pm$ 1,20
FmaxECC (bw)	3,98 $\pm$ 1,14	4,32 $\pm$ 1,16	3,67 $\pm$ 1,06
FmaxCON (bw)	2,57 $\pm$ 0,39	2,49 $\pm$ 0,46	2,64 $\pm$ 0,32
RFDmaxECC (bw/s)	8,77 $\pm$ 5,32	9,59 $\pm$ 5,95	8,00 $\pm$ 4,70
RFDmaxCON (bw/s)	1,43 $\pm$ 0,93	1,31 $\pm$ 0,94	1,54 $\pm$ 0,92
JD (cm)	219,45 $\pm$ 27,58	225,49 $\pm$ 32,51	213,76 $\pm$ 21,45
BH (cm)	156,23 $\pm$ 9,44	157,16 $\pm$ 11,87	155,35 $\pm$ 6,66
BM (kg)	52,10 $\pm$ 13,19	55,35 $\pm$ 12,92	49,05 $\pm$ 13,07
SLJ (cm)	165,45 $\pm$ 24,08	169,13 $\pm$ 27,58	162 $\pm$ 20,50

Legend: RSI – reactive strength index, FmaxECC – maximum eccentric force, FmaxCON – maximum concentric force, RFDmaxECC – maximum eccentric rate of force development, RFDmaxCON – maximum concentric rate of force development, JD – jump distance, BH – body height, BM – body mass, SLJ – standing long jump

In table 2, RSI is statistically significant, correlated to JD with both male and female. FmaxCON is also statistically significant correlated to jump distance, but only in male participants. Inverse correlation was found between jump distance and contact time in male participants. No other variables were significantly correlated.

Table 2. Correlation between jump distance and other variables according to gender

Correlation - *Marked correlations are significant at $p < .05$ N=33						
Variable	Contact time (ms)	RSI (Reactive strength index)	FmaxECC	FmaxCON	RFDmaxECC	RFDmaxCON
JD (cm) - ALL	*-0,49	*0,86	-0,05	*0,40	-0,07	0,09
JD (cm) - F	-0,36	*0,81	-0,09	0,17	-0,27	-0,09
JD (cm) - M	*-0,62	*0,89	-0,13	*0,60	-0,01	0,26

Legend: FmaxECC – maximum eccentric force, FmaxCON – maximum concentric force, RFDmaxECC – maximum eccentric rate of force development, RFDmaxCON – maximum concentric rate of force development

There is a slight difference in jump distance between male and female, but not statistically significant (table 3).

Table 3. T-test according to gender on all measured variables

T-tests; Grouping: GENDER; Group 1: FEMALE, Group 2: MALE											
Variable	Mean	Mean	t-value	df	p	Valid N	Valid N	Std.Dev.	Std.Dev.	F-ratio	p
	F	M				F	M	F	M	Variances	Variances
CT (ms)	294	306	-0,82	31	0,42	17	16	31,68	50,76	2,57	0,07
RSI	7,37	7,68	-0,49	31	0,62	17	16	1,20	2,22	3,42	0,02
FmaxECC	3,67	4,32	-1,66	31	0,11	17	16	1,06	1,16	1,19	0,74
FmaxCON	2,64	2,49	1,10	31	0,28	17	16	0,32	0,46	2,13	0,15
RFDmaxECC	8,00	9,59	-0,86	31	0,40	17	16	4,70	5,95	1,60	0,36
RFDmaxCON	1,54	1,31	0,70	31	0,49	17	16	0,92	0,94	1,04	0,93
JD (cm)	213,76	225,49	-1,23	31	0,23	17	16	21,45	32,51	2,30	0,11

Legend: CT – contact time, RSI- reactive strength index, FmaxECC – maximum eccentric force, FmaxCON - maximum concentric force, RFDmaxECC – maximum eccentric rate of force development, RFDmaxCON - maximum concentric rate of force development, JD – jump distance

## Discussion

Although some researchers used electronic jump mat or platform (Kenny, 2012; Tottori, 2019) even tested unilateral horizontal drop jump (Schuster & Jones, 2016), according to authors knowledge this is first investigation that combined two measurement systems (force platform and optical measurement system) for UHDJ. In the literature there is not many studies about unilateral horizontal drop jump performance in children. Furthermore, in this investigation authors decided to investigate “natural” drop jump performance which included arm swing. The reason to do so was to allow maximum performance which can better describe other important movements in sports and everyday activities such as running and jumping.

Force variables (Fmax and RFDmax) did not differentiate male and female groups significantly. Only FmaxCON had a significant correlation with jump distance, but for all participants together and males separately. Correlation between JD and other variables, significant were Contact time and FmaxCON in all participants and in male group separately, but RSI showed highest correlation with JD. On the other hand, Shuster and Jones (2016) concluded in their study that UHDJ performance is more correlated to sprinting performance than vertical drop jump. But, they did not found any significant correlation between RSI and sprinting performance. Maybe the reason is in different set up of the UHDJ performance (longer distance between drop box and force platform and the use of arm swing). So, these findings are suggesting that further studies need to be done for better understanding the use of RSI in evaluating UHDJ performance. To compare drop jumping performance with sprinting or real specific jumping in many sports, it is necessary to make drop jump performance more specific in terms of ground contact times and movement patterns.

## Conclusion

These findings can be useful in further investigations on SSC movement mechanism. The use of RSI during fast plyometric exercises is an effective application of the performance measure and can enhance the quality of training. Correct fast plyometric exercise technique involves the following: minimize ground contact time, maximize jump height or distance, imagine the ground is a hot surface, imagine your leg is a stiff spring that rebounds off the ground on landing and pretense your leg muscles before landing (Flanagan, 2008). Although, authors expected force variables (Fmax and RFDmax) could significantly differentiate gender groups and correlate with JD, only RSI significantly correlated with JD. The limit of the study may be the fact that the age interval of the tested children is relatively wide and it is an ontogenetically very dynamic period. This can fundamentally affect the results, especially when comparing boys and girls. Similarly, it may be the reason for the difference between a particular study and previous ones. After training program or effects of some specific program RSI can become very useful tool (variable) to get a feedback of monitoring athlete's performance. This research confirms our standings that RSI can contribute in evaluation of untrained children in jump performance.

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## HANDBALL JUMP SHOOT KINEMATICS – DIFFERENCES BETWEEN CROATIAN ELITE AND PROFESSIONAL PLAYERS

Ante Burger<sup>1,3</sup>, Nikola Foretić<sup>1</sup>, Miodrag Spasić<sup>1</sup>, Nenad Rogulj<sup>1</sup>, Vladan Papić<sup>2</sup>

<sup>1</sup>Faculty of Kinesiology, University of Split, Croatia

<sup>2</sup>Faculty of Electrical Engineering Mechanical Engineering and Naval Architecture, University of Split, Croatia

<sup>3</sup>Department of Health Studies, University of Split, Croatia

### Abstract

The main goal of this study was comparison of Croatian elite handball players with players that participate in Croatian premier handball league in the kinematic parameters of jump shoot. The kinematic analysis was conducted by GAIT – LaBACS software system. Five groups of variables was used, totally 25 kinematic parameters. Every variable group corresponded to 5 phases of jump shoot performance: run-up, take-off, flight, throw, and landing. The differences between elite and professional handball players were analysed by multivariate and univariate variance analysis. MANOVA results show significant differences between the groups ( $\lambda=0.01$ ,  $F=10.29$ ,  $p=0.02$ ) and also between two phases of jump shoot performance; run-up ( $\lambda=0.43$ ,  $F=2.83$ ,  $p=0.03$ ) and flight ( $\lambda=0.34$ ,  $F=8.1$ ,  $p=0.00$ ). Differences observed in this study are most probably influenced by different level of handball demands. Elite players play faster and with more optimal technique that force them on minimal number of steps during run-up phase. Speed of the game demands better perception that influence more extended body position during attacking and shooting movements. Players of lower quality compensate morphological deficiencies with different jump shoot technique. It demands more power for jumping higher and longer, especially during use of jump shoot in breakthrough situation. These players, also set ball on higher position during throwing movement which is another compensation mechanism that can give shorter players advantage against higher defenders.

**Key words:** model, technique, breakthrough, attack, biomechanics

### Introduction

The game of team handball have very simple and clear objective: scoring goals. Everything that players do during the game is connected with this objective. They defend they own goal so opponent can't score, they run fast after defence phase so they can score more easily and in positional attack they use complex tactical manoeuvres so they put shooting player in the position with higher possibility of scoring. Handball players score goals while throwing the ball towards the post. During these actions they have two main distractions: defenders that can interfere them with physical contact and goalkeeper who is specially train to foresee and anticipate ball trajectory of movement. Defence players and goalkeeper are significant obstacles for shooter and require from him as accurate and as fast as possible shooting action. Although, handball shoot can be performed in almost ten different ways there are two major shooting techniques: stand shoot and jump shoot. Ball directed with stand shoot technique have more speed than the one directed with jump shoot (Karcher & Buchheit, 2014). Anyway, studies that dealt with frequency of handball technique utilisation show that jump shoot is technique that players use significant more than stand shoot technique. Wagner et al. (2008) found that 73 - 75% of all shoots during the competitive team-handball game are jump shots (Wagner, Kainrath, & Müller, 2008). From this data is evident that jump shoot is very important element of handball technique that need to be studied in all kinesiological aspects. One of those aspects is definitively jumps shoot kinematics.

Several research studied handball jump shoot kinematics with different aims. Šibila et al (2003) tried to identify differences in some basic kinematic parameters between two different jump shot techniques used in handball; jump shot take-off is from the leg which is opposite the throwing and jump shot after take-off with the leg on the same side as the hand with which they are shooting. Many similarities and differences between both shots were found. Authors advised coaches to teach their players both technique since different game situations demands different usage of jump shoot technique (Šibila, Pori, & Bon, 2003). Fradet et al (2003) established a model of handball throwing that could be adaptable to a maximum number of parameters, such as time of ball release, wrist position at ball release and throw type. This was a first study that included jump shoot kinematics in more real situation since it included also goalkeeper reactions (Fradet, Kulpa, Bideau, Multon, & Delamarche, 2003).

Wagner et al (2010) measured differences in ball release speed in team-handball jump throw and anthropometric parameters between groups of different levels of performance. They also analysed upper body 3D kinematics to determine significant differences between these groups. Results of this study suggest that team-handball players who were taller and of greater body weight have the ability to achieve a higher ball release speed in the jump shoot (Wagner, Buchecker, Von Duvillard, & Müller, 2010). One of the few studies done on female players have conducted Ohnjec et al (2010). On the sample of 4 female handball players they analysed jump shoot kinematics. The kinematic variables sample set was made up from the parameters related to the specific phases of a jump shot. Author state that is possible to use registered kinematic parameters to explore the execution of the jump shot with the purpose to detect the characteristics of the jump shot. These features, then might be used to improve and correct the performances of the players within the process of their technical development (correcting mistakes). i.e. they might be considered as indicators relevant for directing the future training process in general (Ohnjec, Antekolović, & Gruić, 2010). Since handball is one of the top four athletic games with highest injury risks Lindner et al (2012) used jump shoot kinematics to calculate and visualise ligament force scenarios during the jumping and landing phases of controlled jump shots. Within the performed jump shots, the ligamentum fibulotalare anterius showed a peak during maximum plantar flexion in the final moment of the lift off. During landing, the force developed by the ligamentum fibulotalare anterius reached its peak value at the first contact with the floor. Author extracted the final moment of the lift off and the first contact with the floor as most risky moments for ankle injury occurrence during jump shoot execution (Lindner, Kotschwar, Zsoldos, Groesel, & Peham, 2012).

One purpose of kinematics is creating movement model which can help coaches in training technique, specifically for mistake corrections and methodical exercises creation. First step of modelling is comparison of highly trained athletes with the less trained group. Accordingly, the aim of this study is comparison of Croatian elite handball players with professional players in the given kinematic parameters of jump shoot performance.

## Methods

Ten male senior players participated in the study. Five were elite players with significant international experience and as Croatian national team members have won numerous medals on European and World Championships and Olympic Games (body mass:  $100.00 \pm 8.00$  kg, body height:  $196.00 \pm 4.64$  cm). Second group was consisted of five professional players, participants of Croatian premier league (body mass:  $91.20 \pm 3.42$  kg, body height:  $192.4 \pm 7.30$  cm).

The kinematic analysis was conducted by GAIT – LaBACS software system designed at the Faculty of Electrical and Mechanical Engineering and Naval Architecture in Split (Blažević et al., 2001). Variables consisted of 5 groups that correspond to 5 phases of jump shoot performance: run-up, take-off, flight, throw, and landing. Run-up phase have 9 kinematic parameters: step number (STNR), first step length (1SL), second step length (2SL), third step length (3SL), total step length (SLT), average step length (SLA), run-up speed (RUS), kinetic energy (KE), run-up time (RUT). Take-off phase have 3 kinematic parameters: lower leg incline (LLI), lowest centre of gravity (LCG), take-off time (TOT). Flight phase have 6 kinematic parameters: flight height (FH), body plane length (BPL), speed of achieving maximal body height (SMBH), trunk angle (TA), shoulder angle (SA) and flight time (FT). Throwing phase have 5 kinematic parameters: throw height (TH), upper arm and trunk angle (UATA), fist speed (FS), upper arm angle in space (UAAS), and throw time (TT). Landing phase have 2 kinematic parameters: distance body movement (DBM) and landing time (LT).

Statistical analysis included calculation of descriptive statistic parameters while normality was tested using the Kolmogorov–Smirnov test procedure. The differences in kinematic parameters between top and quality handball players were analysed by multivariate and univariate variance analysis. The software Statistica ver. 13.0 (Dell Inc. USA) was used for all analyses.

## Results

Results of descriptive statistics and normality test showed that all variables have normal distribution except variable 3SL for elite players group. Lack of distribution normality in this variable is not unexpected since all elite players performed jump shoot after 2<sup>nd</sup> step and didn't use 3<sup>rd</sup> step at all. MANOVA results show significant differences between the groups ( $\lambda=0.01$ ,  $F=10.29$ ,  $p=0.02$ ) and also between two phases of jump shoot performance; run-up ( $\lambda=0.43$ ,  $F=2.83$ ,  $p=0.03$ ) and flight ( $\lambda=0.34$ ,  $F=8.1$ ,  $p=0.00$ ). Differences between 3 other phases wasn't noticed. Analysis of variance for the run-up phase showed significant differences between tested groups in 3 variables; step number (STNR), third step length (3SL), and total step length (SLT). In all 3 variables smaller values were noticed at elite players group.

Table 1. Results of descriptive statistics. MANOVA and ANOVA

1. PHASE – RUN-UP				
$\lambda = 0.43$	F = 2.83		P = 0.03*	
Variable	Elite players	Professional players	ANOVA	
	Mean $\pm$ SD	Mean $\pm$ SD	F	p
STNR (cm)	1.80 $\pm$ 0.41	2.60 $\pm$ 0.63	16.8	0.00*
1SL (cm)	131.54 $\pm$ 33.42	124.08 $\pm$ 54.75	0.2	0.66
2SL (cm)	129.20 $\pm$ 67.7	143.09 $\pm$ 60.94	0.3	0.56
3SL (cm)	0.00 $\pm$ 0.00	96.46 $\pm$ 79.83	21.9	0.00*
SLT (cm)	260.74 $\pm$ 56.61	364.79 $\pm$ 110.37	10.6	0.00*
SLA (cm)	146.74 $\pm$ 19.24	141.98 $\pm$ 32.38	0.2	0.63
RUS (m/s)	6.48 $\pm$ 2.32	5.44 $\pm$ 1.83	1.7	0.20
KE (J)	2323.05 $\pm$ 1669.53	1582.33 $\pm$ 1023.05	2.1	0.15
RUT (ms)	0.45 $\pm$ 0.2	0.72 $\pm$ 0.25	10.6	0.00*
2. PHASE – TAKE-OFF				
$\lambda = 0.83$	F = 1.8		P = 0.17	
Variable	Elite players	Professional players	ANOVA	
	Mean $\pm$ SD	Mean $\pm$ SD	F	P
LLI (°)	75.98 $\pm$ 4.54	71.68 $\pm$ 7.52	3.58	0.07
LCG (cm)	5.54 $\pm$ 4.69	3.72 $\pm$ 2.19	1.85	0.18
TOT (ms)	0.23 $\pm$ 0.03	0.21 $\pm$ 0.03	2.08	0.16
3. PHASE – FLIGHT				
$\lambda = 0.34$	F = 8.1		P = 0.00*	
Variable	Elite players	Professional players	ANOVA	
	Mean $\pm$ SD	Mean $\pm$ SD	F	p
FH (cm)	46.26 $\pm$ 7.32	55.12 $\pm$ 10.08	7.59	0.01*
BPL (cm)	77.0 $\pm$ 17.06	111.55 $\pm$ 25.91	18.6	0.00*
SMBH (m/s)	1.75 $\pm$ 0.3	1.81 $\pm$ 0.49	0.16	0.69
TA (°)	68.32 $\pm$ 2	64.35 $\pm$ 4.36	10.24	0.00*
SA (°)	160.95 $\pm$ 14.53	153.20 $\pm$ 22.71	1.24	0.27
FT (ms)	0.27 $\pm$ 0.03	0.32 $\pm$ 0.08	5.74	0.02*
4. PHASE - THROW				
$\lambda = 0.76$	F = 1.6		P = 0.21	
Variable	Elite players	Professional players	ANOVA	
	Mean $\pm$ SD	Mean $\pm$ SD	F	p
TH (cm)	354.99 $\pm$ 7.36	349.44 $\pm$ 22.49	0.82	0.37
UATA (°)	13.72 $\pm$ 7.43	21.08 $\pm$ 10.82	4.72	0.04*
FS (m/s)	1.87 $\pm$ 0.74	2.13 $\pm$ 1.79	0.28	0.60
UAAS (°)	164.98 $\pm$ 6.45	163.53 $\pm$ 9.92	0.22	0.64
TT (ms)	0.08 $\pm$ 0.05	0.09 $\pm$ 0.06	0.8	0.38
5. PHASE - LANDING				
$\lambda = 0.95$	F = 0.71		P = 0.50	
Variable	Elite players	Professional players	ANOVA	
	Mean $\pm$ SD	Mean $\pm$ SD	F	p
DBM (cm)	53.56 $\pm$ 28.13	52.5 $\pm$ 39.6	0.01	0.93
LT (ms)	0.17 $\pm$ 0.06	0.14 $\pm$ 0.1	0.79	0.38

STNR-step number. 1SL-first step length. 2SL-second step length. 3SL-third step length. SLT-total step length. SLA-average step length. RUS-run-up speed. KE-kinetic energy. RUT-run-up time. LLI-lower leg incline. LCG-lowest centre of gravity. TOT-take-off time. FH -flight height. BPL-body plane length. SMBH-speed of achieving maximal body height. TA-trunk angle. SA-shoulder angle. FT-flight time. TH-throw height. UATA-upper arm and trunk angle. FS-fist speed. UAAS-upper arm angle in space. TT-throw time. DBM-distance body movement. LT-landing time

No differences were noticed between the groups in variables of take-off and landing phase. In flight phase significant differences were noticed between 2 tested groups in 4 variables; flight height (FH), body plane length (BPL), trunk angle (TA) and flight time (FT). Professional players jump higher, jump more forward and stay longer in the air while elite players have bigger trunk angle during this phase of jump shoot. When observing throw phase significant difference was noticed just in upper arm and trunk angle (UATA) were professional players performed throw with larger angle.

## Discussion

Elite players performed less steps in run-up as a response to modern handball game demands. On top level defense players move more deeply and don't allow shooter too much time to prepare (Foretic, Rogulj, & Papić, 2013; Foretić, Rogulj, & Trninić, 2010). So, shooters need to perform technical actions in shorter period of time and shoot from less steps possible. It is obvious that professional players in Croatian premier league don't have this kind of pressure and they adjust their technique to lower criteria. Consequently, they perform jump shoot with 3 steps and have in total longer run-up for 104.05 cm than elite players.

Lack of differences in take-off and landing phase is expected and supported with literature review. This phase of jump shoot is considered to be simplest. All tested players were seniors that master basic jumping skills early in their sports career which contribute a lot to take-off phase performance. Research of Pori et al (2005) confirms this since authors found no difference in take-off and landing phase between different level of handball players (Pori, Bon, & Šibila, 2005).

Higher jump and forward longer movement along with longer time in the air that professional players performed can be commented in 2 ways. First, they have higher motivation to perform this element of technique since they were tested with their role models. Second, morphological deficiency and less quality technique is often compensated in team sport games with strength and power. Shorter players (as in professional group) always have tendencies to shoot from breakthrough situations that demands longer jumps and more time spending in the air (Karcher & Buchheit, 2014; Póvoas et al., 2014). On the other side, trunk angle represent correctness of body position during jump shoot technique performance. If the body is too much lean forward technique doesn't allow good perception and shooting control. Generally, the bigger the trunk angle, the better technique. Results showed that elite players have 3.97° bigger trunk angulation than professional players and it can be stated that their body is in more optimal position during the flight phase of jump shoot.

Bigger upper arm and trunk angle that was noticed at professional players must be commented in context of morphological characteristics. In other words, this angle directly sets ball height before the throw is performed. To get advantage against the defence blockers you need to put the ball as high as possible (Haugen, Tønnessen, & Seiler, 2016). If you are shorter you need to put the ball even higher. And in this study group of professional players were almost 5 cm shorter than elite players which increased their upper arm and trunk angle for 7.36° comparing to elite players.

## Conclusion

Jump shoot definitively belongs to group of most important elements of handball game. Differences observed in this study lead to thinking that different level of handball demands different jump shoot execution. Influence of game level on technique performance is best seen in first phase of jump shoot. Elite players, pressed by speed and depth movement of defenders need to play fast, with optimal technique and with minimal number of steps. This is why they performed run-up in just two steps with more extended body position that allow them better perception and ball control during attacking manoeuvres and shooting actions. On the other hand, players that play in lower quality division compensate morphological deficiencies with different jump shoot variation. This technique demands more explosive power for jumping higher and longer since professional players more often use jump shoot from breakthrough situation. These players, also have tendency to set ball on higher position during throwing movement which is another compensation mechanism that can give shorter players advantage against higher defenders. Results of this study may help coaches to better understand jump shoot technique on different performance level but also to create most efficient methodological exercises in learning process. Future studies should use this data in creating ideal models of jump shoot performance in handball.

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## RELATIONSHIP BETWEEN PRESSURE FORCE AND SOME KINEMATIC PARAMETERS WHEN PERFORMING JUMP SHOT IN BASKETBALL

Stipe Čubrić<sup>1</sup>, Tomislav Rupčić<sup>1</sup>, Vjekoslav Cigrovski<sup>1</sup>, Bojan Matković<sup>1</sup>, Peter Šagat<sup>1</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Health and Physical Education Department, Prince Sultan University, Saudi Arabia

### Abstract

In modern basketball, it is important that the player has the ability to perform a quick and effective jump shot. Situational efficiency of the jump shot is conditioned by a number of parameters. New technologies in sports diagnostics enable fast and objective measurement of these parameters. The aim of this study is to determine the relationship between the force caused by the pressure on the ground in the concentric phase and some kinematic parameters during the performance of the jump shot. The analysis of parameters was performed on five senior basketball players (age  $25.30 \pm 2.58$  years; height  $188.74 \pm 9.45$  cm; weight  $86.40 \pm 11.41$  kg). The Xsens Awinda system was used for measuring kinematic parameters, 94 Fifty Smart Sensor Basketball for measuring ball release speed parameters, and Novel (Pedar) insoles for measuring pressure force values during shooting. The correlation results showed that there is a statistically significant correlation between the pressure force and the kinematic parameters of the jump shot.

**Key words:** Xsens, kinematic analysis, kinetic analysis

### Introduction

Due to its complexity, the jump shot is an element that requires great attention to proper performance during the learning process. According to the basic structure, shooting can be divided into three segments: shooting with one hand from place, jump shot and free throws (Matković, Knjaz, Rupčić, 2005). Also, shooting is a basic means of scoring points during a basketball game. Consequently, shooting is one of the most used elements during a basketball game (Hay, 1994). In today's basketball, it is important that the player has the ability to perform a jump shot quickly and efficiently. The jump shot, as an element of the basketball game, represents a complex motor movement on the quality of which the situational efficiency of each basketball player largely depends (Rupčić et al., 2016). The height of the vertical jump, the duration of contact with the ground, the ball release height, the angle at which the ball enters into the basket, and the duration of the shot from a distance for 2 and 3 points are the parameters that determine situational efficiency during the jump shot (Fontanella, 2006; Krause, Meyer, Meyer, 2008). These parameters can be objectively and precisely determined through kinematic analysis. The collected and analysed data can be compared with the model of a top basketball player, and thus the players' technical performance quality of different elements of the basketball game can be determined (Trninić, 1996). In order for a player to be able to perform a structurally correct jump shot of adequate speed, which will ultimately ensure maximum precision, his preparatory phase before the moment of receiving the ball is crucial, among other things. This refers to the low position of the centre of gravity of the body and the proper footwork that allows the player to use the reaction force of the ground (Matković et al., 2010). The correct stopping technique, whether it is a parallel (jump stop) or a diagonal landing (1-2 landing), plays an extremely important role during the preparation phase. The stopping technique significantly affects the ability to convert horizontal motion into vertical motion. Furthermore, the time period of transition from the eccentric phase of muscle activation to the concentric phase is extremely short. Due to the mentioned short period of time, it is extremely important that the player technically optimally performs the movement in order to make the most of the concentric phase during the performance of the jump shot. Using modern technology for kinetic analysis, it is possible to determine the values of the pressure force on the ground. The development of wireless insoles for measuring force and pressure distribution has enabled the collection of reaction force data between the foot and the sneaker on the ground during dynamic activities (Mei, Graham, Gu, 2014). This kinematic and kinetic analysis can objectively determine the parameters of a successfully performed shot that are used as guidelines for the development of technical performance of basketball players. The collected data enable a better understanding of the relationship between individual parameters from the moment of preparation for the jump shot to the technical performance itself. The aim of this research is to determine the relationship between the pressure force on the ground in the concentric phase and some kinematic parameters during the performance of a jump shot in basketball.



## Methods

### Participants

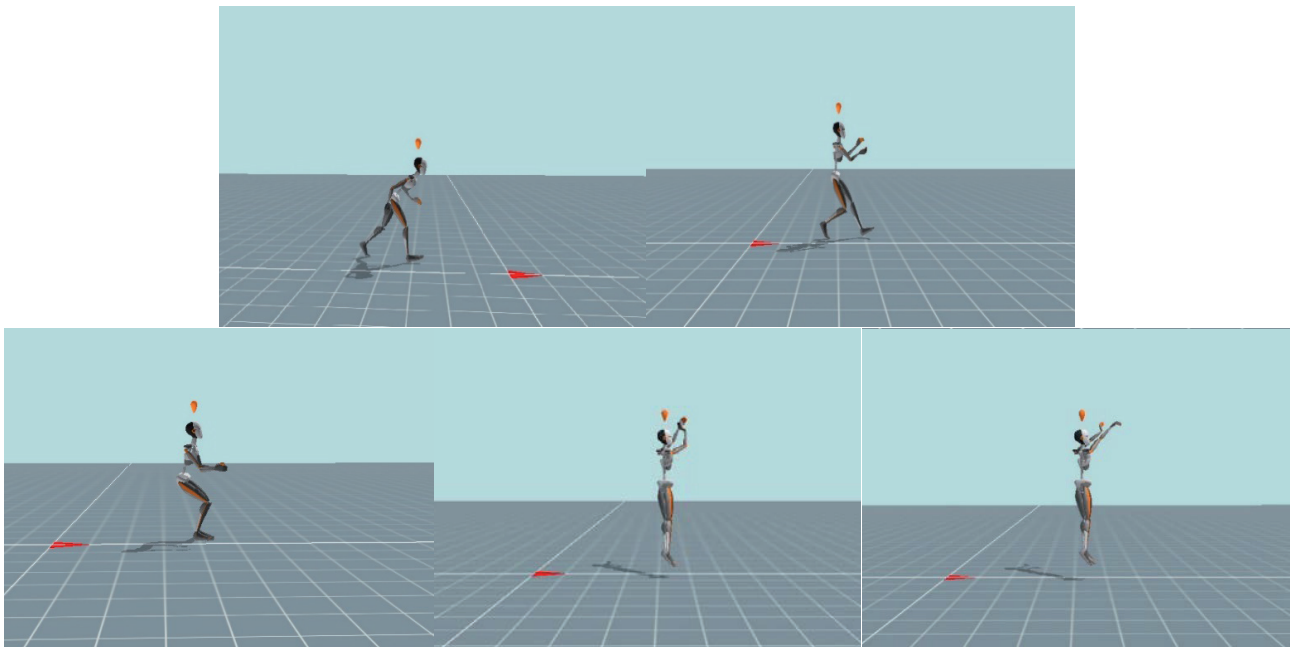
Analysis of kinetic and kinematic parameters was conducted on 2- and 3-point jump shot in basketball. They were performed by five basketball players (age  $25.30 \pm 2.58$  years; height  $188.74 \pm 9.45$  cm; weight  $86.40 \pm 11.41$  kg). Prior to the start of the study, participants were informed in detail about the study aims and they agreed to participate voluntarily. Participants did not have any prior injuries that could affect their jump shot technique or kinetic and kinematic variables during their shooting performance.

### Variables

Variable sample included five variables in total. Three of them regarding kinematic and four of them regarding kinetics. There was a total of 50 jump shots analysed (25 2-point jump shots and 25 3-point jump shots). Kinematic variables were shoulder angle while releasing the ball ( $^{\circ}$ ), release height (cm), time from receiving until releasing the ball (sec). Kinetic variables were maximum force of the left foot in the concentric phase (N), maximum force of the right foot in the concentric phase (N).

### Study protocol

The task of each participant was to perform five successful 2- and 3- points jump shots. A shot for 2 points was performed from a distance of 5.85m, and a shot for 3 points was performed from a distance of 6.75m. The warm-up protocol lasted 5 minutes and consisted of the general and dynamic preparations with the ball, after which every subject performed 3 jump shots from a distance for 2 and 3 points. The player performed the shot after being passed the ball, which was preceded by a run from the center line of the basketball court. In order to standardize the speed and accuracy of the pass, a basketball cannon (Dr.Dish) was used. The release angle of the ball from the basketball cannon si set during a shooting in the warm-up, in such a way that the player receives the ball at chest height at the moment of stopping. Shots were performed with a 94 Fifty smart ball to obtain shot parameters. The measurement characteristics of the “smart ball” were previously determined by Erčulj, Marković and Broder (2014), Rupčić et al. (2016). Also, each participant wore a MVN BIOMECH XSENS kinematic suit to accurately measure the value of the angle in the shoulder during the release of the ball. The research of Blair et al. (2018) confirms the reliability of the measuring device for measuring the stated kinematic parameters. For the purpose of measuring the value of the pressure force during shooting, insoles (Novel, Pedar) were used. Previous research by Stricker et al. (2010) confirmed the validity of this kinetic system.



Picture 1, 2, 3, 4, 5. Jump shot display.

## Methods

“Statistica” program, version 13.5, was used for the statistical analysis. Basic descriptive parameters were calculated for all variables. Pearson correlation test was used for the detection of correlation between the observed parameters for 2- and 3-points jump shots. Results were considered significant in case of  $p < 0.05$ .

## Results

Table 1. Basic descriptive parameters of each tested variable

Variable	N	Mean	Min.	Max.	SD
MAX_F_L_2p	25	1039.35	787.20	1492.40	214.65
MAX_F_R_2p	25	1134.84	715.40	1374.89	210.56
MAX_F_L_3p	25	1035.41	783.82	1309.88	166.05
MAX_F_R_3p	25	1093.01	787.60	1324.86	140.82
SH_2p	25	113.87	98.16	129.93	8.79
R_height_2p	25	232.52	211.28	250.30	11.61
Time_2p	25	0.89	0.80	1.04	0.06
SH_3p	25	115.29	97.74	127.33	9.08
R_height_3p	25	230.54	206.46	247.63	11.70
Time_3p	25	0.86	0.68	0.99	0.06

Legend: \*MAX\_F\_L\_2p – the maximum force of the left foot in the concentric phase during a 2-point jump shot; MAX\_F\_R\_2p – the maximum force of the right foot in the concentric phase during a 2-point jump shot; MAX\_F\_L\_3p – the maximum force of the left foot in the concentric phase during a 3-point jump shot; MAX\_F\_R\_3p – the maximum force of the right foot in the concentric phase during a 3-point jump shot; SH\_2p – shoulder angle while releasing the ball in a 2-point jump shot; SH\_3p – shoulder angle while releasing the ball in a 3-point jump shot; R\_height\_2p – ball release height during a 2-point jump shot; R\_height\_3p – ball release height during a 3-point jump shot; Time\_2p – time from receiving until releasing the ball during a 2-point jump shot; Time\_3p – time from receiving until releasing the ball during a 3-point jump shot.

According to the descriptive indicators shown in Table 1., during the 2-point jump shots, the maximum pressure forces (1492.40N; 1374.89N) are slightly higher than the forces generated during the execution of the 3-point jump shots (1309.88N; 1324.86N). Further analysis shows that the players achieve higher values in the shoulder joint during the 3-point jump shots (115.29 °; 113.87 °). Also, a higher average value is visible in the ball release height of the 2-point jump shots (232.52cm). The recorded duration of the shots shows that the basketball players have faster values during the 3-points jump shots (0.86sec; 0.89sec).

Table 2. Correlation between the observed parameters of the 2-point jump shots

Variable	MAX_F_L_2p	MAX_F_R_2p	SH_2p	R_height_2p	Time_2p
MAX_F_L_2p	1,00	0,71*	0,54*	0,58*	-0,07
MAX_F_R_2p	0,71*	1,00	0,40*	0,82*	0,22
SH_2p	0,54*	0,40*	1,00	0,38	0,01
R_height_2p	0,58*	0,82*	0,38	1,00	0,51*
Time_2p	-0,07	0,22	0,01	0,51*	1,00

Legend: \* $p < 0.05$ ; MAX\_F\_L\_2p – the maximum force of the left foot in the concentric phase during a 2-point jump shot; MAX\_F\_R\_2p – the maximum force of the right foot in the concentric phase during a 2-point jump shot; SH\_2p – shoulder angle while releasing the ball during a 2-point jump shot; R\_height\_2p – ball release height during a 2-point jump shot; Time\_2p – time from receiving until releasing the ball during a 2-point jump shot.

The correlation between the maximum pressure force on the ground and the angle in the shoulder joint was observed ( $p = 0.54$  \*;  $p = 0.40$  \*) in Table 2. Further analysis showed a statistically significant correlation between the ball release height and the maximum pressure force on the ground ( $p = 0.58$  \*;  $p = 0.82$  \*). Observing the duration of the shot, a statistically significant correlation with the ball release height is visible ( $p = 0.51$  \*).

Table 3. Correlation between the observed parameters of the 3-point jump shots

Variable	MAX_F_L_3p	MAX_F_R_3p	SH_3p	R_height_3p	Time_3p
MAX_F_L_3p	1,00	<b>0,66*</b>	<b>0,52*</b>	<b>0,65*</b>	-0,06
MAX_F_R_3p	<b>0,66*</b>	1,00	0,23	<b>0,57*</b>	-0,14
SH_3p	<b>0,52*</b>	0,23	1,00	<b>0,43*</b>	0,09
R_height_3p	<b>0,65*</b>	<b>0,57*</b>	<b>0,43*</b>	1,00	<b>0,41*</b>
Time_3p	-0,06	-0,14	0,09	<b>0,41*</b>	1,00

Legend: \* $p < 0.05$  MAX\_F\_L\_3p – the maximum force of the left foot in the concentric phase during a 3-point jump shot; MAX\_F\_R\_3p – the maximum force of the right foot in the concentric phase during a 3-point jump shot; SH\_3p – shoulder angle while releasing the ball in a 3-point jump shot; R\_height\_3p – ball release height during a 3-point jump shot; Time\_3p – time from receiving until releasing the ball during a 3-point jump shot.

The degree of correlation is visible between the maximum pressure force and the ball release height ( $p = 0.65$  \*;  $p = 0.57$  \*). By further analysis of the observed variables, the correlation was noticed between the angle in the shoulder and the ball release height ( $p = 0.43$  \*). Observing the duration of the shot, a statistically significant correlation with the ball release height is visible ( $p = 0.41$  \*).

## Discussion

Observing the individual tactics of a player with the ball in the offense, the jump shot is derived from a triple threat position from which the player has three options, namely shooting, passing, and dribbling. It should be emphasized that the jump shot technique is an extremely complex motor task, which requires a high level of adoption of various basketball elements, but also a high development of the upper and lower extremities muscles. From Table 2 it can be seen that the maximum forces recorded during the concentric shooting phase for 2 points, have a statistically significant correlation with the angle in the shoulder at the time of ball release ( $p = 0.54$  \*;  $p = 0.40$  \*). However, the highest degree of correlation was recorded with the ball release height ( $p = 0.58$  \*;  $p = 0.82$  \*). These results point to the fact that the creation of a larger force impulse in the concentric phase affects the increase of the angle in the shoulder joint. Ultimately, due to the increase in the previous parameters, there is a change in the point of the ball release height along the vertical line. Similar values (Table 3) in the degree of correlation between the previously mentioned variables, are also visible during the execution of the 3-point jump shot. The maximum pressure force on the ground has a significant relationship with the angle in the shoulder joint ( $p = 0.52$  \*), and with the ball release height along the vertical line ( $p = 0.65$  \*;  $p = 0.57$  \*). Also, Table 3 shows a statistically significant correlation between the shoulder angle and the ball release height during a 3-point jump shot ( $p = 0.43$ ). Although the values of the angle of the ball incidence were not measured in this study, it can be assumed that due to the increase in the values in the previously mentioned parameters, there will be an increase in the angle of the ball incidence in the basket. Miller and Bartlett (1996) emphasize that the ball release height and the angle of the ball incidence into the basket are the most relevant kinematic parameters on which shooting performance depends and therefore put emphasis on their interrelationship. In addition to the correct execution of technical elements, this mostly refers to the correct stopping technique that allows us to annul the force of inertia created by horizontal movement as quickly and easily as possible and convert the same force into vertical movement. Different motor abilities are of great importance for creating greater force in the concentric phase. The relative explosive power of the jump type is one of the basic abilities that is considered in the success of athletes in team sports (Golec, Vučetić, Đurković, 2015). Previous research has shown that there is a link between vertical jump and the explosive power of the lower extremities (Kasović-Vidas and Medved, 1998). Observing the descriptive parameters of the 2- and 3-point shot duration (Table 1), it can be seen that players during the 3-point jump shot have a shorter time of performance compared to the 2-point jump shot performance. A study done by Okazaki and Rodacki, (2012) was conducted on a sample of ten basketball players who took shots from different distances. It has been proven that increasing the distance from the basket reduces the duration of the jump shot.

## Conclusion

Due to its complexity, the shooting technique requires a great deal of attention to proper performance in the learning process. According to the results obtained from previous research and the previously determined relationship between kinetic and kinematic parameters in the jump shot, it can be concluded that there is a certain biomechanical interaction between kinematic parameters of the jump shot and the maximum pressure force on the ground in the concentric phase. In the further training process, coaches should increase the amount of work on improving the technique of stopping, especially when players moving with the ball. It is extremely important that the player performs the stopping technique correctly in order to make the most of the concentric phase during the performance of the jump shot, and thus improve the efficiency of shooting during a basketball game.

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# KINEMATICS AND KINETICS OF A SINGLE SET UNTIL FAILURE USING MAGNESIUM CARBONATE DURING DEADLIFT OF TOP-LEVEL POWERLIFTERS

**Damjan Bruno, Saša Vuk**

*University of Zagreb Faculty of Kinesiology, Croatia*

## Abstract

The goal of this study was to determine whether and to what extent magnesium, as an ergogenic aid, could provide better results in performance and number of repetitions in deadlift. Selected population of top level powerlifters ( $n = 8$ ) performed deadlift in two conditions: with magnesium (WM) and without magnesium (NM). Lifts were made with 85% of 1RM and they performed the maximum number of repetitions until muscle failure. The results of the T-test for the dependent samples showed a statistically significant difference between the conditions only in the number of repetitions, while for the variables peak and average power, and peak and average velocity, amplitude and duration there were no statistically significant differences. The use of magnesium increased the number of repetitions compared to the NM by 102%. In conclusion, the use of chalk gave better results in the number of repetitions during the deadlift, which may be very important in increasing the total work volume, but it did not directly affect the performance quality of each repetition.

*Key words: ergogenic aids, chalk, magnesium powder*

## Introduction

Ergogenic aids are all the external factors that we use to increase or improve the performance, or to avoid negative effects (Porrini & Del Bo, 2016). Many scientists and coaches have noticed that when performing deadlift, fatigue of the forearm muscles and lack of grip strength occur (Coswig, Machado Freitas, Gentil, Fukuda & Del Vecchio, 2015). Since these two facts can be a major problem in training, the need to put an end to forearm muscle fatigue and grip strength is indicated, implying the use of ergogenic aids. Magnesium is the most well-known and commonly used ergogenic aid that is used as a desiccant and increases the friction between the lifter's hands and the bar (Church et al., 2016). Higher levels of friction lead to improved performance of a deadlift. The most commonly used magnesium is traditional cubed magnesium carbonate, which can be easily crushed to produce fine powder (Church et al., 2016).

Various approaches have been identified based on the scientific studies to date regarding the use of magnesium. Research on professional powerlifters has not been conducted so far, and magnesium is one of their main assets in training and competitions.

We can assume that magnesium will have a positive effect on deadlift performance, however it is unknown to what extent and whether there are differences between repetitions with and without using magnesium.

Therefore, the aim of this paper is to determine whether and to what extent the use of magnesium affects the deadlift performance of powerlifters.

H1 - Powerlifters will perform a higher number of repetitions by using magnesium compared to the lifting without magnesium in a deadlift with a load of 85% 1RM.

H2 - Powerlifters will have higher peak and average power and peak and average velocity in the performance of a deadlift with magnesium compared to lifting without magnesium.

## Methods

### Experimental Design

This study utilized a cross-over trial (AB/BA) with randomization. Subjects were randomly assigned to the group that first performed the lifts with magnesium (WM condition), followed by the lifts without magnesium (NM condition) or in the group that first performed the lifts without magnesium (NM) followed by the lifts with magnesium (WM condition). The time interval between the individual tests was seven days, which was long enough that the potential effect of testing the first condition was not transferred to the results of testing the second condition.

## Subjects

The sample consisted of eight professional male powerlifters, five of whom were national champions and three vice-champions in their respective categories (age:  $26.13 \pm 7.3$  years; height:  $181.7 \pm 19.7$  cm; body weight:  $95.0 \pm 15.4$  kg; training experience:  $6.13 \pm 3.5$  years). Subjects were training four times per week on average, they did not suffer any injuries, and were not engaged in any additional physical activity during the study.

## Deadlift Methods

Two techniques were allowed: sumo deadlift and classic deadlift, depending on the preference of the subjects. Lifts were performed on the touch and go principle and only the correct repetitions were counted, ie. the repetitions with full range of motion, or until the cancellation of the grip. Subjects performed lifts with overhand grip or mixed grip, depending on which grip they achieved with their 1RM. An Olympic bar of 220 cm length and 20 kg weight was used.

## Testing

Subjects performed the testing on three occasions: (1) determining one maximum repetition (1RM); (2) testing the first condition after one week; and (3) testing a second condition after one week. The determination of 1RM was conducted at the official state powerlifting competition (in 2019). Then, 85% of the 1RM was calculated for each subject separately, which represented the weight that the subjects had to overcome while performing the task. The instruction given to the subjects concerned the performance of the maximum number of repetitions by the correct technique. Condition testing was performed each time on the same day and at the same time, with identical training and rest schedules to minimize any external influences on the results.

## Kinematic Variables

Each repetition was recorded in the frontal plane for the purpose of 2D video analysis in the *Tracker - video analysis and modeling tool* (The Open Source Physics Software). The total number of repetitions was observed, as well as the peak and average velocity, peak and average power, amplitude of the lift and average duration of each repetition within a set.

## Statistical Analyses

The data collected were processed using the software package STATISTICA (ver 13.4 for Windows). Descriptive parameters as means and standard deviations were calculated. T-test for dependent samples established statistical significance between all variables. The results obtained were considered statistically significant at the error level  $p < 0.05$ .

Also, the effect size was calculated as Cohen's  $d$  where  $d < 0.35$  was considered as a trivial effect,  $0.35-0.8$  as a small effect,  $0.8-1.5$  as a moderate effect and  $d > 1.5$  as a large effect (Rhea, 2004); and the magnitude of the increase (expressed as a percentage).

## Results

The results obtained in Table 1 show the means and standard deviations, as well as the values of the t-test, which established the statistical significance in favor of magnesium over the lifts without it. The magnitude of the increase and the effect sizes for both conditions are also shown in the Table 1.

Table 1. Results

	NM		WM		t	p	Cohen's d	Size increase
	MEAN	SD	MEAN	SD				
Max. No. Repetitions	4.75	2.19	9.75	1.98	-3.99	0.005*	2.28	105.26
vpeak (ms <sup>-1</sup> )	0.67	0.13	0.63	0.11	0.97	0.366	-0.31	-5.97
vmean (ms <sup>-1</sup> )	0.34	0.10	0.34	0.07	-0.01	0.999	0.00	0.00
Ppeak (W)	1217.09	282.71	1159.69	187.18	0.78	0.461	-0.20	-4.72
Pavr (W)	620.54	202.37	618.02	162.78	0.05	0.964	-0.01	-0.41
amplitude avr (mm)	504.59	78.43	496.17	81.90	1.54	0.168	-0.11	-1.67
duration avr (s)	1.54	0.47	1.57	0.52	-0.16	0.880	0.06	1.95

\*statistically significant difference



## Discussion

The main finding of this study shows a significantly higher number of repetitions of a deadlift using magnesium compared to not using of magnesium thus confirming the first hypothesis. In the other variables, i.e. peak and average power and peak and average velocity, as well as amplitude and repetition duration, did not produce a statistically significant difference between the conditions, so the second hypothesis is rejected. Interestingly, previous research suggests that there is no need to use magnesium when lifting weights, while its use in climbing is indisputable. Specifically, in a laboratory study (Carré, Tomlinson, Collins, & Lewis, 2012), the correlation of rock friction and fingertips using magnesium was examined. Contradictory results have been reported because of the reduction of friction using magnesium, while on the other hand, some studies indicate the effectiveness of magnesium, i.e. the increase of friction (Carré, Tomlinson, Collins, & Lewis, 2012). Another interesting study compares the deadlift with and without lifting straps, and indicates to us that there is no statistically significant difference in the number of repetitions between the two conditions, but a statistically significant difference occurs in average and peak forces in favor of lifting straps (Coswig et al., 2015). The finding of our study shows that magnesium definitely improves the grip strength and friction coefficient, which is why a statistically significantly better result was obtained compared to lifting with the bar only, magnesium even increased the number of repetitions by 105.26%. This increase is reflected by an effect size of  $d = 2.28$ , which is a large effect on this population of subjects (Rhea, 2004). The number of repetitions can play a significant role in one of the most important components of training - the work volume that represents the total number of sets and repetitions performed in one training session (Bird, Tarpennig and Marino, 2005). As the use of magnesium allowed for a significantly higher number of repetitions of a deadlift in one set than without it, it can be assumed that the use of magnesium could have an equally significant effect on the total training volume. A study by Amca, Vigouroux, Aritan and Berton (2012) involving 11 experienced climbers who performed 42 practical tests holding a handle on a specially designed friction coefficient plate also indicates that there is a significant positive effect of magnesium on the coefficient of friction.

However, at peak and average power and velocity, there is no statistically significant difference in lifting using magnesium versus not using an ergogenic aid.

In top powerlifters training, the performance of a deadlift with magnesium is definitely recommended. It should be mentioned that subjects had previously used magnesium in training so this “habit” can affect performance under altered conditions. The use of magnesium produces a much higher number of repetitions, which plays a very important role in the volume of training and in the planning and programming of different training cycles. It is evident that the use of magnesium, in addition to improving the coefficient of friction, is close to powerlifters as it is used in every workout and competition, and they feel best when using it while performing a lift.

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## BIOMECHANICAL EVALUATION ASPECT OF PES PLANUS BASED ON SUBTALAR JOINT ANALYSIS

Mihail Michi Geambesa, Andreea Ungureanu, Andreea Rosca, Alexandru Chivaran,  
Mihnea Ion Marin, Ligia Rusu

*University of Craiova, Romania*

### Abstract

At this time there are several studies that analyze the types of pes planus, such as rigid or flexible. The aim of this study is to present the relation between foot axis, loading and subtalar angle during a cycle of gait. By this way is possible to have information about how subtalar joint is involved in pes planus during gait and how it is possible to make the correction using the foot orthoses like insole. Biomechanical gait evaluation was performed using the Foot Scan plate Scientific Version – RS Scan International, a platform for force distribution and plantar pressure distribution. Measurements allow us to study the foot axis in relation with subtalar angle and also the relation between the loading of the plantar side (force) and subtalar angle, depending on time. The results included information about the relation between foot axis and subtalar joint, relation between loading (force of loading) and subtalar joint angle, for each foot. Assessing foot function is important for determining the efficacy of various preventive protocols based on physiotherapy and orthotic procedures for patients with tarsal coalition (rigid foot) and pes planus (flexible foot).

*Key words: subtalar joint, assessment, pes planus*

### Introduction

Pes planus valgus is one of the most important pathologies in children and not only. Therapy of this pathology needs a complex evaluation using a clinical assessment, a functional assessment and last but not least, biomechanics and kinetic evaluation. In this moment there are a lot of studies that speak about the pes planus valgus types, if they are flexible or rigid. In this way we can speak about the study who addresses about the variations of medial plantar arch (Lawrence, 2012). Also the evolution of this arch could give the definition of the pes planus flexible. The opposite aspect is rigid pes planus which is defined by restriction of subtalar joint movement and associate with pain. Review of literature conclude that development of the foot depends on a lot of factors and segmental alignment seems to have the main role and involve a complex evaluation (James, 2016).

The aim of this study is to present the relation between foot axis, loading and subtalar angle during a cycle of gait. By this way is possible to have information about how subtalar joint is involved in pes planus during gait (Tarnita et al., 2016) and how is possible to make the correction using the foot orthotics like insole.

### Materials and Methods

This research included a lot of 23 patients, average age 13 years. +/- 1 years, clinical diagnostic of pes planus, predominant to right foot, without clinically detectable gait disorders. This research was carried out in accordance with ethical principles covered by the Declaration of Helsinki and the Law No.206/2004. All participants acknowledged their willingness to take part in the study by signing a written informed consent document.

Biomechanical gait evaluation was performed using a platform for force distribution and plantar pressure distribution - FootScan Scientific Version, RSScan International, Olen, Belgium, which is able to perform measurements with a frequency of 500 Hz in 2D and record the complete action of both plants. The platform was used to record the pressure distribution values in the lower limb at ground contact. The foot applied on the platform, measure local pressure at full contact with the ground at high frequency, the operational substrate is represented by the total impact force measured at the level of a sensor matrix on a known surface (Binghua, 2014). RS Scan force platform makes the gait analysis in terms of ground reaction force and the pressure developed during gait. The values are expressed in [N] for force. These measurements allow us to study the foot axis in relation with subtalar angle and also the relation between the loading of the plantar side (force) and subtalar angle, depending on time. Both feet were recorded during two gait cycles, paying attention to alternative placement of the right/left lower limb. In the present study, we grouped the eight stages of gait into three stages, namely: ground attack phase – the initial contact heel; midstance phase, in which the middle region of

the plant is involved, and propulsion phase, in which the load is higher in the metatarsals; this stage depends on the way the tibial-tarsal control is achieved.

### Results

The results included information about the relation between foot axis and subtalar joint, relation between loading (force of loading) and subtalar joint angle, for each foot.

Using the graphic method we design this relation present in the next figures:

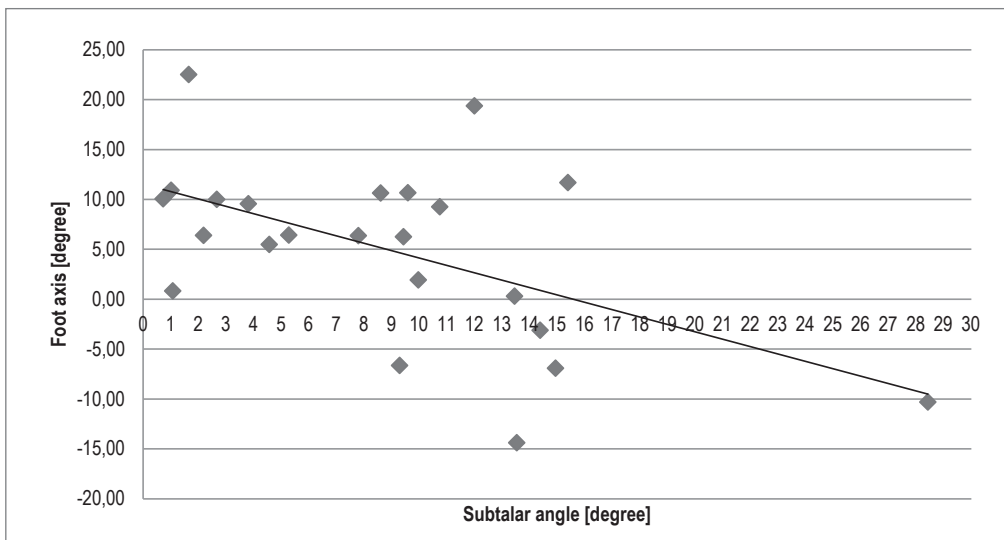


Figure 1-Variation of left foot axis in relation with subtalar angle

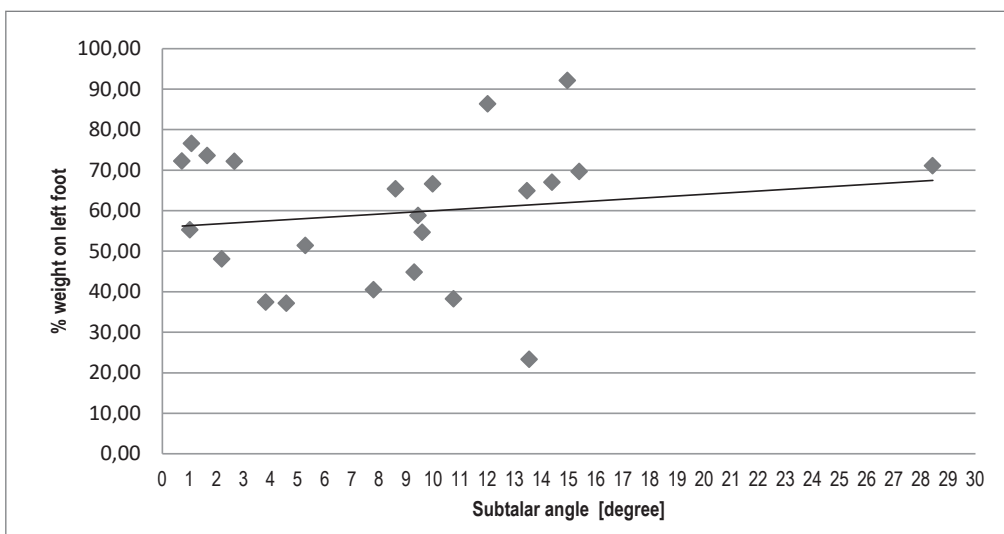


Figure 2-Variation of left heel loading in relation with subtalar angle

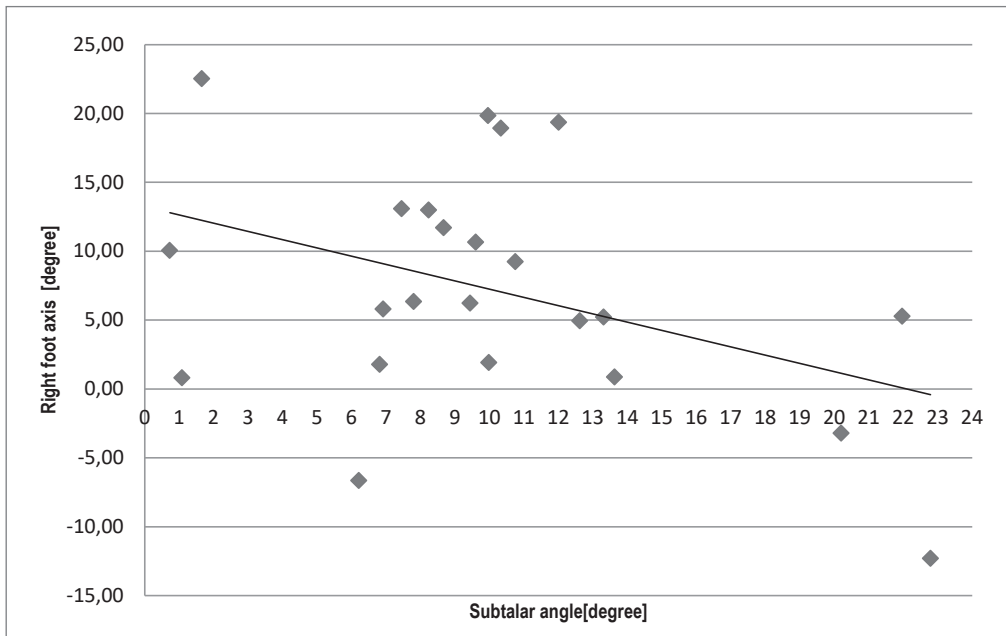


Figure 3-Variation of right foot axis in relation with subalar angle

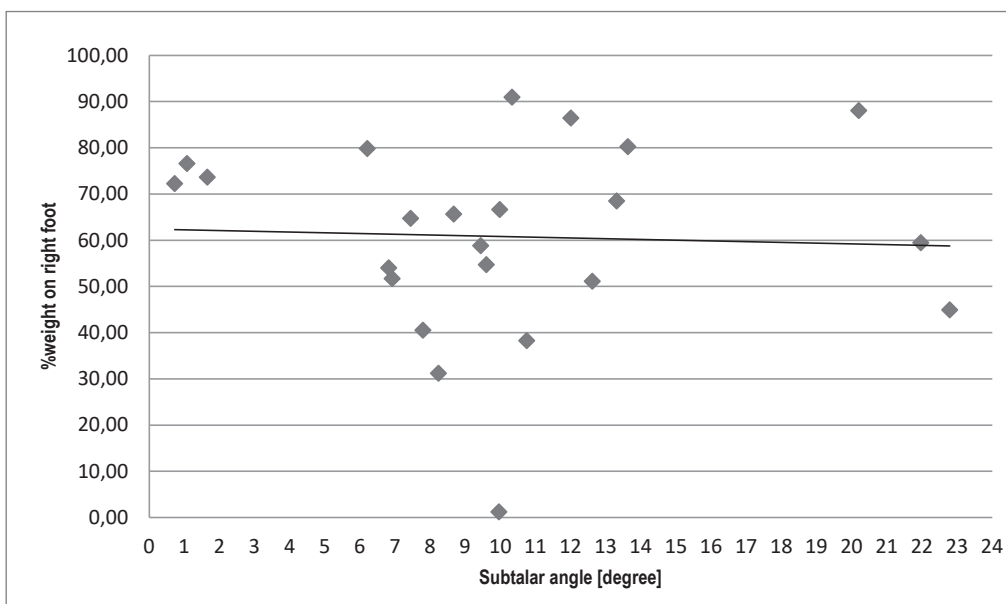


Figure 4- Figure 2-Variation of right heel loading in relation with subalar angle

The average subalar angle is 8-24 degrees of medial deviation in the transverse plan relative to the long axis of the foot along the second ray.

In our results we see that for the right foot the foot axis has positive value 0°-20°, that is associated with subalar angle 7°-15°, and has the tendency to decrease in the same time with the increase of subalar angle. This means that evolution of subalar angle increase the eversion and the severity of the loading under the medial arch of the foot. The loading on the right foot is 30%-90% and decrease also in relation with the increase of subalar angle.

For the left foot, foot axis is 0°-10°, and subalar angle is 0°-15°. The evolution of foot axis has also negative value in the same time with increase of subalar angle. The loading on the left foot is 10%-90% on the heel and increase in relation with subalar angle.

## Discussion

We observe a functional asymmetry between left and right foot, it is an inverse evolution of loading, (Tarnita et.al, 2017) which means decrease the loading on right foot and increase the subtalar angle because of weight distribution on plantar region. In the same time on the left foot we have an increase of the loading and the subtalar joint. All these aspects suggest us that increase the eversion of right foot and on the left foot developed a compensatory mechanism for conserving the balance and stability during the gait.

By this biomechanical analysis is possible to predict the evolution of pes planus or to estimate the possibility to develop this pathology and to design the rehabilitation protocol.

Gait cycle give the subtalar joint experiences rotatory and gliding motion of the talus against the calcaneus. During and following the heel strike and the talocalcaneal joint assumes relative external rotation and valgus with eversion during the first half of the stance (Pfeiffer, 2006). The subtalar joint transmits forces from the tibia to the foot. Mobility of the transverse tarsal joint is determined by the position of the subtalar joint, when the hindfoot is everted into a valgus position, and the transverse tarsal joint is unlocked.

Normal subtalar kinematics reduce the ground reaction impact forces and limits subtalar eversion. This increases the magnitude of the impact loading experienced during gait (Lawrence, 2012).

## Conclusions

The foot function assessment its important for determining the efficacy of various preventive protocols based on physical therapy and orthotics procedures for patients with tarsal coalition and pes planus.

This joint modifies the forces of ambulation imposed on the rest of the skeleton and influences the performance of the more distal foot articulations as well.

In people with pes planus the axis of the subtalar joint is more horizontal than in those with more normal feet.

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# THE ROLL-OVER PATTERN AND PLANTAR PRESSURE DISTRIBUTION CHANGES DURING THE FIRST GAIT DEVELOPMENT IN TODDLERS AND THE EFFECT OF GENDER

Marta Gimunová, Martin Zvonař, Kateřina Kolářová, Tomáš Vodička

Masaryk University, Faculty of Sports Studies, Czech Republic

## Abstract

**Introduction:** The first gait in toddler is different from adult walking. The purpose of this study was to compare gender differences in foot loading and gait development in the first's months of walking experience by analyzing plantar pressures during a barefoot walk. **Methods:** Seventeen toddlers, 8 girls and 9 boys, participated in this study at the onset of their independent walk ( $5.75 \pm 1.83$  and  $6.44 \pm 2.74$  for girls and boys, respectively) and one month after the first data collection session ( $10.13 \pm 2.17$  and  $10.22 \pm 3.03$  for girls and boys, respectively). Participants were encouraged to walk barefoot over the Emed-at platform (Novel GmbH, Germany) at their self-selected speed. Using the Emed-at software, the foot was divided into 10 regions. At each region, the contact area, maximal force normalized to body weight and peak pressure were analysed. **Results:** The results of this study show gender-specific differences in the first gait development in toddlers. Toddler girls tend to acquire the postural balance better/faster resulting in the predominance of mature heel to toe roll-over pattern and increase load on forefoot region during their third month of walking experience. On the other hand, toddler boys have increased contact area at the area of midfoot, indicating a different foot structure. **Conclusions:** These findings support the suggestion, that shoe design should reflect the different gender needs to enable the optimal foot and gait development and function as reported previously.

**Key words:** Gait, Gender, Plantar pressure, Roll-over pattern, Toddler

## Introduction

Human gait is a complex movement. Walking pattern is very individual and it is influenced, among others, by gender and age (Levine, Richards, & Whittle, 2012). The first gait in toddler is different from adult walking. When gaining experience with walking during the first months after the first step, there is a large number of changes in gait parameters. The first toddlers' gait is characterized by a great variability, typical for the learning processes, low speed, short step length, greater step width and extended phase of double support. Gradually, toddlers improve their balance, learn to produce sufficient strength to advance forward and learn to co-ordinate individual movements to optimize the energy cost of walking (Chang et al., 2006; Hallems et al., 2005).

Gender-specific differences in the foot shape and structure were described in adults. Foot size, both in absolute and relative dimension when the stature is considered is smaller in females (Fessler et al., 2005) and the sexual dimorphism in bones of the foot, e.g. talus, calcaneus, metatarsals or phalanges, has been reported previously (Steel, 1976; Smith, 1997). Also in toddlers, gender-specific differences of the foot were observed previously. Boys were observed to have a broader midfoot area indicating a lower longitudinal foot arch, whereas girls were observed to have higher heel and forefoot pressures indicating a more dynamic ground contact when walking (Unger, & Rosenbaum, 2004).

Five months after the onset of walking, a heel to toe roll-over pattern was observed to predominate, suggesting the improved balance control (Hallems et al., 2006). In the previous period of gait development, three different foot-contact patterns were described in toddlers' gait in previous studies: forefoot, flatfoot and heel (Hallems et al., 2003; Hallems et al., 2006). Forefoot foot contact pattern is characterized by the initial contact of metatarsals, then the midfoot and heel are placed on the ground. Then, the roll-over pattern continues by the heel to toe contact pattern. For the flatfoot pattrer the simultaneous contact of the forefoot and heel and subsequent heel to toe roll-over is typical. Finally, the heel foot contact pattern starts with the initial contact of heel and then the heel to toe roll-over continues (Hallems et al., 2006).

The purpose of this study was to compare the first gait development in toddler girls and boys analyzing the step type and plantar pressures during a barefoot walk with the aim to understand the relationship between the foot loading and gait development in the first's weeks of walking experience.

## Methods

Seventeen toddlers, 8 girls (mean age  $14.36 \pm 1.52$  months) and 9 boys (mean age  $13.99 \pm 1.41$  months), participated in this study at the onset of their independent walk and one month after the first data collection session. Their body mass, body height and walking experience in weeks is shown in Table 1. Exclusion criteria consisted of any orthopaedic diagnosis affecting the gait. Informed consent was obtained from parents of toddlers participating in this study prior to the first measurement. The study was approved by a local ethical committee.

Table 1. Participants characteristics.

	1 <sup>st</sup> data collection session						2 <sup>nd</sup> data collection session					
	Walking experience (weeks)		Body mass (kg)		Body height (cm)		Walking experience (weeks)		Body mass (kg)		Body height (cm)	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
<b>Girls</b>	5.75	1.83	9.51	0.83	77.50	3.96	10.13	2.17	10.00	1.03	78.00	4.04
<b>Boys</b>	6.44	2.74	10.42	0.76	79.23	2.68	10.22	3.03	11.04	0.86	80.11	3.52

Participants were encouraged to walk barefoot over the Emed-at platform (Novel GmbH, Germany; 50 x 145 cm) at their self-selected speed toward a parent or experimenter a several times wearing a bodysuit and a diaper as clothes were observed to influence the gait cycle of toddlers (Theveniau et al., 2014). From obtained footprints, 10 steps (five steps of the right and 5 steps of the left foot) of each participant at each data collection session were chosen for further analysis. Selection criteria included a full foot contact with platform and no stop or change of direction during the trial.

During the footprints selection, four different step types were observed. Forefoot, flatfoot and heel type were described in the literature previously (Halleman et al., 2003; Halleman et al., 2006). "Heel dance" type, observed in this study, seems to be a transitional type between flatfoot and heel step types and may be therefore observed only in several weeks of gait development. For this step type the initial heel contact, then the roll-over toward midfoot, subsequent backward roll-off toward heel and final heel to toe roll over is typical.

At each participant's data collection session, a number of heel, flatfoot, forefoot or heel dance step types was counted (Table 2). Using the Emed-at software, the foot was divided into 10 regions: toe 1, 2, lesser toes, first, second, third, fourth and fifth metatarsal heads (MH1-5), midfoot and heel. At each region, the contact area, maximal force normalized to body weight (BW) and peak pressure were analysed.

Table 2. The number of different step types of each participant at the first and second data collection session.

	step type:	1 <sup>st</sup> data collection session				2 <sup>nd</sup> data collection session			
		heel	flatfoot	forefoot	heel dance	heel	flatfoot	forefoot	heel dance
<b>Girls</b>	mean	2.13	2.88	2.25	2.75	6.13	1.25	0.63	1.75
	SD	2.03	2.75	1.67	1.83	2.42	0.46	0.74	1.58
<b>Boys</b>	mean	2.78	1.89	2.11	3.22	4.56	1.67	1.67	1.56
	SD	2.73	1.45	2.15	2.91	2.35	1.94	1.66	1.24

To compare the difference in contact area, maximal force normalized to body weight and peak pressure between boys and girls at the first and second data collection session and the difference between the first and second data collection session within the gender, effect size obtained by Cohen's d was used. Cohen's d was used also to compare the gender and developmental differences in step types. Cohen's d is interpreted as  $\geq 0.20$  small,  $\geq 0.50$  medium,  $\geq 0.80$  large effect (Cohen, 1977). The use of effect size without the statistical analysis was suggested previously by Soukup (2013).

## Results

### Gait development in girls

During the second data collection session significantly greater number of steps belonged to the heel step type compared to the first data collection session when a significantly greater number of step belonged to other step types. With the transition to the heel step type, an increase in maximal force normalized to body weight at the area of midfoot, MH1-MH4, increase in peak pressure at all areas except second toe and lesser toes, and increase in contact area of hindfoot

and MH1-MH4 was observed. At big toe, the maximal force normalized to body weight and contact area were decreased during the second data collection session (Table 3).

Table 3. Results of effect size comparison of maximal force normalized to BW (%BW), peak pressure (kPa) and contact area (cm<sup>2</sup>) between the first and second data collection session in girls. (\*) small, (\*\*) medium, and (\*\*\*) large effect.

		Hind foot	Midfoot	MH1	MH2	MH3	MH4	MH5	Big toe	Second toe	Toes 345
Cohen's d	Max force normalized to BW	0.19	0.48*	0.32*	0.30*	0.34*	0.47*	0.16	0.27*	0.00	0.11
	Peak pressure	0.28*	0.33*	0.46*	0.26*	0.82***	0.58**	0.23*	0.26*	0.02	0.05
	Contact area	0.51**	0.19	0.43*	0.57**	0.38*	0.44*	0.27*	0.31*	0.14	0.09

### Gait development in boys

As in girls, during the second data collection session significantly greater number of steps belonged to the heel step type compared to the first data collection session. Comparing the first and second data collection session, significant increase in the maximal force normalized to body weight was observed at midfoot and MH1-MH4 areas. Peak pressure was increased in the area of hindfoot, midfoot, MH3-MH5 and lesser toes. Contact area was significantly increased in the area of hindfoot and MH1-MH4 during the second data collection session (Table 4).

Table 4. Results of effect size comparison of maximal force normalized to BW (%BW), peak pressure (kPa) and contact area (cm<sup>2</sup>) between the first and second data collection session in boys. (\*) small, (\*\*) medium, and (\*\*\*) large effect.

		Hind foot	Midfoot	MH1	MH2	MH3	MH4	MH5	Big toe	Second toe	Toes 345
Cohen's d	Max force normalized to BW	0.17	0.28*	0.22*	0.37*	0.37*	0.31*	0.06	0.02	0.08	0.11
	Peak pressure	0.29*	0.32*	0.16	0.18	0.66**	0.73**	0.28*	0.08	0.05	0.27*
	Contact area	0.57**	0.16	0.21*	0.41*	0.40*	0.29*	0.15	0.02	0.05	0.13

### Gender differences

Differences in the number of different step types performed by girls and boys during the first and second data collection session are shown in Table 5. During the first data collection session, boys performed a significantly greater number of heel type steps and girls of flatfoot type. During the second data collection session, a significantly greater number of heel step type was performed by girls, boys performed a significantly greater number of flatfoot and forefoot step types.

At the first data collection session, medium effect was observed in peak pressure at the area of MH1 and in contact area at hindfoot. At the second data collection session, differences between girls and boys with medium effect were observed in contact area at hindfoot and midfoot.

Table 5. Results of effect size analysis of the number of different step types observed in girls and boys during the first and second data collection session. (\*) small, (\*\*) medium, and (\*\*\*) large effect.

	1 <sup>st</sup> data collection session				2 <sup>nd</sup> data collection session			
	heel	flatfoot	forefoot	heel dance	heel	flatfoot	forefoot	heel dance
Cohen's d	0.27*	0.45*	0.07	0.19	0.66**	0.30*	0.81***	0.13

### Discussion

The purpose of this study was to compare the first gait development in toddler girls and boys analyzing the step type and plantar pressures during a barefoot walk. Four different step types were observed during the gait in toddlers in this study. Forefoot, flatfoot, heel type were described in the literature previously (Halleman et al., 2003; Halleman et al., 2006). Heel dance type, observed in this study, seems to be a transitional type between flatfoot and heel step types. Furthermore, the results of this study show gender-specific differences in the first gait development in toddlers.

## Gait development in girls and boys

In girls, during the 10.13 week of walking experience the heel step type significantly predominated compared to the first data collection session. With the transition to the mature step type the increase in contact area at hindfoot, increase in peak pressure and contact area at MH2-MH4 were observed with medium to large effect. Similar observations, higher forefoot pressures were described in toddler girls also in previous study (Unger, & Rosenbaum, 2004). In boys, increase in peak pressures at the area of MH3 and MH4 and contact area at hindfoot were observed at the second data collection session in this study with a medium effect. The difference in analyzed step types usage between the first and second data collection session in boys was not as prominent as in girls. However, also in boys the tendency toward the predominance of the heel step type at their 10.22 week of walking experience was observed. Similarly, in previous literature, a developmental shift at two months of walking experience was observed, probably caused by an increase in postural control (Bisi, & Stagni, 2015). The forefoot region allows better muscular control to produce stability during the gait than the hindfoot and midfoot regions. The increased load at forefoot during the heel type of step, and the forefoot and flatfoot step types, often observed at the onset of walking, contribute to improved balance during the gait (Hallemans et al., 2003).

## Gender differences in gait development

When comparing toddler girls and boys at their 5,75 and 6,44 weeks of walking experience, respectively, boys tended to use more the heel dance type of step type, whereas girls preferred the flatfoot type. Statistically significant differences between girls and boys at the first data collection session were observed in peak pressure at MH1 and in the contact area at hindfoot, with a medium effect. Observed higher values of peak pressure at MH1 in boys compared to girls might be reflecting the increased load at forefoot needed for better balance control when performing the heel roll-over pattern (Hallemans et al., 2003).

As mentioned before, during the second data collection session, significantly greater number of heel step type footprints was observed in girls, suggesting their faster acquisition of balance control when learning to walk. At the second data collection session, significant differences with a medium effect were observed in the contact area at hindfoot and midfoot. The higher contact area at the area of midfoot in boys observed in this study was described previously in Unger and Rosenbaum (2004) and similar observations were described also in pre-school and school-aged children (Pfeiffer et al., 2006; Chang et al., 2010; Mickle et al., 2008). Better balance performance was observed in females compared to males in previous studies focused on both, adults and children (Bryant et al., 2005; Lee, & Lin, 2007; Smith et al., 2012; Mickle et al., 2011). The gender differences in balance control were suggested to be caused by a different foot structure as boys tend to have flatter foot compared to girls (Mickle et al., 2011) and the postural control have been reported to be affected in persons with a flat foot (Anzai et al., 2014).

There are several limitations of this study. The age of toddlers varied between 12 to 19 months as the study inclusion criteria consisted of a week of walking experience and not age. The higher age of girls in this study may affect their gait performance. Another limitation of this study was wearing a diaper during the gait analysis, however; participants were used to wear it every day and all participants wore it.

Seventeen toddlers is a small number of participants to draw general conclusions; however, it seems that in the first gait development gender-specific differences exists. Toddler girls tend to acquire the postural balance better/faster resulting in the predominance of mature heel to toe roll-over pattern and increase load on forefoot region during their third month of walking experience. On the other hand, toddler boys have increased contact area and peak pressure at the area of midfoot, indicating a different foot structure compared to girls and observed also in older children and adults. These findings support the suggestion, that shoe design should reflect the different gender needs to enable the optimal foot and gait development and function as reported previously by Unger and Rosenbaum (2004) and Wunderlich and Cavanagh (2001).

## Conclusions

Seventeen toddlers, 8 girls and 9 boys, participated in this study at the onset of their independent walk and one month after the first data collection session to analyze the gender differences in foot loading and gait development in the first's months of walking experience. The results show that toddler girls tend to acquire the postural balance better/faster resulting in the predominance of mature heel to toe roll-over pattern and increase load on forefoot region during their third month of walking experience. On the other hand, toddler boys have increased contact area at the area of midfoot, indicating a different foot structure and probably affecting the postural control needed when performing the mature heel to toe roll-over pattern.

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## COMPARATIVE KINAMATIC ANALYSIS OF RUN-UP AND HOP IN A PREPARATORY ACROBATIC SERIES FOR BACKWARD SOMERSAULTS

Željko Hraski<sup>1</sup>, Slobodan Dragičević<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology

<sup>2</sup>University College Aspira, Split

### Abstract

The aim of this study was to determine the differences in the performance of the initial part of the preparatory acrobatic series (PAS) including Run-up, Hop, Round-off and Back handspring, that precede the execution of three basic variants of backward somersaults: Tuck, Layout and Double tuck. The subject of this research was the member of the Croatian national male gymnastics team, ranked among the top 20 gymnasts in the world on the floor exercises. After performing 10 of each somersault variants, the best 3 are subjected to further analysis. The sample of variables consisted 22 kinematic parameters with the greatest impact on the height and length of the somersault trajectory, as well as on the generation of the necessary angular momentum. Based on the results obtained by the correlation analysis specific relations among biomechanical parameters are defined ( $p < 0,05$ ). This particularly applies to the COM height in second Run-up step (.71), horizontal velocity during the take-off for Hop (0.76), length of the Hop (0.81) and to the horizontal velocity at a maximal Hop height (0.78). The results of this research can be used in everyday gymnastics practice, in terms of a better understanding of the technical execution, the identification of errors as well as the efficiency maximization of the preparation for somersaults.

**Key words:** acrobatic series, biomechanics, somersault

### Introduction

The term “Preparatory Acrobatic Series” (PAS) refers to a combination of different elements of movement, including a Run-up, Hop, Round-off, and a Back handspring. The function of the Run-up and Hop is to achieve the optimal horizontal velocity as well as to initiate the angular momentum necessary for efficient execution of a certain somersault type. In PAS gymnasts strives to achieve optimal horizontal velocity as quickly as possible. The sum of the length of running steps and hop is about 7m, which is almost half of the total length of the complete acrobatic series (max = 16.97 m). Considering that the basic biomechanical parameters which define the amount of rotation and the shape of the somersault trajectory are generated through the PAS, the aim of this research was to determine the basic kinematic parameters of the first part of the PAS: Run-up and Hop, as well as the relationship of these parameters to the basic variants of the back somersaults: Tuck, Layout and Double tuck.

### Methods

The subject of this research was a member of the Croatian national male gymnastics team (Height 173 cm, Weight 70 kg), national champion on the floor exercises. The data acquisition was made just before the Croatian gymnastic championships, when the athlete was in full competition form to perform the tested acrobatic backwards series. In a specially organized training, the gymnast performed thirty preparatory acrobatic series which ended with ten Tuck and ten Double tuck, as well as the ten Layout back somersault. Video data were collected with four cameras, at a rate of 60 Hz. Cameras were set in two pairs, each pair at 90° (45° left and right left and right to the direction of movement), covering the space of Run-up, Hop, Round off, Back handspring and Somersault. After the video acquisition, the data were processed according to the standards of the APAS procedure (Ariel Performance Analysis System). Correlation analysis was used to analyze the relationship between the biomechanical variables of selected parts of the preparatory acrobatic series and the final somersault type.



## Results and discussion

The characteristic of this short run is that the length of the steps increases progressively, similar to the run for a long jump in athletics, except for the last step prior the take-off for the Hop, which is shortened. This shortening causes the reduction of the COM angle to ground at the take-off for the Hop, thereby starting generation of angular momentum. The shortest step before the take-off (1.14 m) is registered for the Double tuck somersault. The examination of the results shows that there are no major differences in the sum of the Run-up steps between the three variants of PAS, which confirms the uniqueness of the Run-up characteristics regardless of which variant of the somersault is the final goal of the PAS. Unlike the lengths of the Run-up steps, the Hop length values differ significantly (Table 1). Thus, the length of the Hop is the greatest for the Double tuck somersault (2.49 m), for the Layout somersault is 2.33 m, and for the Tuck somersault is the shortest (2.22 m). From this it also follows that the length of the Run-up and Hop is the longest for the Double tuck somersault (6.72 m).

Table 1. Lengths of the Run-up steps and the Hop

VARIABLES	TUCK	LAYOUT	DOUBLE
Length of the Hop – COM (m)	1,75	1,80	2,04
Length of the Hop – Feet (m)	2,22	2,33	2,49
Sum of the Run-up step lengths and Hop (m)	6,43	6,58	6,72

Differences in Hop lengths, registered through horizontal COM translation, and Hop lengths registered through the contact coordinates of the foot with the ground, are the consequences of the flexion in the hip joint during the downward flight path of the Hop. As the most important goal of this short and intense Run-up is to achieve optimal horizontal velocity, the basic characteristic of the body during these four running steps is to lean forward with minimal oscillations of the center of gravity along the y axis (Table 2). Such a rapid Run-up produces a low and a long Hop, with some differences between somersault types. The difference in COM height in maximum Hop flight from COM height in take-off ranges from 10 cm in PAS for Double tuck somersault, to 15 cm in the PAS for Layout somersault.

Table 2. Vertical displacement of the COM in Run-up and Hop

VARIABLES	TUCK	LAYOUT	DOUBLE
COM height in the start of Run-up (m)	0,89	0,89	0,85
Max COM height in Run-up (m)	0,93	0,92	0,90
Min COM height in Run-up (m)	0,81	0,82	0,77
COM height in the Hop take-off (m)	1,11	1,08	1,09
Max COM height in the Hop flight (m)	1,24	1,23	1,19
COM height in the landing from the Hop (m)	0,93	0,95	0,91

Table 2 also shows that the COM height in starting position is the lowest for the Double tuck somersault. The reason for this is that bending the knees, as well as leaning the trunk forward in the starting position, is conditioned by the need to achieve a higher horizontal velocity immediately from the start. The lowest values of vertical COM displacements from starting position to the end of the Hop were recorded at the beginning of the second step. This is due to the pronounced forward tilt of the body in this step, with a slightly greater knee flexion of the take-off leg, with purpose to achieve more effective take-off in the next step. Subsequently, the COM curve gradually increases until the beginning of the take-off for Hop, when it begins to rise sharply. At the highest point of the Hop trajectory, the jump is 34 cm (Layout, Double tuck) and 35 cm (Tuck) higher than the value of COM at the starting position. Lower COM height values in landing from Hop, than those in the take-off, are the consequence of bending the trunk more forward, which starts at the maximum height of the Hop and continues through the landing until the placement of the hands for the round-off. The lowest COM height in a Hop flight, with the longest flight length, is found in Double tuck somersault. This is conditioned by the smallest COM angle to the x-axis during take-off for the Hop, which contributes to the incrementation of the horizontal component of the velocity at take-off. Most authors (Geiblinger and McLaughlin, 1995; Cuk and Ferkolj, 2000; Sands, 2001; Hraski, 2002; Hraski and Mejovsek, 2004; Sadowski et al., 2009; Mkaouer et al., 2013; Król et al., 2016), involved in the analysis of backward somersaults, consider COM vertical velocity ( $V_y$ ) at the take-off as the most significant biomechanical parameter that determines the efficiency of somersault performance (height of the trajectory). However, high values of  $V_y$  are produced from high values of the  $V_x$  accumulated throughout the preparatory acrobatic elements. In the case of this research, horizontal velocity, from zero values at the start of the Run-up, approaches the maximum values at the end of the take-off for the Hop, ranged from 4.58 m/s in the PAS for Tuck, 4.78 m/s for Layout, to 5.27 m/s for Double Tuck somersault (Figure 1).

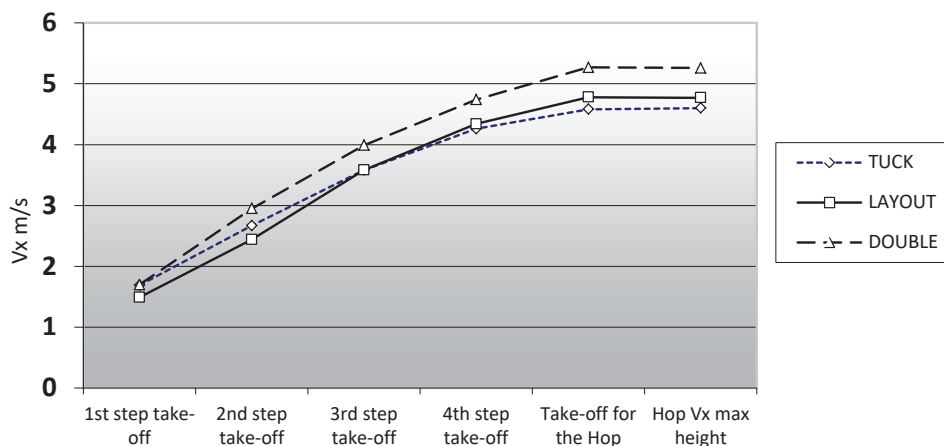


Figure 1. Vx values of the Run-up and Hop

Generally, the increase of the vertical velocity ( $V_y$ ) in the Run-up and Hop, as well as in the entire PAS, has a negative effect on its biomechanical efficiency, since it necessarily affects the reduction of the horizontal velocity component. So, in the case of this research, decrease in the value of  $V_y$ , registered in the first step of the Run-up was expected. Namely, flexion in the hip and knee joint lowers the body (to the lowest point in the entire Run-up curve), so that a stronger push from the supporting leg can be performed which causes the body to accelerate forward. With each subsequent step, the  $V_x$  increase, while  $V_y$  decreases, with a new significant  $V_y$  increase in the take-off for a Hop. According to the earlier conclusions, about  $V_y$  negative relation with the efficiency of PAS, the largest  $V_y$  value at the end of the Hop take-off is found in the PAS for the Tuck somersault (1.31 m / s) and the lowest for the Double tuck somersault (1.26 m / s).

A review of Table 3 shows significant ( $p < 0.05$ ) negative correlations of the somersault trajectory height with the COM height in the starting position (-.71\*) as well as with lowest COM height in Run-up (-.71\*), registered in the second take-off step. This relationship becomes more understandable after analysis of the correlation coefficients of certain  $V_x$  values of Run-up and Hop trajectory characteristics with COM displacements along the y axis. It is observed that PAS with the highest horizontal velocity have the highest correlations with the height of the COM in the starting position and in the second step of the run-up. One of the reasons for that is increased flexion in the knee joint, which enables a more effective thrust forward. The lowest position in the second step is also created by flexing the trunk and moving the COM forward and down, which puts the trunk in a more favorable position for achieving starting acceleration. As Run-up length is limited with the diagonal length of the floor area, it is important to achieve high horizontal velocity in the first four steps.

Table 3. Correlations with height (Max Dy) and length (Max Dx) of the somersault trajectory

VARIABLES	Max Dy	Max Dx
COM height in the start of Run-up	-.71*	0.61
Min COM height in Run-up (m)	-.71*	-.49
COM $V_y$ at the end of 4th take-off	-.49	-.69*
COM $V_x$ at the end of take-off for Hop	.76*	.62
COM V at the end of take-off for Hop	.80*	.61
COM Dx in the Hop flight	.81*	.74*
COM $V_x$ in the max height of the Hop flight	.78*	.60
COM $V_x$ in landing from Hop	.73*	.63
COM V in landing from Hop	.68*	.51

\* $p < 0.05$

In this phase of the PAS positive correlation with maximal height of the COM trajectory is found for  $V_x$  during Hop take-off (.76\*) as well as for the resultant velocity (.80\*), which, due to small vertical displacements, is almost indistinguishable from the  $V_x$ . The main task of the Hop in the PAS is to initiate the angular momentum, while keeping the loss of the horizontal velocity component as low as possible. These requirements imply that the Hop has long and low COM trajectory. Positive correlations of somersault trajectory height with Hop length (.81\*) are expected because both parameters depend on horizontal velocity, one of the most important predictors of the somersault flight trajectory (Table 3). This variable is also significantly correlated with somersault trajectory length (.74\*), since in the case of a significant reduction in velocity in the take-off, it also has a decisive influence on flight length. Confirmation of this conclusion is the

also a significant correlation of the horizontal velocity component in the maximum Hop height and trajectory height of the somersault (.73\*). Due to the small influence of the vertical velocity on the resulting velocity, it has a similar value of the correlation coefficient with the maximum height of the somersault, (.68 \*) as it was the case with the horizontal velocity.

## Conclusion

The aim of this research was to determine the basic kinematic parameters of the Run-up and Hop, as well as the relationship of these parameters to the basic variants of the back somersaults. Based on the results obtained by the correlation analysis specific relations among biomechanical parameters are defined. This particularly applies to the COM height in second Run-up step, horizontal velocity during the take-off for Hop, length of the Hop and to the horizontal velocity at a maximal Hop height. The results of this research can be used in everyday gymnastics practice, in terms of a better understanding of the technical execution, the identification of errors as well as the efficiency maximization of the preparation for somersaults.

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## EFFECT OF CONTROLLED SUBMAXIMAL TEETH CLENCHING ON STATIC POSTURAL CONTROL AND DURING VOLUNTARY DYNAMIC MOTOR PERFORMANCE TASKS

Hans Isselée, Henri De Vroey, Marco Konings, Antoon De Laat

*KU Leuven - University of Leuven*

**Introduction:** There is growing evidence that jaw clenching may affect postural reflexes under static conditions (1). However, this relationship in dynamic conditions is not clear since different underlying motor control mechanisms may be present (2). The aim of the present study was to investigate the effect of submaximal teeth clenching on static postural balance, during a conscious perturbation task induced by a forward arm swing and on the voluntary transition from bipedal to unipedal stance.

**Methods:** Eight healthy subjects (4 females – 4 males) aged 22 - 25 years were recruited among physiotherapy students. Included subjects were free of temporomandibular, oral or musculoskeletal disorders. In a random order they all performed five motor performance tasks (static, foam, forward arm sway, transition from bipodal to unipedal stance with eyes open/closed) on a force platform (AMTI, Watertown MA, USA). Anterior-posterior (AP) and medio-lateral (ML) centre of pressure (COP) position and COP path length were analysed. Bite force was continuously monitored by means of a custom-made bite sensor (Loadstarsensors, Fremont CA, USA) placed between the 2nd molars. Each trial involved a 20s non-clenching and a 20s clenching phase that is equal to 20 % of their individual maximal clenching force based on realtime feedback. In each phase, a conscious voluntary motor task was performed.

**Results:** The results showed that during clenching the COP displacements, expressed as the root mean square, were significantly reduced in ML ( $p=0,003$ ) and AP ( $p=0,027$ ) direction on the static tests. Also, clenching induced a significant forward displacement of the COP ( $p=0.0046$ ) in static conditions. No significant differences ( $p>0.05$ ) in COP displacements were found during the dynamic perturbation task and on the balance recovery after the conscious forward arm swing. Interestingly, a substantially release of bite force was observed during the arm swing.

**Conclusion:** Jaw clenching could affect static postural balance and induce a forward displacement of the COP. However, clenching had no effect on dynamic postural stability during or after a conscious voluntary perturbation task.

*Key words: Jaw clenching postural motor control*

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## THE INFLUENCE OF SCHOOL BAG WEIGHT ON BACK PAIN IN PRIMARY-SCHOOL AGE CHILDREN (CZECH REPUBLIC)

Katerina Jencikova<sup>1</sup>, Mario Kasović<sup>2</sup>, Martin Zvonar<sup>1</sup>

<sup>1</sup>Masaryk University, Czech Republic

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The back pain is one of the most common health problem in the population (80%) which is no longer issue for adults only but it has presently passed to children also. The purpose of this study was to find out the current situation of pupils in the Czech Republic and their school bag as main risk factor in the back pain in children in primary school and propose a solution for the identified situation. A total of 481 pupils aged 6 to 11 years old (253 boys and 228 girls) of the primary school were included in this study. Children were from 5 different primary schools (Brno) with disaggregation to the classes 83 pupils of 1<sup>st</sup> grade, 123 of 2<sup>nd</sup> grade, 86 of 3<sup>rd</sup> grade, 113 of 4<sup>th</sup> grade, 76 of 5<sup>th</sup> grade). Besides ordinarily anthropometric data the weight of the school bags was measured. Most of the pupils 267 (55,7%) out of 481 were carrying bags with weight more than 15% of their body weight. The maximum limit which is considered as weight between 10 – 15% of child total body weight were carried by 214 pupils (37,5%). That makes only 33 pupils (6,9%) who were carrying the recommended weight on their school bag which means <10% of the child total body weight. Back pain was reported by 53% of school children. According negative results this problem needs to have dedicated full attention, be closely evaluate and take the necessary steps to rectify the situation by parents, school staff and children themselves.

**Key words:** posture, kids, health, backpack

### Introduction

Lifetime prevalence of low back pain gradually increases with age (Hestbaek et al., 2006). The posture is major factor in the health of the musculoskeletal system. Postural changes are related to painful and debilitating conditions. (Ferreira, Duarte, Maldonado, Burke, & Marques, 2010; McEvoy & Grimmer, 2005). Back pain is one of the most common health problem and it has become a common issue also for youger children in school which is reaching up to 60% (continuing by higher percentage to adulthood) in some European countries (Ayanniyi, Mbada& Muolokwu, 2011; Calvo-Muñoz, Gómez-Conesa, & Sánchez-Meca, 2013; Martínez-Crespo et al., 2009).

Pain is such a state of the body or soul when something subjectively hurts us, when we feel something uncomfortable. Back problems include ligament and muscle strains, overuse injuries, problems with posture, and poor conditioning of the back muscles. Most common muscular back pain will respond to rest and modifications in activities such as adjustment of movement stereotypes or inclusion of regular stretching and strengthening of the back muscles (Patrick, Emanski & Knaub, 2014).

As warning signs of the more serious problems in children backpack we consider: the night pain (especially pain that awakens child from sleep), constant symptoms of pain, symptoms of generalized illness (fever, chills, malaise, weight loss), symptoms persisting beyond several weeks, symptoms in very young children, leg pain, numbness, or weakness (Hestbaek et al., 2006). These warning signs necessarily does not mean there is a more serious problem. However, they are a very good screening test to determine if more evaluation should be pursued. For example, muscular back pain can persist for months, however, if the symptoms have been going on for several weeks, it's best to ensure the diagnosis is clear (Joergensen, Hestbaek, Andersen & N. Andersen, 2019).

There are many factors involved in the development of problems with the back. Some of them are closely related to how we have been significantly changed as humanity over the past 100 years as weaking of certain muscle group (from sedentary lifestyle, lack of exercise etc.). Another ones are sleeping on the wrong mattress, incorrect sitting position, various injuries, hypermobility, being overweight etc. There is also one more factor affecting children which is a significant influence of their school bags.

The maximum weight of the school bag should be 10 – 15% of the children's total body weight. The correct size and a load that isn't too heavy are significant parameters of the appropriate child's backpack (Shahid, 2018). The school bags should be worn on the back, symmetrically (over both shoulders), with firm back for good support and padded shoulder

straps (Brzek, 2017). The shoulder and waist straps should be adjustable. Importance is on adjusting the shoulder straps so that the bottom of the backpack is just above the child's waist. To avoid back problems is necessary to do not allow children to wear the backpack low over their buttocks (Marathon Bag Direct, 2019).

## Methods

As method of this study we used mixed methods research. A total of 481 children (253 boys and 228 girls) of the primary school (aged 6–11 years old) were included in this study. They were from five different primary schools from Brno, Czech republic. Study was implemented at the primary schools (82 pupils of 1<sup>st</sup> grade, 123 pupils of second grade, 86 pupils of third grade, 113 pupils of fourth grade, 77 pupils of fifth grade). Besides ordinarily anthropometric data (height and weight of the children) the weight of the school bags was measured, so we were able to get the percentage of school bag to the total body weight. The school bag was weighed without modification (it contained everything the children had in it, usually: textbooks, exercise books, pencil cases, drinks or snack, things for afternoon activities, etc.)

Table 1. Participants characteristics

Variable		Number (Total amount)	Percentage
<b>Gender</b>	Male children	253	52,59
	Female children	228	47,41
<b>Primary school</b>	School A	70	14,55
	School B	54	11,22
	School C	60	12,47
	School D	109	22,66
	School E	188	36,08
<b>Grades</b>	1 <sup>st</sup>	82	17,25
	2 <sup>nd</sup>	123	25,36
	3 <sup>rd</sup>	86	17,87
	4 <sup>th</sup>	113	23,49
	5 <sup>th</sup>	77	16,00
<b>TOTAL</b>		<b>481</b>	<b>100</b>

Besides ordinarily anthropometric data (height and weight of the children) the weight of the school bags was measured, so we were able to get the percentage of school bag to the total body weight. Prior to the actual measurement in selected primary schools, the informed consent about this study and the completed questionnaire were filled out and signed by parents (possibly by legal representatives). The child's measurement and completion of the questionnaire took about 20 minutes on average. The aim of the questionnaires was to find out about the physical activity of the child because lack of the exercise (or excessive amount or inappropriate method) is considered one of the main risk factors of back pain.

As a second part of the study 60 children were deliberately selected from the group of 481 pupils (1<sup>st</sup> to 5<sup>th</sup> grade) to describe their possible back problems (if appear), way of transportation, daily time of wearing school bags. The children responded themselves, sometimes it was their estimation, calculations or feelings.

## Results

Most of the pupils 267 (55,7%) out of 481 were carrying bags with weight more than 15% of their body weight. The prevalence is higher among female children (59,64%) as compared with the male children (52,17%). According to grades the curve has a downward trend (as 1<sup>st</sup> grade 67,46%; 3<sup>rd</sup> grade 63,35%; 5<sup>th</sup> grade 43,42%).



Table 2. Overview of pupils who have schoolbags heavier than 15% of their total body weight

Variable		Number (Total amount)	Number of pupils who have school bag heavier than 15% of their total body weight	Percentage of pupils who have school bag heavier than 15% of their total body weight
Gender	Boys	253	132	52,17
	Girls	228	136	59,64
Grades	1 <sup>st</sup>	82	55	67,46
	2 <sup>nd</sup>	123	74	60,16
	3 <sup>rd</sup>	86	55	63,35
	4 <sup>th</sup>	113	50	44,24
	5 <sup>th</sup>	77	33	43,42
<b>TOTAL</b>		<b>481</b>	<b>267</b>	<b>55,70</b>

School bags between 10-15% of total body weight of the child is considered as a maximum limit for kids to carry. 214 pupils out of 481 pupils in our study had bags of this weight. 40,3% of male children and 34,2% of female children carry this spread of weight. During children's ageing the percentage of pupils with this weight increases irregularly (1<sup>st</sup> grade 29,3%; 5<sup>th</sup> grade 46,8%).

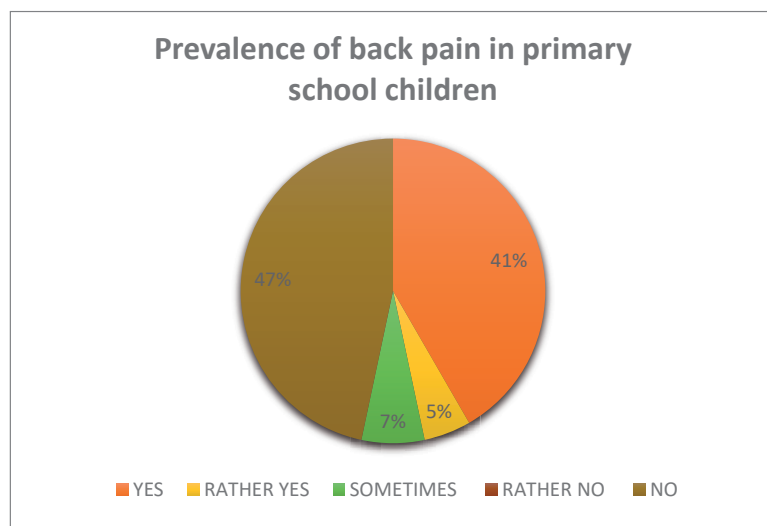
Table 3. Overview of pupils who have schoolbags between 10 – 15% of their total body weight.

Variable		Number (Total amount)	Number of pupils who have school bag between 10 - 15% of their total body weight	Percentage of pupils who have school bag between 10 - 15% of their total body weight
Gender	Boys	253	102	40,3
	Girls	228	78	34,2
Grades	1 <sup>st</sup>	82	24	29,3
	2 <sup>nd</sup>	123	40	32,5
	3 <sup>rd</sup>	86	26	30,2
	4 <sup>th</sup>	113	55	48,7
	5 <sup>th</sup>	77	36	46,8
<b>TOTAL</b>		<b>481</b>	<b>181</b>	<b>37,5</b>

The prevalence of school bag heavier than 20% is 65 (13,51%) children and for school bags heavier than 25% is 7 (1,55%) out of 481 children. Within school age the prevalence of both cases is highest in pupils of 1<sup>st</sup> grade. That makes only 33 pupils (6,9%) who were carrying the recommended weight on their school bag which means <10% of the child total body weight. In female children the average of school bag to their total body weight was (15,9%) and also in male children came to more than 15% of their total body weight (15,5%). Total average of school bag's weight is 15,7% of total body weight. Average weight of school bag for primary aged children (girls and boys) is according to this research 4,7 kg.

The way of carrying the school bag was 99,16% regular, which is characterised by bag with two straps worn over two shoulders. Only 3 first grade students out of 481 have trolley bags and 1 child has bag over one shoulder.

60 children were asked about their daily time of wearing of school bags. The most children (30%) answered that their time of wearing school bags is 60 – 120 minutes per day (Mo – Fri), 25% of them having backpack on their back 21 – 60 minutes per day. 18,3% of primary school pupils states that they are carrying school bags more than 120 minutes daily and 15% of children is having school bag 20 minutes or less per day. The rest of the respondents (11,6%) did not state the time in the questionnaire or could not estimate. Back pain was reported by 53% of these deliberately selected school children (60).



Picture 1. Prevalence of back pain in primary school children.

As next the young respondents were describing the back pain. For almost half of them was hard to answer when and how the back pain usually occurs. The most common reason was they couldn't remember or realize. The rest of them stated answers as carrying heavy schoolbag, the time right after and during sport activity or straight up position as times while back pain occurs. The children responded themselves, sometimes it was their estimation, calculations or feelings.

## Discussion

The aim of this research was to map the current situation of children in the Czech Republic and their school bag as one of the main risk factor in the back pain in children in primary school and propose a solution for the identified situation. The results of this study represent an alarming situation as 59,64% of female children and 52,17% of male children (55,70%) were carrying school bags of >15% of their body weight which means more than the highest limits according to the international guidelines. Only total 6,9% pupils of primary schools were carrying school bags up to 10% of their body weight (the recommended weight). These results are very surprising, even more so as the measurements were taken just before Christmas which according to school experience, we would expect reduced results rather than above standard.

The question is why children has to carry such a load on their backs and if is that necessary. The fault could probably be placed on one of three sides. First would be the school, mostly the grade school teacher who have high demands and may require many school tools every day. Everyday heavy backpack use can be influenced in a positive way if the pupils could keep their textbooks under their desks or somewhere in the classrooms or the dressing rooms. Also maybe possibility to print one paper for child instead of the whole book could be good solution to make school bag easier. As we are talking about a specific reading book, is there really reason to carry them every day? Every child has a lot of great books at home waiting to be read. In the Czech republic at the primary schools the class teacher has usually the power over the students schedules, so it could be made it that way to have only one book on kid's back per day. A primary school teacher (the most from 1<sup>st</sup> to 3<sup>rd</sup> grade) represents 100% authority for children therefore, the teacher is mostly the one who is setting rules and that is up to him/her to devote some of the time to educate children about load on their back (Srouji, Ratnapalan and Schneeweiss, 2010). Another side of the problem might be the parents who also have a huge influence to their children. Due to lack of their time or lack of the awareness about the school's schedule for the next day, the child can be tasked to carry more than is necessary. Children can be also helpful to not put unnecessary things into their bags such as toys, extra books and so on. Of course, they will initially need good advice and control from the teacher and parents, but the primary goal should be to teach them these habits and instil them into children so they would be able to manage for themselves in the future. Another way to reduce the weight of school bags can be for example: tapping water at school, having snacks at school or using the space at a school to put things away.

The Czech republic is not the only one with these kind of results. Other countries have a similar alarming results of heavy backpacks. (De Paula, Silva and Silva, 2015; Watson, 2019). Also, more studies are based on a close correlation between back pain and heavy school back (Akbar, Albesharah, Al-baghli, Bulbul, Mohammad, Qadoura and Al-taiar). In spite of this, Yamato and others (2018) claim in their review that there is no convincing evidence that aspects of schoolbag use increase the risk of back pain. We know there is colleration between backpack and heavy load but we as population we should be much more specific in our guidelines (in literature can be found 5% - 20% of human body weight). To assess the true relationship between back pain and school bags and to map the situation closer would be appropriate a long-term study to monitor children in their pre-school age, then their whole studies and also in adulthood to make retrospective research possible.

## Conclusions

481 children (253 boys and 228 girls) of the primary school (aged 6–11 years old) were included in this study. The result of the research is that most children of younger school age have a disproportionately heavy bag (> 15% of their body weight) that they carry on their backs daily. Only 33 pupils (6,9%) had the recommended weight on their school bag (which means <10% of the child total body weight). Back pain was reported by 53% of deliberately selected school children. This problem needs to have dedicated full attention to closely evaluate and take the necessary steps to rectify the situation. Also, parents, students and school staff should be informed and should start to cooperate together and improve the situation about heavy school bags as much as possible.

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*Complement:* This article presents the results of the diploma thesis 2019: The influence of school bag weight and wear style on back pain in primary-school age children (MU).

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## DIFFERENCES IN KINEMATIC PARAMETERS OF BASKETBALL JUMP SHOT PERFORMED FROM DIFFERENT SHOOTING POSITIONS

Feng Li<sup>1</sup>, Vedran Dukarić<sup>1</sup>, Dražen Orešković<sup>1</sup>, Slobodan Simović<sup>2</sup>, Zhongchun Bi<sup>3</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>University of Banja Luka, Faculty of Physical Education and Sport, Bosnia and Herzegovina

<sup>3</sup>Beijing Sport University, China

### Abstract

Shooting accuracy is common way for rating the quality of individual player and team performance. The most relevant factors are release height, release velocity and angle of release. However, some researchers reported that the angle of entry of the ball into the basket, dependent upon release speed and angle, is a major factor in determining shot successfulness. Percentage of successful shots are significantly lower in dynamic shooting conditions. There has been a lot of research related to kinematic parameters of shooting, but little is known about the difference between 0° and 45° shooting positions (regarding the basket) for 2 points. The aim of this study is to examine whether there are differences in some kinematic parameters between 0° and 45° position shots. Differences between shooting positions were determined with the use of multivariate analysis of variance (MANOVA). There is significant difference in ball angle and shot time between two observed shooting positions (ball angle -  $p=0.00$ ; shot time -  $p=0.03$ ). Kinematic parameters related to body position (hand height, shoulder angle) did not differ regarding shooting position (0° and 45°). Presented results denote that athletes were able to maintain shooting technique in both situations. Different position of shooting significantly affects ball parameters but not precision.

*Key words: basketball, youth, jump shot*

### Introduction

Basketball is one of the world's most popular and widely viewed sports, played in more than 200 countries, and a multi-billion dollar industry (Pojskić, Šeparović & Užičanin, 2011). Nowadays, not only professional players want to achieve good performance in the game, but also ordinary basketball enthusiasts focus on how to improve their basketball playing level. In basketball, points are scored by shooting the basketball through a hoop mounted above the playing surface. Shooting accuracy is common way for rating the quality of individual player and team (Erčulj & Supej, 2006; Zambová & Tománek, 2012). Therefore, it can be stated that optimal shooting technique can enhance a player's ability to score points and a team's performance. Shooting accuracy is affected by multiple factors. The most relevant factors are release height, release velocity and angle of release. Also, as the shooting distance changes, mentioned factors change accordingly (Brancazio, 1981; Miller & Bartlett, 1996; Okubo & Hubbard, 2015). However, some researchers reported that the angle of entry of the ball into the basket, dependent upon release speed and angle, is a major factor in determining success (Miller & Bartlett, 1996; Miller & Bartlett, 2007). A higher angle enables the player to be more precise because the ball has more space for entering the basket (Fontanella, 2006; Okazaki, Rodacki, & Satern, 2015). Several studies have investigated the relationship between shooting accuracy and different situations (i.e. stationary and dynamic shots, shooting under fatigue, two or three points shots) (Tang & Shung, 2005; Pojskić et al., 2011; Pojskić et al., 2014). Pojskić et al. (2014) reported that percentage of successful shots are significantly lower in dynamic shooting conditions. Additionally, longer distance and shooting under fatigue also decrease the shooting accuracy. Development of advanced equipment in field of kinematic analysis provides objective data that are shown to have great influence on shooting accuracy. Erčulj & Supej (2006) used the system of 3 digital cameras to study the effect of fatigue on longer distance shooting. By using 3 digital cameras, all shots can be recorded and kinematic analysis was applied to calculate the height of the shoulder and wrist of the release arm, as well as the elbow and upper arm angles. The results of this study clearly demonstrate effect of different degree fatigue on the shooting technique. Rojas et al. (2000) used three-dimensional technology to study the difference in the angles of the shoulder and knee joints with and without defender. This study reported that shooter's shoulder angle was increased and release velocity was higher in order to avoid blocking from the opponent. Moreover, the study of Slawinski et al. (2018) have shown that hand height, joint angles and ball angle play an important role in shooting accuracy. As mentioned above, there has been a lot of research related to kinematic parameters of shooting, but little is

known about the difference between 0° and 45° shooting positions (regarding the basket) of shooting for 2 points. The aim of this study is to examine whether there are differences in some kinematic parameters between 0° and 45° position shots.

## Methods

### Subjects

This study selected 27 U16 Croatian youth male basketball players who are members of Croatian national team. Their average age are  $15.44 \pm 0.41$ y, body height  $192.77 \pm 7.24$ cm, body weight  $81.50 \pm 9.95$ kg. All subjects were provided with a detailed explanation of the study procedures and participants gave written informed consent prior to data collection.

### Variables

There are 5 variables measured in this study: hand height, shoulder angle, ball angle, shot time and successfulness of shooting. Hand height (cm) is the highest hand position of shooting arm; shoulder angle (°) is the angle between the shooting upper arm and the trunk when the ball is released; ball angle (°) is the angle of ball approaching to basket; shot time (sec) is the time from receiving the ball until the moment of releasing the ball; successfulness of shooting is related to number of scored baskets.

The data of hand height and shoulder angle were obtained using Xsens kinematic suit and the variables of shot time and ball angle were derived from 94Fifty Smart Sensor Basketball. Previous studies confirmed validity of Xsens kinematic suit for the analysing different motor skills (Skogstad et al., 2011; Paulich et al., 2018; Isabelle Poitras, 2019). It is possible to use 94Fifty Smart Sensor Basketball for practical purposes, but also for scientific reasons in view of the accuracy of the obtained results (Rupčić et al., 2016).

### Measurement protocol

Basic anthropometric characteristics were measured and used for system calibration performed according to instruction of manufacturer (Robert-Lachaine et al., 2017). All participants took part in one testing session. The measurement protocol was explained in detail before the experiment started. Each player had 5 minutes dynamic shooting warmup before the shooting test. Cones were used for marking the shooting positions. First shooting position was parallel to baseline (0°) and second shooting position is on a 45° angle between baseline and player position (45°). The player makes movement around the cone and after receiving the ball executes the jump shot on 0° and 45° position of both sides respectively. The player executes 2 shots from each side (Figure 1.)

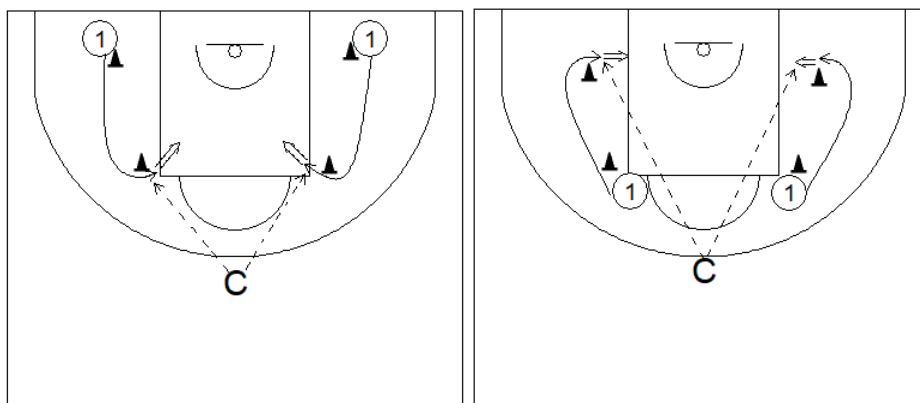


Figure 1. Illustration of shooting test.

### Statistics

For the statistical analysis program „Statistica“ version 13.5 was used. Basic descriptive parameters were calculated for all measured variables. Differences between shooting positions were determined with the use of multivariate analysis of variance (MANOVA). Results were considered significant when  $p < 0.05$ .



## Results

Table 1. Basic descriptive parameters of 0° shooting and 45° shooting

Variable	Valid N	Mean	Minimum	Maximum	Std.Dev.
Hand height 0°	27	230,50	211,05	251,68	11,49
Hand height 45°	27	232,40	212,48	251,90	10,56
Shoulder angle 0°	27	111,85	91,95	133,80	10,39
Shoulder angle 45°	27	113,36	85,85	132,88	11,31
Ball angle 0°	27	28,73	21,50	43,00	5,13
Ball angle 45°	27	33,85	25,00	49,50	5,49
Shot time 0°	27	0,83	0,68	1,04	0,08
Shot time 45°	27	0,88	0,75	1,03	0,07
Success/Unsuccess 0°	27	1,96	0,00	3,00	0,85
Success / Unsuccess 45°	27	2,30	0,00	4,00	0,99

As shown in Table 1, results of hand height for 0° position is lower than 45° position shooting for 2 points (0° = 230,50; 45° = 232,40). Accompanying hand height, shoulder angle values are also lower in 0° shooting position (0° = 111,85; 45° = 113,36). Shot time value in 45° shooting position is higher than 0° (0° = 0,88; 45° = 0,83); ball angle value is higher in 45° shooting position (0° = 28,73; 45° = 33,85). Amount of points scored is lower in 0° shooting position in relation to 45° (0° = 1,96; 45° = 2,30).

Table 2. Results of MANOVA for two observed shooting positions

	Test	Lambda value	F	p
criteria	Wilks	0,69	4,38	0,00*

Results shown in Table 1 show statistically significant difference between 0° and 45° shooting positions (F= 4,38; p=0,00).

Table 3. ANOVA for each measured variable

Variable	F	p
Hand height	0,40	0,53
Shoulder_angle	0,26	0,61
Ball_angle	12,54	0,00*
Shot_time	5,06	0,03*
S/U	1,75	0,19

\*marked values are significant when p<0.05

There is significant difference both in ball angle and shot time between two observed shooting positions (ball angle - p=0.00; shot time - p=0.03). The ball angle of 45° shooting position is higher than of 0° shooting position (45° = 33.85; 0° = 28.73). The duration of shot time of 45° shooting position is higher than of 0° shooting position (45° = 0.88; 0° = 0.83).

## Discussion

This study showed that there is no significant difference between 0° and 45° shooting position in hand height, shoulder angle, and shooting accuracy. However, ball angle and shot time are significantly different between observed shooting positions (ball angle - p=0.00; shot time - p=0.03). Findings of this study regarding ball angle differs from previous studies (Brancazio, 1981; Miller & Bartlett, 1996). They reported that a higher angle enables players to be more precise because the ball has more space for entering the basket. The reason why results in observed variables in this study differs from previous studies may be that the sample size is small (27 players totally). Therefore, it can be suggested that future research should consist of larger sample size to determine whether ball angle affects the accuracy of shooting. There is also significant difference between 0° and 45° shooting position in shot time (45° = 0.88; 0° = 0.83), which means that player needs more time for preparation in 45° shooting position. Results could be different if there was a defender who

was blocking a player. An article which observed kinematic parameters with and without defender noted that release speed was faster with defender in order to avoid blocking from opponent (Rojas et al., 2000). The difference between 0° and 45° in terms of shot angle may be related to visual interference while shooting from different positions (de Oliveira, Oudejans & Beek, 2008). As mentioned above, results of hand height, shoulder angle and shooting accuracy show no significant difference between 0° and 45° position. Although this variables in several studies (Slawinski et al., 2018; Rojas et al., 2000) show great influence on accuracy, this research did not show similar results.

## Conclusion

Kinematic parameters related to body position (hand height, shoulder angle) did not differ regarding shooting position (0° and 45°). Presented results denote that athletes were able to maintain shooting technique in both situations. Parameters related to ball trajectory and duration of shot (ball angle, shot time) were significantly different in comparison of two shooting positions. Different position of shooting significantly affects ball parameters but not precision. In future research it should be taken in consideration more shooting conditions with different ball and player kinematic parameters.

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## HAND-EYE COORDINATION EVALUATED ON A SAMPLE OF CROATIAN AND POLISH FEMALE UNIVERSITY STUDENTS OF EARLY CHILDHOOD AND PRESCHOOL EDUCATION

Marija Lorgjer<sup>1</sup>, Magdalena Lelonek<sup>2</sup>, Ivan Prskalo<sup>1</sup>

<sup>1</sup>University of Zagreb, Faculty of Teacher Education, Croatia

<sup>2</sup>University of Kielce, Faculty of Wydział Pedagogiczny i Przystyczny, Poland

### Abstract

The objective of the study was the analysis of measuring characteristics of the Soda Pop Test, used to evaluate hand-eye coordination on a sample of first- and second-year early childhood and preschool education female students enrolled at the Faculty of Teacher Education, branch in Petrinja (N = 55). In addition, a comparison was made of the results obtained from the sample of Croatian and Polish (N = 119) female university students with the aim to establish possible differences in test performance. The results indicated good measuring characteristics of the test thus confirming its possible implementation among university student population. Student t-test did not show any statistically significant differences between the results achieved by Croatian students as compared to those achieved by Polish students.

**Key words:** *measuring characteristics, motor control, motor skills, Soda Pop Test*

### Introduction

Hand-eye coordination is the ability needed in almost all daily activities, and it is possible that for this reason, it is not perceived as a complex action during the performance of certain motor movements. However, it is a very complex control of hand-eye coordination that requires the synergy of the nervous system in order for the eye movements to be in harmonised with hand movement or movements (Boisseau, Scherzer, & Cohen, 2002). A high level of perceptual abilities is extremely important for achieving outstanding results in sports competitions (Vuk, 2010). Vidoni, Mc Carley, Edwards, and Boyd (2009) indicated in their research that the use of gaze is specific and highly dependent on the characteristics of the task to be performed. When performing a task, the eyes focus on the target before the movement of the hands, indicating that the gaze, i.e. the eyes provide spatial information for the hands (Johanson, Westling, Böckstrom, & Flanagan, 2001). The duration of target fixation required for hand movement is variable. The eyes are sometimes completely focused on the task, until the end of its performance, and sometimes the gaze explores an object before the hand begins to manipulate it (Johanson et al., 2001). The timing of gaze movement (gaze shift) in relation to hand movements in a task that requires contacting virtual objects in a horizontal plane using a handle was investigated by Bowman, Johansson, and Flanagan (2009). They were interested whether gaze movements were predictive or triggered by tactile feedback. Based on the results, they concluded that gaze movements are predictively controlled, but also time-limited, so a mismatch between the expected and actual tactile information may prompt a realignment of gaze movements if these are performed 130 milliseconds subsequent to the contact. The ability to direct eye movements towards the hand is closely linked to a sense of proprioception with the appearance of minor errors (Ren & Crawford, 2009), which means that people with a better sense of the position of their body in space will be more successful in performing movements that require hand-eye coordination and when there is a narrowed (restricted) field of view. The relation between eye movement and hand movement in performing a rhythmic test was investigated by Lazzari, Mottet, and Vercher (2009). They confirmed that eye and hand movements are dynamically aligned during a rhythmic task for the purpose of achieving best performance. Vidoni et al. (2009) investigated oculomotor coordination and hand coordination in targeting tasks. The results showed that both systems are learned simultaneously, but performance improvements are manifested differently and depend on different elements of motor performance. Hand-eye coordination ability can be adversely affected by various factors, such as different impairments and diseases, but also by years of life (especially in precision movements), resulting in the loss of visual stimuli and their association with hand movements (Boisseau, Scherzer, & Cohen, 2002). Knowing the basics of hand-eye coordination mechanisms is very important for future early childhood and preschool teachers not only for the purpose of performing different motor movements but also for other activities dependent on this ability, such as graphomotor ability. Introducing pre-service early childhood and preschool teachers to the basics of kinesiology and simple instruments for assessing hand-eye coordination is important for the possible construction of new measuring instruments, adaptation of the existing instruments and their application in teaching practice. The aim of this paper is

therefore to introduce pre-service early childhood and preschool teachers to the Soda Pop Test measuring instrument for the assessment of hand-eye coordination, which can easily be modified for use with early childhood and preschool children, and to test its measuring characteristics. The secondary objective of this paper was to examine the possible differences in the Soda Pop Test results between pre-service early childhood and preschool education female teachers enrolled at the University of Zagreb Faculty of Teacher Education, branch in Petrinja and female students enrolled at the University of Kielce Faculty of Wydział Pedagogiczny and Przystyczny, Poland.

## Methods

### Sample

A total of 174 first- and second-year early childhood and preschool education female university students from Croatia and Poland participated in the research. The number of students enrolled at the University of Zagreb Faculty of Teacher Education, branch in Petrinja was  $N = 55$ , and the number of Polish students enrolled at the University of Kielce Faculty of Wydział Pedagogiczny i Przystyczny was  $N=119$ .

### Measure: Soda Pop Test

The Soda Pop Test is a manual dexterity test or coordination test of fine motor abilities, which involves turning over cans. The purpose of this test is to measure manual dexterity and hand-eye coordination. The full description of the test on: <https://www.topendsports.com/testing/tests/soda-pop.htm>

### Statistical analysis

The analysis and data processing was done using the computer program Statistica 13.5

### Procedure

The test was implemented during October 2019. The participants performed the test with their dominant hand and they had one trial attempt prior to testing. For the purpose of testing its measuring characteristics, in this research the Soda Pop Test was performed with three repetitions with female students in Petrinja so that its factor structure could be analysed.

## Results

Table 1. Descriptive parameters of the Soda Pop Test – students of the University of Zagreb Faculty of Teacher Education, branch in Petrinja ( $N=55$ )

Variables	M	Min	Max	SD	K-S
Soda Pop Test – dominant hand 1	8.99	6.93	14.96	1.37	$p > .20$
Soda Pop Test – dominant hand 2	8.38	6.52	12.58	1.15	$p > .20$
Soda Pop Test – dominant hand 3	8.29	6.42	12.23	1.11	$p > .20$

Legend: mean (M), minimum (Min) and maximum (Max) result, standard deviation (SD), Kolmogorov – Smirnov test (K – S)

Average results of the dominant hand in all three repetitions had very similar values. By repeating the test, the results were improved. The values obtained for other descriptive parameters were similar. The smallest dispersion of results, and hence its highest homogeneity, was achieved during the third series, which may indicate that the number of repetitions has a positive effect on the values of the results. The distribution of results was normal for all three attempts.

### Measuring characteristics of the Soda Pop Test

Table 2. Reliability of the Soda Pop Test items

	ITC	SMC	$\alpha$
Soda Pop Test, Dominant hand 1	0.73	0.57	0.87
Soda Pop Test, Dominant hand 2	0.85	0.72	0.75
Soda Pop Test, Dominant hand 3	0.73	0.60	0.85
Cronbach Alpha ( $C\alpha$ )			0.88
Average inter-item correlation			0.72

Legend: Item Total Correlation (ITC), coefficient of determination (SMC), coefficient alpha if deleted ( $\alpha$ )

The correlation values of individual items with other items are very satisfactory and range from 0.73 to 0.85. The values of the coefficient of determination indicate the existence of a common object of measurement, and alpha coefficient, after individual item deletion, contributes equally to the reliability of the test with its high values. The internal reliability coefficient of the test - Cronbach alpha ( $C\alpha$ ) is very high (0.88) as is the value of the average test item correlation (0.72), which indicates satisfactory reliability of the Soda Pop Test in this sample.

Table 3. Principal components

	(L)	%	cum %
1	2.43	80.97	80.97

Legend: Eigenvalue (L), percentage of explained variance matrix of items (%), cumulative percentage of variance (cum %)

Factor analysis of the test items yielded one characteristic root that carries more than 80% of the total variance value of the item inter-correlation matrix. The isolated factor indicates the existence of a common measurement item.

Table 4. Factor loadings (Varimax normalized)

Soda Pop Test	Item number Soda Pop Test	Factor
	1	-0.88
	2	-0.94
	3	-0.88

The values of the items projected on the factor show a very high factor saturation. On the basis of the presented results, it can be concluded that the factor structure corresponds to the hand-eye coordination factor, so the extracted factor can also be called hand-eye coordination (F1).

### Differences in the values of the results of the Soda Pop Test between Polish and Croatian female university students

The average Soda Pop Test scores of Polish and Croatian female university students are almost identical regardless of the difference in the number of participants.

Table 5. Descriptive Statistics - the sample of Polish and Croatian female university students

Variable	N	M	Mdn	Min	Max	SD	K - S
Soda Pop Test - Poland	119	8.411	8.210	6.080	14.090	1.290	$p < .10$
Soda Pop Test - Croatia	55	8.257	8.200	6.520	12.580	1.098	$p > .20$

Legend: mean (M), median (Mdn), minimum (Min) and maximum (Max) results, standard deviation (SD), Kolmogorov - Smirnov test (K - S)

Similar values were also observed for other descriptive parameters in both groups. Such values of the results show that there probably are no significant differences between Croatian and Polish female university students, which was verified by student t-test.

Table 6. T-test for Independent Samples - Croatian and Polish female university students

	M (N=119) Poland	M (N = 55) Croatia	t	df	p
Soda Pop Test - Poland vs. Soda Pop Test - Croatia	8.411	8.257	0.766	172	0.445

Legend: mean (M), t value (t), degrees of freedom (df), coefficient of significance (p)

As mentioned earlier, given the quantitative similarity of the obtained results, t - test results did not show significant differences between Croatian and Polish female university students on the Soda Pop test, which assessed hand-eye coordination.



## Discussion

Hand-eye coordination is a specific type of coordination that plays an important role in people's daily activities. In addition, the importance of hand-eye coordination has been confirmed in a number of sports such as tennis (Kulušić, Marković, & Novak, 2011), handball (Lorger, Kunješić, & Mraković, 2016), basketball (Lješević & Kvesić Tomaško, 2016) and other ball sports where appropriate estimate of the ball flight and good hand manipulation of the ball, whether it be dribbling or hitting the target, in connection to the speed factor can be one of the basic elements of winning. Successful execution of motor structures that depend on hand-eye coordination requires a high level of precision and a sense of space and time (Sekulić & Metikoš, 2007). The results obtained in this study, to the authors' knowledge, could only be compared with those of a study conducted with forty elementary school students  $M = 10.4$  (Who, 2017), where the author characterized the Soda Pop Test as a "cognitive function test". The mean results obtained in this measurement with the dominant hand are significantly better ( $M = 8.411$ , Poland and  $M = 8.257$ , Croatia) than the results obtained in the abovementioned study. This is understandable because there is a noticeable difference in age, which implies certain motor experience and the maturation of some cognitive functions on the part of female university students. Confirmation of such categorization is the fact that the sensory-perceptual system, and primarily visual abilities, are the first to participate in cognitive processing of information, with the reaction time relying on central vision being shorter than the reaction time where peripheral vision prevails (Brebner & Welford, 1980, as cited in Zanini, Trivić, & Drid, 2011). Reaction time is related to movement control and is an indicator of the speed of mental operations required in task completion (Kosinski, 2009, Luce, 1986; Weldorf, 1980, as cited in Jeronem, Barić, & Kajtna, 2010). The response time to the stimulus is faster if there is only one possible response, and slower if there are multiple response options (Schmidt & Wrisberg, 2000, as cited in Jeronem et al., 2010). Data analysis showed that success of the test performance increases with the number of repetitions (Table 1), which could be a consequence of motor learning, or better motor control of movement. It can also be a consequence of focusing attention, which can be active (concentration) and requires greater level of mental effort, both passive and non-directional (Brebner & Welford, 1980, as cited in Zanini, Trivić, & Drid, 2011). Assessment of the metric characteristics of the Soda Pop Test on a sample of female university students of the Faculty of Teacher Education showed very satisfactory properties of the test. Reliability analysis yielded high values of the Soda Pop Test reliability coefficients as well as high average correlation between test items. The projections of item values onto the factor are also extremely high, which means that the extracted factor estimates the desired object of measurement in this hand-eye coordination study. Perhaps this hand-eye coordination test should also be applied more frequently with the younger population in order to test its metric properties for a possible practical application and creation of a database which could be used for comparisons of study results on the basis of the participants' age.

## Conclusion

The applied Soda Pop Test in this study showed very satisfactory metric properties, both in item reliability and in internal reliability, therefore it is suitable for practical application. In the factor analysis one factor was extracted: hand-eye coordination. Student *t* - test did not confirm significant differences between Croatian and Polish female university students. In order for the test to be applied in practice with children, elementary and secondary school students, and for a database to be created, it is necessary to additionally assess its measuring characteristics on a younger and sufficiently large sample of respondents.

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## DIFFERENCES IN KINEMATICAL PARAMETERS BETWEEN MEN AND WOMEN IN TSUKAHARA ENTRY ON VAULT IN ARTISTIC GYMNASTICS

Lucija Miličić, Kamenka Živčić

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The purpose of this investigation was to determine kinematical differences between men and women in the first flight, Tsukahara entry on vault. The sample consisted of ten Tsukahara jumps performed by elite gymnasts (men and women) participants of the World Cup in Osijek - the FIG World Cup 2017. A sample of variables consisted of eleven kinematic variables of the first flight. Investigation was done in real-time at the competition and videotaped by three cameras. Data processing and kinematic 3D analysis were performed by the Ariel Performance Analysis System (APAS, 2016). The normality of data distribution was determined by the Shapiro-Wilk test. Differences in kinematic variables between men and women were calculated by univariate analysis of variance (ANOVA) with Bonferroni correction at the level of statistical significance  $p < 0.05$ . The results show that there is a statistically significant difference ( $p = 0.02$ ) between men and women in only one variable: angle in the left hip at first foot contact with springboard (ALHFCS) where women have a greater angle of  $10.62^\circ$  than men. This is due to the men have stronger take-off before the springboard, so the legs pass the trunk earlier, and they come sooner to the springboard, and this is the reason why angle in the hip is smaller and the trunk was in the forward bend.

**Key words:** artistic gymnastics, vault, Tsukahara entry, first flight, biomechanics

### Introduction

Men's and women's gymnastics are almost different sports because some apparatus is completely different, only the vault and the floor are constructively the same apparatus in both genders. In artistic gymnastics, most biomechanical research has been conducted on a vault regarding other disciplines because performance consists of a single movement, which is the reason why the vault is often investigated apparatus but mostly descriptive investigation (Prassas, Kwon, & Sands, 2006). Generally investigated a group of jumps on the vault are handsprings (45%), Yurchenko (10%) and Tsukahara (5%) jumps, and the reason why Tsukahara group of jumps are the least investigated is because of their complexity of performance (Fernandes, Carrara, Serrao, Amadio, & Mochizuki, 2016). The trend of jumps on vault performance was not the same thirty years ago. The most common jumps performed by the women in the 1984 Olympic Games on vault were Cuervo, Tsukahara, Yurchenko jumps (Nelson, Gross, & Street, 1985). In the last two Olympic cycles, women typically perform 51% of Yurchenko jumps, 24.5% of handsprings jumps and 24.5% of Tsukahara jumps (Schärer, Lehmann, Naundorf, Taube, & Hübner, 2019). Men dominantly perform Tsukahara jumps, 69%, then handspring jumps 19% and 12% Yurchenko jumps (Schärer, et al., 2019). The reason for this is the progression of the gymnastic elements, the change of the apparatus and finally the difficulty value of the jumps. In the period from 2008 to 2016, there was a progression in the weight, quality, complexity of the jumps in the women, where jumps from group four (Yurchenko) dominate with the highest frequency for the first jump and jumps from group five for the second jump (Yurchenko with  $180^\circ$  turn in the first flight) (Delaš Kalinski, Atiković, & Jelaska, 2017). This paper aimed to determine if there are any kinematical differences between men and women in the first flight, Tsukahara entry on vault.

### Methods

The sample consisted of 10 Tsukahara jumps performed by elite gymnasts (five men and five women) participants of the World Cup in Osijek in 2017 - the FIG World Cup 2017. Entrance to the apparatus is defined with a turn from  $\frac{1}{2}$  to  $\frac{1}{4}$  ( $90^\circ$  to  $180^\circ$ ) as Tsukahara.

The videotaping was done with three DV cameras (Sony HDR-HC9E), recording at 50 frames per second with a shutter speed of  $1/1000$  in real-time during the competition. The cameras were placed at an angle of  $45^\circ$  in the direction of the gymnasts to the axis of the apparatus, where one was placed on the competition floor at a distance of 1-2 meters, other about 5-7 meters, and the third camera also at a distance of 10-12 meters from the apparatus. Before and after shooting, for the accurate space calibration, a reference frame ( $180 \times 180 \times 180$  cm) was recorded by cameras. Kinematic analysis processed 5 men's and 5 women's jumps.

The processing and kinematic 3D analysis of the data in this study was performed by the Ariel Performance Analysis System (APAS, 2016). Videos from all three cameras are converted as Microsoft avi. uncompressed digitized video format timed for all three cameras of each jump. Further processing of the data was done through a Digitize module through the reference point of the body for each video image. 18 reference points have been identified and digitized on a 14-segment body model: feet (2), lower legs (2), upper legs (2), trunk (2), palms (2), forearms (2), upper arms and (2) head. Eight points are also digitized for each camera, which defines the calibration frame and the fixed point. Sample of the variables consisted of eleven key kinematical parameters of first flight: LLS - length of the last step (cm), ALHFCS - angle in the left hip at first foot contact with springboard (°), ARHFCS - angle in the right hip at first foot contact with springboard (°), ALKFCS - angle in the left knee at first foot contact with springboard (°), ARKFCS - angle in the right knee at first foot contact with springboard (°), TTOFF - duration of the take-off (s), ACGLCS - a center of gravity angle of the body in the last contact with the springboard (°), ALSLCS - angle at the left shoulder in the last foot contact with the springboard (°), ARSLCS - angle at the right shoulder in the last foot contact with the springboard (°), HVCGLCF - horizontal velocity of the center of gravity at the last foot contact with the floor (m/s), VVCGLCS - vertical velocity of the center of the gravity at the last contact with the springboard (m/s).

The normality of data distribution was determined by the Shapiro-Wilk test. The homogeneity of the variance was calculated by Levene's test. Differences in kinematic variables between men and woman were calculated by univariate analysis of variance (ANOVA) with Bonferroni correction at the level of statistical significance  $p < 0.05$ .

## Results

Results of the basic descriptive statistics are shown in Table 1.

Table 1. Basic descriptive statistics

Variable	MeanM	MeanW	MinM	MinW	MaxM	MaxW	Std.Dev.M	Std.Dev.W
LLS	289,17	284,77	258,56	268,80	334,11	299,77	37,37	14,15
ALHFCS	104,22	114,84	96,23	104,68	109,19	121,10	5,07	6,62
ARHFCS	110,12	107,68	102,44	97,72	124,65	114,99	8,80	6,99
ALKFCS	152,06	160,34	148,45	148,99	162,09	168,53	5,81	7,41
ARKFCS	156,41	158,67	148,90	156,31	165,90	164,62	7,02	3,43
TTOFF	0,40	0,42	0,14	0,14	0,58	0,62	0,23	0,26
ACGLCS	76,20	82,20	67,00	78,00	83,00	85,00	6,14	2,77
ALSLCS	123,68	122,46	100,09	117,24	141,99	126,29	17,51	3,27
ARSLCS	150,74	135,52	135,76	127,46	167,98	151,85	14,18	9,83
HVCGLCF	8,11	6,58	6,49	5,02	9,21	8,02	1,03	1,41
VVCGLCS	3,46	3,82	2,95	3,19	4,09	4,67	0,44	0,63

Note: MeanM – average values for men; MeanW – average values for women; MinM – minimum values for men; MinW – minimum values for women; MaxM – maximum values for men; MaxW – maximum values for women; Std.Dev.M – Standard Deviation form men; Std.Dev.W – Standard Deviation for women.

Shapiro-Wilk test shows that variable (TTOFF) is not normally distributed. Levene test of the homogeneity of the variance between two populations – men and women have shown that variances of variables LLS,  $p = 0,00$  and ALSLCS  $p = 0,00$  are not homogeneous.

Table 2 shows the results of the Welch test and there are no significant differences between the men and women for variables LLS,  $p = 0,82$  and ALSLCS,  $p = 0,58$  at the level of statistical significance  $p < 0,05$ .

Table 2. Welch test – analyses of variances between men and women

Variable	SS Effect	df Effect	MS Effect	SS Error	df Error	MS Error	F	p	Welch df Effect	Welch df Error	Welch F	Welch p
LLS	48,40	1	48,40	6386,76	8	798,34	0,06	0,81	1	5,12	0,06	0,82
ALSLCS	3,67	1	3,67	1269,91	8	158,74	0,02	0,88	1	4,28	0,02	0,89

Note: Welch p = statistically significant value,  $p < 0,05$

Results of Anova test (Table 3), indicate that there is a statistically significant difference between men and women in the variable ALHFCS,  $p = 0,02$ .

Table 3. One-Way Anova test between men and women

Variable	Multiple R	Multiple R <sup>2</sup>	Adjusted R <sup>2</sup>	SS Model	df Model	MS Model	SS Residual	df Residual	MS Residual	F	p
ALHFCS	0,71	0,50	0,44	282,08	1	282,08	278,02	8	34,75	8,12	0,02*
ARHFCS	0,17	0,03	-0,09	14,94	1	14,94	504,70	8	63,09	0,24	0,64
ALKFCS	0,57	0,33	0,24	171,15	1	171,15	354,89	8	44,36	3,86	0,09
ARKFCS	0,22	0,05	-0,07	12,84	1	12,84	244,03	8	30,50	0,42	0,53
ACGLCS	0,58	0,33	0,25	90,00	1	90,00	181,60	8	22,70	3,96	0,08
ARSLCS	0,57	0,33	0,24	579,12	1	579,12	1190,68	8	148,83	3,89	0,08
HVCGLCF	0,57	0,33	0,24	5,87	1	5,87	12,16	8	1,52	3,86	0,09
VVCGLCS	0,34	0,12	0,01	0,32	1	0,32	2,39	8	0,30	1,07	0,33

Note: \*= statistically significant value, p<0,05

The results of the Mann-Whitney U Test shown in Table 4 indicate that there is no statistically significant difference between men and women in the variable TTOFF, p=0.39,

Table 4. Mann-Whitney U test between men and women

Variable	Rank Sum 1	Rank Sum 2	U	Z	p-value	Z adjusted	p-value	Valid N 1	Valid N 2	2*1sided exact p
TTOFF	23	32	8	-0,84	0,40	-0,87	0,39	5	5	0,42

## Discussion

The results show that there is a statistically significant difference between the men and women in only one variable: angle in the left hip at first foot contact with springboard (ALHFCS) where women have a greater angle of 10.62° than men. The difference of 2.44° for the same variable on the right (ARHFCS) in favor of the men is not statistically significant. This kind of arrival on the springboard since men have a stronger take-off before the springboard, and the legs pass the trunk earlier, and they come sooner to the springboard, so the angle in the hip is smaller and the trunk in the forward bend. This was due to the higher velocity of run-up but also to the higher explosive properties of the lower extremities in the men. Men had a different technique with the smaller angle of the first flight where they arrived earlier than the women, and take-off from the springboard consequently lasted shorter. In women (juniors) during the first phase, the acceleration of the angle in the hips for the piked Tsukahara is 17.09 m/s<sup>2</sup> (Dimitrova, Bonka Tankusheva, & Petrova, 2015). Although there is no statistically significant difference between the men and women in the variable last step length (LLS), men have a longer last step than women by 4.4 cm. The difference can be attributed to the length of the foot and the velocity of run-up. Usually, a last step before the springboard is made from a distance of 2.30 to 2.80 m (Antonov, 1975; Semenov, 1987; Živčić Marković & Krističević, 2016) and also was recorded from 2.80 to 3.50 m (Čuk & Karacsony, 2004). In this study, the maximum length of the last step was 3.34 m in the men and 2.99 m in the women, so it can be concluded that the increase in the length of the last step comes together with the development of the gymnastics. There is also no statistically significant difference between the men and women in the center of gravity angle of the body in the last contact with the springboard (ACGLCS), although in the women the angle is greater by 6°. The result indicates that the women had a stretched body in the first flight to the apparatus. The men had a smaller angle in their hips which mean that they were in forward bent to the apparatus in the first flight. The reason for this result can be that over the years changes in the rules and training technologies, the gender angle is slowly being equalized. Given the results, the gymnasts were stagnating in this part, so they did not change their technique. The variable distance between the hands in the first contact with the apparatus (UDLPKS) did not show statistically significant differences between the men and women, although the men put their palms on average 9.56 cm wider than the women. Kerwin, Harwood, & Yeadon, (1993) studied the effects of two different techniques (at the beginning and the end) of placing the hands on the apparatus when performing Tsukahara and Kasamatsu jumps, but on the old vault horse, and the results showed that the technique of placing the palms at the end of the horse is safer, but it reduces the linear speed in the second flight and does not increase rotation. Although this research was carried out on an old horse where the men's apparatus was turned by length and in women's by width, and the distance between the palms was different and larger in men because of the apparatus. There is no statistically significant difference between men and women in the variable duration of the take-off (TTOFF), although the take-off is shorter by 0.02 seconds in the men. The shorter time on the springboard in men's resulted from a more explosive take-off than women. Take-off from the springboard is a key part of the jump, where the gymnasts must convert linear running momentum to the appropriate angular momentum ratio required for a successful jump (Greenwood & Newton, 1996). The angle at the left shoulder in the last foot contact with the springboard (ALSLCS) is 1.22° bigger at the men, while for the right shoulder (ARSLCS) the angle is bigger by 15.22° for the men and is also

not statistically significant. This is in support of the fact that the men put their palms on the apparatus faraway than the women, especially the right palm, so this is the reason why is the shoulder angle bigger. The horizontal velocity of the center of gravity at the last foot contact with the floor (HVCGLCF) is 1.63 seconds slower in the women, which means that men are faster. And this can be explained by the transfer of running velocity from the run-up where men were faster than women and thus lost less speed in the last step. For the Kasamatsu and Tsukahara jumps, the horizontal velocity of the center of gravity decreases, the vertical velocity of the center of gravity increases and the angular momentum develops at the moment of contact with the springboard (Fernandes, et al., 2016; Motoshima & Maeda, 2015).

## Conclusion

Obtained results showed that there are similarities in kinematic parameters between men and women in the variables: the length of the last step, which differs them by only 4cm and did not statistically significant; the last contact of the foot with the springboard where the women had a 6° greater angle. Although there are differences in some variables in favor of men but not statistically significant, they cannot be considered as differences. Although the sample of gymnasts is specific and small, when we take into account the frequency of performance of Tsukahara jumps in women and competitive conditions. This information can help coaches and gymnasts as essential information for further progress and greater representation of Tsukahara jumps in women's gymnastics.

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## KINEMATIC CHARACTERISTICS OF 60M HURDLE RUNNING IN YOUTH ATHLETES

Melis Mladineo Brničević<sup>1</sup>, Lidija Vlahović<sup>2</sup>

<sup>1</sup>University of Split, Faculty of Law, Croatia

<sup>2</sup>University of Split, Faculty of Humanities and Social Sciences, Croatia

### Abstract

The purpose of this research is to determine the main kinematic parameters of 60 meters hurdler running in both male and female youth athletes. Also, the aim was to define differences between genders. Therefore, 5 male and 10 female athletes aged 11-12 years were measured. According to statistical method ANOVA, there is a statistically significant difference between male and female young athletes with p level 0,05. It is shown that male athletes have greater values in time variables of 60 meter running, running on the first, third, fourth and fifth hurdle. Also, in the kinematic variables before the hurdle, above the hurdle and behind the hurdle, there are statistically significant differences in values of horizontal velocity (VH), swing leg angle, body lean above the hurdle, and the angle of the swing leg in the hip and angle of the swing leg in the knee behind the hurdle. Based on the obtained results male athletes have achieved better running times in 60 meters hurdle running, which is logical considering that in this age they are more powerful than girls. To assess kinematic parameters, we have used the following equipment: six sets of photo cells, Opto jump, electronic starting block and movement structure analysis software by Kinovea.

*Key words: gender, male, female, young athletes, hurdle running*

### Introduction

Quality and efficacy of sports performance on hurdle running is built on stable running rhythm between the hurdles, speed of hurdle clearance and rational technique and optimal hurdle clearance in the race, specific sprint endurance and the ability to maintain maximal velocity in performance. Hence, it is necessary to apply biomechanical aspect for reliable and accurate information which can be used as a model for further training processes. Implementing biomechanical methods and aspects in hurdle running can be used as an optimal model for youth athletes to compare future obstacles on their path for achieving better results in older competitive categories. Previous researches are mostly based on senior hurdle runners (Ecker, 1985; Winckler, 1994; Hay, 1993); Čoh and Dolenc, 1996; Čoh et al., 1998; Gonzales, et al., 2008). Also, there are many researches based on young hurdle runners (Bujak, 2011; Otsuka, et al., 2010) examined effect of different distances between hurdles on the results of 60m hurdle running in sixth grade students. The main purpose of this study was to determine some kinematic parameters in athletics discipline of 60m hurdle running and to examine differences between youth male and female athletes in some parameters.

### Methods

For this research, 5 active male and 10 active female youth competitors aged 11 and 12 were measured. All examinees were tested in 60m hurdle running two times in the same conditions. Each attempt in this research was observed as an examinee. Total of 18 variables was observed; 12 variables which describe movements before the hurdle, above the hurdle and behind the hurdle, and 6 time variables (total time and time on each 5 hurdles).

### Results and discussion

Table 1 implicates main descriptive kinematic parameters (arithmetic mean, min and max results) for both genders of youth athletes. All variables have normal distribution. There can not be a comparison with other data; as far as the authors are aware, there are no similar studies in the younger age group of respondents.



Table 1. Main descriptive kinematic parameters for male and female youth athletes on 60 m hurdle running

Variables	FEMALE ATHLETES			MALE ATHLETES		
	AM	MIN	MAX	AM	MIN	MAX
<b>Hurdle (1-5)</b>						
<b>Before hurdle</b>						
Hight of centre of mass (CM)	100.88	96.88	103.16	101.54	98.27	103.03
Take off leg distance from hurdle	161.27	145.03	173.80	167.28	146.94	182.60
Take off angle	9.97	7.93	11.20	11.06	8.50	11.40
<b>Above hurdle</b>						
Horizontal velocity	4.95	4.53	5.69	5.29	4.83	5.43
Vertical velocity	-2.21	-2.64	-1.91	-1.97	-2.34	-1.87
Leaning of the body	46.51	36.54	55.80	46.54	34.24	48.60
Angle of swing leg (knee)	159.07	141.02	168.40	160.26	144.46	163.60
Hight of centre of mass (CM)	119.68	114.58	123.28	120.19	115.38	122.67
<b>After hurdle</b>						
Swing leg distance from hurdle	128.47	110.48	137.20	127.60	100.00	132.60
Angle of swing leg (hip)	60.97	42.88	82.00	51.24	32.72	52.80
Angle of swing leg (knee)	60.02	37.49	72.60	73.98	40.88	79.00
Take off angle of swing leg	62.92	58.12	67.00	67.06	59.28	70.60

AM (arithmetic mean), MIN (sample minimum), MAX (sample maximum)

The results of the variance analysis of the Running time variables (Table 2) indicate that male athletes differ significantly from female athletes in the following variables: score at 60 meters, running time on first hurdle, running time on fourth and fifth hurdle. It does not differ significantly in the variables of running time on the second hurdle. Male athletes have achieved better times in the specified variables.

Table 2. Analysis of variance (running time) between youth male and female athletes

Variables	AM(F)	AM(M)	F <sup>A</sup>	p <sup>A</sup>
Result on 60m hurdle run	10.98	10.34	11.21	0.00
Running time to the first hurdle	2.77	2.65	7.13	0.01
Running time to the second hurdle	1.33	1.30	1.28	0.27
Running time to the third hurdle	1.32	1.25	4.06	0.05
Running time to the fourth hurdle	1.31	1.23	6.25	0.02
Running time to the fifth hurdle	1.34	1.27	4.03	0.05

AM (arithmetic mean), F<sup>A</sup> – F-test for ANOVA, p<sup>A</sup> – significance level

The results of the analysis of the variance of kinematic parameters (before, above and after the hurdle) indicated that boys differ from girls in the following variables: Horizontal speeds above the hurdle, forward lean of the body above the hurdle, angle of swing leg in the hip behind the hurdle and angle of knee behind hurdle. Similar studies were carried out on the senior hurdlers (Čoh and Iskra, 2012; Krzeszowski et al., 2016).

According to the results shown in Table 3 and Table 3a., statistically significant differences are observed, which are manifested according to the difference values on the first hurdle in the variables of the horizontal and vertical speed of the body mass centre, the forward lean of the body above the hurdle, the distance of the Swing the leg from the hurdle, the angle of the swing leg in the hip and the angle of take off leg behind the first hurdle. Male athletes achieved higher values of horizontal velocity, had less distance values of the swing leg of the hurdle and a smaller angle of the swing leg in the hip, as well as a larger angle of take off with a swing leg than female athletes. On the second hurdle there were significant differences in vertical speed, forward lean of the body above the hurdle and angle of the swing leg in the hip and angle of the swing leg in the knee behind the hurdle.

Cadets had higher values of the forward lean of the body above the hurdle. The angle of the swing leg in the hip behind the hurdle is smaller in the male athletes, while the angle of the swing leg in the knee is smaller in young female athletes.

On the third hurdle the younger male athletes differ significantly from the female athletes in the variable of horizontal velocity of CM (higher values in the male athletes) and all the angles behind the hurdle (lower values younger male athletes have in the angle of the swing legs in the hip, and the higher values in the angle of the swing leg in the knee and the angle of take off leg than female athletes).

Analyzing the differences in the fourth hurdle can be determined that statistically significant differences have been achieved in only two variables (younger male athletes have a smaller angle of the swing leg in the hip and a larger angle of take off swing leg). On the fifth hurdle, the male athletes and female athletes differ significantly in the variables of the horizontal velocity of CM, the forward lean of the body above the hurdle, the angle of the swing leg in the hip and the angle of the swing leg in the knee behind the hurdle. The male athletes also achieved higher values of the horizontal velocity of CM than female athletes. As well male athletes have higher angle values of swing leg in the knee. Female athletes had higher values of the angle of the swing leg in the hip than male athletes.

Table 3. ANOVA kinematic variables (variables before, above and after hurdle)

Variables	1. hurdle				2. hurdle				3. hurdle			
	AM(F)	AM(M)	F <sup>A</sup>	p <sup>A</sup>	AM(F)	AM(M)	F <sup>A</sup>	p <sup>A</sup>	AM(F)	AM(M)	F <sup>A</sup>	p <sup>A</sup>
<b>Before hurdle</b>												
Hight of centre of mass (CM)	100.71	100.52	0.04	0.84	100.80	100.32	0.24	0.63	101.22	100.98	0.06	0.81
Take off leg distance rom. hurdle	161.15	168.70	2.73	0.11	162.50	164.80	0.17	0.68	162,90	163.90	0.03	0.86
Take off angle	9.65	8.50	1.68	0,21	9.45	9.00	0.60	0.44	10,00	10.40	0.74	0.40
<b>Above hurdle</b>												
Horizontal velocity	5.28	5.74	20.07	0.00	4.95	5.16	1.88	0.18	4,80	5.22	8.89	0.01
Vertical velocity	-2.12	-1.92	2.67	0.11	-2.24	-2.05	2.13	0.16	-2,18	-2.07	1.35	0.26
Leaning of the body	45.70	38.20	6.50	0.02	46.65	42.40	1.95	0.17	46,70	42.50	2.04	0.16
Angle of swing leg (knee)	159.10	156.30	0.64	0.43	159.00	158.70	0.01	0.94	160,15	157.80	0.36	0.55
Hight of centre of mass (CM)	119.31	118.08	0.80	0.38	119.53	117.86	1.12	0.30	119,79	118.97	0.39	0.54
<b>After hurdle</b>												
Swing leg distance from hurdle	128.40	121.00	3.80	0.06	124.50	119.50	1.28	0.27	125,25	121.40	0.86	0.36
Angle of swing leg (hip)	56.40	41.60	11.83	0.00	58.45	42.60	11.70	0.00	58,50	42.80	5.94	0.02
Angle of swing leg (knee)	58.45	71.40	15.53	0.00	56.45	66.10	2.59	0.12	55,00	70.40	6.19	0.02
Take off angle of swing leg	62.60	65.40	4.03	0.05	62.70	68.20	10.05	0.00	62,10	67.60	9.90	0.00

AM (arithmetic mean), F<sup>A</sup> – F-test for ANOVA, p<sup>A</sup>– significance level

Table 3a. ANOVA kinematic variables (variables before, above and after hurdle)

Variables	4. hurdle				5. hurdle			
	AM(F)	AM(M)	F <sup>A</sup>	p <sup>A</sup>	AM(F)	AM(M)	F <sup>A</sup>	p <sup>A</sup>
<b>Before hurdle</b>								
Hight of centre of mass (CM)	100.99	100.61	0.17	0.68	100.68	101.19	0.20	0.66
Take off leg distance from.hurdle	161.55	162.20	0.01	0.92	158.25	168.50	2.73	0.11
Take off angle	9.80	10.70	1.69	0.20	10.95	11.20	0.19	0.67
<b>Above hurdle</b>								
Horizontal velocity	4.94	5.11	1.65	0.21	4.80	5.07	5.92	0.02
Vertical velocity	-2.25	-1.97	9.00	0.01	-2.28	-2.11	1.97	0.17
Leaning of the body	46.50	41.30	5.33	0.03	47.00	45.50	0.19	0.67
Angle of swing leg (knee)	158.35	155.30	0.41	0.53	158.75	157.50	0.10	0.75
Hight of centre of mass (CM)	119.41	118.72	0.28	0.60	120.36	120.79	0.09	0.76
<b>After hurdle</b>								
Swing leg distance from hurdle	127.15	125.80	0.09	0.77	137.05	124.30	5.01	0.03
Angle of swing leg (hip)	63.25	44.40	17.16	0.00	68.25	49.40	9.95	0.00
Angle of swing leg (knee)	60.15	75.80	16.42	0.00	70.05	71.60	0.05	0.83
Take off angle of swing leg	63.50	64.90	0.81	0.38	63.70	67.60	4.74	0.04

AM (arithmetic mean), F<sup>A</sup> – F-test for ANOVA, p<sup>A</sup>– significance level

In the hurdle running it is important that the athlete does not lose speed. Because of the loss of rhythm or shortening, as well as the prolongation of the strides, there is a decrease in speed when clearing the hurdle, and thus the time achieved on the hurdle is slower. Variables that represent angular relationships between parts indicate that optimum angles allow for good balance and timely reactions of certain muscle groups when clearing the hurdle.

The larger angle, i.e. the more vertical position of the body above the hurdle, distorts the balanced position of the body and creates greater resistance when passing- running over the hurdle which ultimately disrupts the favorable rhythm and preparation for the continuation of the running.

Male athletes have achieved better (faster) time in the running variables, which is understandable considering that in this age they are more powerful than girls. In addition, female athletes have more optimal angular relations above and beyond the hurdles for reasons and have better mobility in joints especially in the hip than male athletes. The resulting differences point to certain particularities among young male and female athletes in the hurdler run. This is of utmost importance due to the understanding of the technique of hurdle running in all stages of the race, and also because of the development of certain motor skills during the training process.

## Conclusion

The study was conducted in order to determine the basic kinematic parameters of 60m hurdle running in both male and female youth athletes. Also the goal was to identify differences in the mentioned parameters between the sexes. A total of 5 male athletes and 10 female athletes aged 11 and 12 years were measured for this purpose. Basic descriptive parameters of all applied variables were determined, however, it was not possible to compare them due to a lack of research on a similar population. Analysis of variance determined that there was a statistically significant difference in the kinematic parameters between youth athletes.

Male athletes have a statistically better value than female athletes, especially in the variables of time and in the score of 60 meters, the duration of running on the first hurdle, the running time on the fourth and fifth hurdles. While in the variables of the transition over the hurdles, statistically Significant differences were achieved in values of the horizontal velocity of CM, the angle of the swing leg in the knee, the trunk leaning above the hurdle and the angle of the swing leg in the hip and angle of the swing leg in the knee behind the hurdle. During the measurement implementation all subjects were active competitors in Discipline 60 meters hurdles. The results obtained can be good guidelines for planning and programming of training processes, as well as for better implementation of selection in younger age categories. The indicative values of kinematic parameters for this younger age category are also obtained, which will certainly serve in the practice of hurdles running.

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## ANALYSIS OF VARIABILITY OF LUMBAR SPINE MOBILITY DURING RAISING AN OBJECT

**Catalin Popa, Eduard Robert Sakizlian, Doina Miron, Oana Alis Sandu, Mihnea Marin,  
Mihai Robert Rusu, Ligia Rusu**

*University of Craiova-Sport Medicine and Physical Therapy Department, Romania*

**Introduction:** Analysis of the lumbar spine represents an element in designing and improving the program for good posture and physical therapy management. That's why a real analysis for specific activities could improve the spine balance and help to design the specific exercises (Tarnita et.al, 2016). To understand the functional aspects of the lumbar spine kinematic, is a challenge, because the spine balance and alignment are influenced by inter-related factors. The **purpose** of this research is to make the measurement of lumbar spine mobility during the activity of raising an object, with a view to offer information about interactions between mobility - muscle activity.

**Methods:** The biomechanical analysis has been made with VICON - complex system of capture and image processing, in the Laboratory of Innovative Processes and Techniques in Bioengineering - Research Infrastructure in Applied Sciences – INCESA - University of Craiova. Markers were applied at every level of the spine and 3 angles were defined and measured during the activity of raising an object, in 4 positions: u11-between T12(thoracic 12) and L2(lumbar 2) around L1(lumbar1); u12-between L1 and L3(lumbar 3), around L2; u13-between L2 and L4, around L3.

**Results:** an amplitude of 92.41degree for position1, 39.56degree for position 2, 19.65degree for position 3, 95.35degree for position 4, average value for all three angles being closed to the same value 175degree; maximum mobility was at L2-L4 segment, but the difference from maximum and minimum values is on angle u11, and is 1,82degree from position 1 to position 4. The amplitude is high on first segment of the lumbar spine, because is possible to have an interaction between trunk strength and sagittal lumbar mobility of the spine.

**Conclusions:** Biomechanical analysis of spinal mobility for each segment could give information about interactions mobility - muscle activity, during specific activities, helping the physician to design the protocols for evaluation and estimating the point of maximal overuse at spine.

*Key words: spine, biomechanic, mobility*

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## DIFFERENCES IN SOME KINEMATIC PARAMETERS IN PASSING THE BALL WITH THE DOMINANT AND NON-DOMINANT HAND IN BASKETBALL

Tomislav Rupčić, Stipe Čubrić, Damir Knjaz

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

Catching and passing the ball represent the basic elements of basketball technique. According to the structural analysis of the basketball game, there are four basic passing techniques, namely: chest pass, overhead pass, push pass and baseball pass. The aim of this paper is to determine whether there are statistically significant differences in the observed kinematic parameters in passing the ball between the dominant and non-dominant hand. The analysis of parameters was performed on 11 Croatian basketball players (age:  $18.36 \pm 0.67$  years old; height:  $192.32 \pm 9.98$  cm; weight:  $83.35 \pm 11.19$  kg; body fat percentage:  $15.00 \pm 4.40\%$ ; arm span:  $194.34 \pm 10.39$  cm). The observed variables in the study were measured using the Xsens Awinda kinematic system and the Stalker ATS 2 ball speed measurement system. The results of the analysis of variance showed that there is a statistically significant difference between passing the ball with the dominant and non-dominant hand ( $F = 4090.07$ ;  $p = 0.00^*$ ).

**Key words:** Xsens, kinematic analysis, passing accuracy

### Introduction

Basketball belongs to the group of complex sports that are composed of simple and complex movements in the game with and without the ball, and in terms of cooperation between team members during the game (Matković et al., 2005).

The technique of catching and passing the ball is also included in the group of technical elements that the player performs with the ball. The basketball passing technique is a rational, economical, rhythmic movement that allows players to solve different situations on the court during the game (Knjaz, Matković, Janković, 2012).

Passing the ball refers to directing the ball to a teammate, and according to the structural analysis of basketball, there are four basic passing techniques, namely: chest pass, overhead pass, push pass and baseball pass. Although catching and passing the ball are basic basketball elements in the player training process, too little of the training process is dedicated to perfecting them. The duration of the offense and the number of passes, as technical-tactical parameters of the game, are one of the indicators of success in basketball because they significantly affect the form of the offense. The use of longer offense with a larger number of passes has a positive effect on achieving the position of the shot closer to the basket and, therefore, greater performance (Gomez et al. 2007). The technical element of passing is one of the key tactical tools in resolving situations in offense (Selmanović, 2015). Examining different passing techniques, the authors agree that chest pass is the basic and most common way of passing in basketball, followed by bounce pass, overhead pass and baseball pass (Theoharopoulos et al., 2010). In order for each of the above passes to be maximally situationally efficient, they must be technically correct. This implies that certain kinematic parameters are in the optimal ratio. Kinematic analysis can directly determine the correct movement and the impact of proper technique on the passing accuracy (McClay, 1994). Based on 33 randomly selected NCAA final tournament games in the season 2012, it was determined that fewer passes during the offense ultimately have a higher probability of a positive outcome. However, it is important to mention that teams that had fewer passes during offensive actions had a very high percentage of passing accuracy. This indicates the fact that quality technical performance of passing significantly affects the situational efficiency, so it is very important to develop the correct technique of different types of passing the ball in the process of training young players (Swalgin, 2014). Each pass must be precise, strong, timely, performed with a structure i.e., the type of pass that is most appropriate to the current situation on the field and directed to the player who is in the most favourable position for further development of the action. When performing a one-handed pass, the emphasis must be on the correct performance with the dominant, but also non-dominant hand. In the younger age categories, there is an extremely large difference in the quality of passing performance when comparing the dominant and non-dominant hand. If the passing technique is not adopted in the correct way in the younger categories, the assumption is that this shortcoming will also manifest in the senior age.

The aim of this paper is to determine whether there are differences in some kinematic parameters in passing the ball with the dominant and non-dominant hand in U18 basketball players who are assumed to have already automated proper movement with both hands with a high percentage of accuracy.



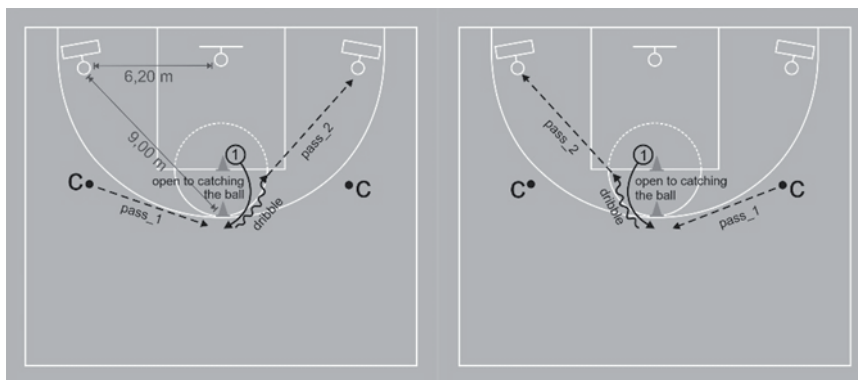
## Methods

**Sample of subjects:** The analysis of parameters was performed on 11 Croatian basketball players (age:  $18.36 \pm 0.67$  years old; height:  $192.32 \pm 9.98$  cm; weight:  $83.35 \pm 11.19$  kg, body fat percentage:  $15.00 \pm 4.40\%$ ; arm span:  $194.34 \pm 10.39$  cm). Each subject performs 6 passes with the dominant and non-dominant hand. The total number of measured passes performed with each hand was 66. Due to some technical issues with equipment and incorrect data, 9 passes with each hand were not included for further analysis. Subjects were informed about the purpose and protocol of the research and voluntarily agreed to participate in the research.

**Variables:** The observed variables during passing the ball with the dominant and non-dominant hand are: maximum angular velocity in the shoulder joint when passing the ball with the dominant hand (Angular\_SH\_D), maximum angular velocity in the shoulder joint when passing the ball with the non-dominant hand (Angular\_SH\_N), maximum angular velocity in the elbow joint when passing the ball with the dominant hand (Angular\_EB\_D), maximum angular velocity in the elbow joint when passing the ball with the non-dominant hand (Angular\_EB\_N), maximum angular velocity in the wrist when passing the ball with the dominant hand (Angular\_WR\_D), maximum angular velocity in the wrist when passing the ball with the non-dominant hand (Angular\_WR\_N), maximum ball speed when passing the ball with the dominant hand (Radar speed\_D), maximum ball speed when passing the ball with the non-dominant hand (Radar speed\_N), accuracy points when passing the ball with the dominant hand (Accuracy p\_D), accuracy points when passing the ball with the non-dominant hand (Accuracy p\_N).

**Measurement protocol:** The observed variables were measured using the Xsens Awinda kinematic system. The system consists of 17 sensors that measure spatial-temporal parameters. The installed measuring device does not affect the motor performance of the basketball element. Sensor calibration is performed immediately after all sensors are installed according to the manufacturer's defined instructions (Xsens Technologies). Research conducted by Cutti et al. (2008) confirms the reliability of the measuring device for measuring the stated kinematic parameters. The ball speed was measured using the Stalker ATS 2 system. The reliability of this device in the field of sports has been confirmed by the research of Okorooha et al. (2019). Subjects underwent a standardized warm-up that included a three-minute run and general preparatory exercises, followed by a specific warm-up with a basketball. Before the start of the test, two basketball players with a ball were placed on the left and right sides of the set polygon and they passed the ball to the test subject. After the start signal, the subject runs in a semi-circular motion to the top of the three-point line where he uses a one-two stopping technique. After receiving the ball, he performs one dribble and a penetration in the same direction towards the basket, and by performing the technique of one-handed push pass, he pushes and directs the ball towards the defined target. After performing the pass, the subject repeats the same task on the other side. The target on which the hoop is placed is at a height of 1.30 m from the ground and 6.20 m away from the basket. The entire performance of the test was recorded with a Panasonic GH5 video camera, and an additional video camera was placed next to each target to further verify the points awarded for each pass. Each pass was scored as follows:

- 8 points were awarded for a pass that hit the target without touching the hoop.
- 6 points were awarded for a pass that hit the target with one touch of the hoop.
- 4 points were awarded for a pass that hit the target with more than one touch of the hoop.
- 2 points were awarded for a pass that did not hit the target but touched the hoop.
- No points were awarded for a pass that neither hit the target nor touch the hoop or the subject did not make a pass with the given technique.



Figures 1 and 2. Demonstration of performing the one-handed push pass to the dominant and non-dominant side.

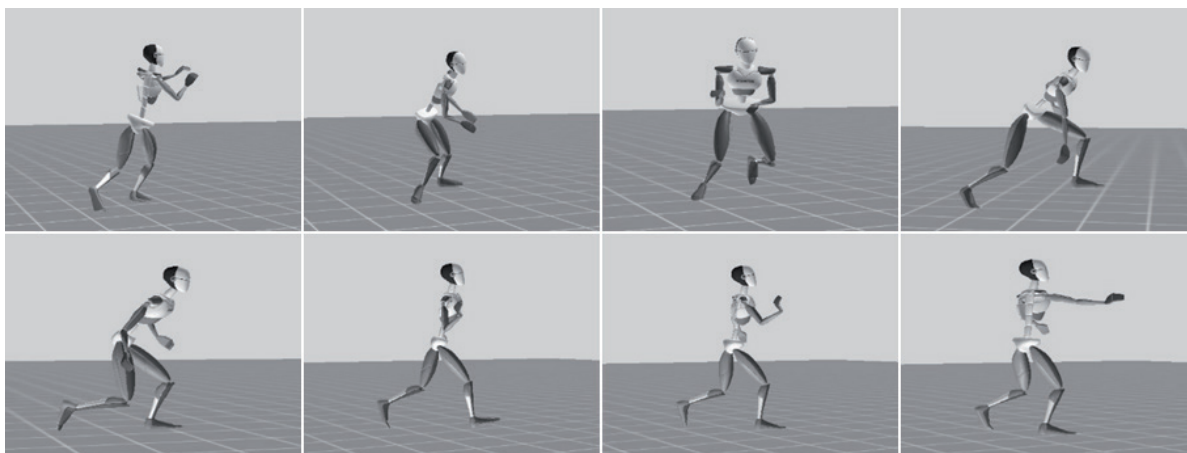


Figure 3. Kinogram from the point of receiving the ball to the release from the wrist.

**Data processing methods:** The collected data were processed using the statistical program Statistica 13.4. The Shapiro-Wilk test was used for the purpose of testing the normality of the distribution in all observed variables. Basic descriptive statistical indicators of variables (arithmetic mean, minimum, maximum, standard deviation) were calculated. Multivariate analysis of variance (MANOVA) was used to determine the significance of the differences between passes with the dominant and non-dominant hand.

## Results

Table 1. Basic descriptive indicators in the observed variables in the one-handed push pass technique (the dominant and non-dominant hand)

Variable	N	Mean	Minimum	Maximum	Std.Dev.
Angular_SH_D	57	804,41	461,89	1313,97	200,13
Angular_SH_N	57	658,36	398,63	1169,66	153,81
Angular_EB_D	57	1348,92	884,77	1811,54	192,60
Angular_EB_N	57	1180,36	982,71	1513,56	126,92
Angular_WR_D	57	1604,03	521,33	4274,68	852,14
Angular_WR_N	57	1458,80	436,90	4476,40	669,55
Radar speed_D	57	44,75	38,00	56,00	4,01
Radar speed_N	57	40,01	33,70	49,00	3,00
Accuracy p_D	57	3,33	0,00	8,00	2,86
Accuracy p_N	57	2,28	0,00	8,00	2,66

Legend: Angular\_SH\_D - maximum angular velocity in the shoulder joint when passing the ball with the dominant hand; Angular\_SH\_N - maximum angular velocity in the shoulder joint when passing the ball with the non-dominant hand; Angular\_EB\_D - maximum angular velocity in the elbow joint when passing the ball with the dominant hand; Angular\_EB\_N - maximum angular velocity in the elbow joint when passing the ball with the non-dominant hand; Angular\_WR\_D - maximum angular velocity in the wrist when passing the ball with the dominant hand; Angular\_WR\_N - maximum angular velocity in the wrist when passing the ball with the non-dominant hand; Radar speed\_D - maximum ball speed when passing the ball with the dominant hand; Radar speed\_N - maximum ball speed when passing the ball with the non-dominant hand; Accuracy p\_D - accuracy points when passing the ball with the dominant hand; Accuracy p\_N - accuracy points when passing the ball with the non-dominant hand

As can be seen from the descriptive indicators shown in Table 3, the average value of the maximum angular velocity in the shoulder joint of the dominant hand (804.41°/s) is higher than the recorded angular velocity in the shoulder joint of the non-dominant hand (658.36°/s). In further analysis, it can be seen that basketball players achieve higher values of angular velocities in the elbow joint of the dominant hand (1348.92°/s) compared to the elbow joint of the non-dominant hand (1180.36°/s) when performing a passing technique. Also, a higher average value of the maximum angular velocity is visible in the wrist of the dominant hand (1604.03°/s) although the difference is not statistically significant. The recorded ball speed shows that the basketball players achieve higher values (44.75°/s; 40.01°/s) in the observed variable when using the dominant hand. Moreover, by analysing the results obtained in the variables Accuracy p\_D and Accuracy p\_N, it can be noticed that basketball players are more precise when passing the ball with the dominant hand (3.33) compared to passing the ball with the non-dominant hand (2.28).

Table 2. MANOVA results in the observed groups

Test	Value	F	p
Wilks	0,01	4090,07	0,00*

\* level of significance  $p < 0.05$ 

The results of the variance analysis in Table 1 show a statistically significant difference in the observed variables between passing the ball with the dominant and non-dominant hand ( $F = 4090.07$ ;  $p = 0.00^*$ ).

Table 3. ANOVA results for all observed variables

Variable	F	p
Angular_SH	19,08	0,00*
Angular_EB	30,44	0,00*
Angular_WR	1,02	0,31
Radar speed	51,23	0,00*
Accuracy points	4,14	0,04*

\* level of significance  $p < 0.05$ 

The results shown in Table 2 indicate that there is a statistically significant difference in the variables Angular\_SH and Angular\_EB ( $p = 0.00$ ). Furthermore, a statistically significant difference between the dominant and non-dominant hand was also found in the achieved speed of passing (Radar speed,  $p = 0.00$ ). The passing accuracy also differed statistically significantly (Accuracy points,  $p = 0.04$ ).

## Discussion

The results collected in this study indicate a statistically significant difference in the observed variables between passing the ball with the dominant and non-dominant hand ( $F = 4090.07$ ;  $p = 0.00$ ). It should be emphasized that the one-handed push pass technique is an extremely complex motor task. The complexity of this passing technique is also reflected in the obtained differences in the performance with the dominant and non-dominant hand.

The results show that basketball players achieve higher values of angular velocities in the shoulder joint of the dominant hand ( $804.41^\circ/s$ ) when passing the ball compared to the non-dominant hand ( $658.36^\circ/s$ ). Consequently, due to higher values in the shoulder joint of the dominant hand, basketball players achieve a higher angular velocity in the elbow of the dominant hand. The previously mentioned differences in the elbow joint can be seen ( $1348.92^\circ/s$ ;  $1180.36^\circ/s$ ) in Table 3. Also, although the difference is not statistically significant, it is also noticeable in the wrist between the dominant and non-dominant hand ( $1604.03^\circ/s$ ;  $1458.80^\circ/s$ ).

Although differences in angular velocities exist between the dominant and non-dominant hand, the results on the other hand indicate the possible correct performance of this passing technique, which is especially based on the correct ending in the wrist, which is evident from the results and which enables the player to give the ball the correct direction and speed.

According to further analysis, there is a statistically significant difference in the passing speed ( $F = 51.23$ ,  $p = 0.00^*$ ) and the passing accuracy ( $F = 4.14$ ,  $p = 0.04^*$ ). Higher passing speed of the ball was recorded during the dominant hand pass ( $44.75^\circ/s$ ;  $40.01^\circ/s$ ), which is expected given that the player achieves higher values of maximum angular velocities in all of the above kinematic parameters.

From the aspect of accuracy, the basketball players scored more points when penetrating to the dominant side and passing the ball with the dominant hand, as opposed to the non-dominant hand, and penetrating to the non-dominant side (dominant hand - 3.33; non-dominant hand - 2.28).

The obtained results indicate the fact that the observed sample of subjects does not have a uniform motor performance of one-handed push pass to the dominant and non-dominant side in terms of maximum angular velocities in the upper extremities, and consequently the passing speed and accuracy.

Although one-handed push pass is performed with the correct movement of the dominant and non-dominant hand, in today's, modern basketball the passing speed, and consequently accuracy are extremely important given the high mobility of defence in space. Very often, even though the passing technique is performed with proper motor movement, reduced passing speed and accuracy can affect the player not to receive the ball in the correct spatial-temporal relations and thus not gain a possible advantage over the set defence.

As mentioned, during the training process for younger age groups, coaches devote very little time to perfecting the passing technique, although this is an element that greatly affects situational efficiency. One of the studies that analyses the situational importance of passing the ball was conducted through 5 competitive seasons in the NBA league. Melnick (2001) followed the relationship between the variables of assistance (a measure of teamwork) and the win/loss ratio in teams. A significant correlation was found between these two variables. It was also found that the total number of assists of an individual team recorded higher coefficients of correlation with the variable ratio of wins and losses. Ortega et al. (2007) investigated the impact of ball possession efficiency on the differentiation of winning and losing teams of basketball players under 16 years of age. Winning teams have shorter ball possession, but a greater number of precise passes and accordingly a larger number of players participate in the action.

## Conclusion

According to the findings from previous research and the differences found in this research, coaches should focus a larger part of the training process on improving the passing technique, especially the passing technique with the non-dominant hand. This will consequently reduce motor errors that can occur during the game and it will ultimately increase the situational efficiency of the individual and the team. In addition to the emphasis on the correct passing technique with the dominant and non-dominant hand, it is crucial to include more situational exercises in the training process, so that players, with the prerequisite of proper technique, practice spatial-temporal relations in relation to the position of defence.

Given that there are very few studies that observe kinematic parameters when performing different passing techniques, there is considerable possibility for future research.

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## BODY INCLINATIONS IN MALES AND FEMALES IN SWIMMING RESUMPTION AFTER PUSH-OFF START

Jelena Stosic<sup>1</sup>, Santiago Veiga<sup>1</sup>, Alfonso Trinidad<sup>2</sup>, Milivoj Dopsaj<sup>3</sup>, Enrique Navarro<sup>1</sup>

<sup>1</sup>Technical University of Madrid, Spain

<sup>2</sup>Francisco de Vitoria University, Spain

<sup>3</sup>University of Belgrade, Serbia

**Introduction:** It is well known that rotational torque (passive torque) differ between males and females due to differences in the distance between the body center of mass and the body center of buoyancy. However, it is unknown whether active torque or angle of attack and / or active body inclinations differ between genders when swimmers resume from underwater to surface swimming. Therefore, the present study aimed to investigate differences between genders in active body inclinations measured by two angles.

**Methods:** National level swimmers (33 males and 40 females) performed 4 x 25 m maximal efforts one of each stroke in a random order, and with a 3 min rest between them. They were recorded with two cameras (JVC GY-DV500E, 50 Hz, 1/1000 s) whereas optical axis was perpendicular to sagittal plane of the swimmers. Measured inclinations were: trunk inclination – the angle between the line that passes through the shoulder and the hip and the water surface; and body inclination – the angle between the line that passes through the shoulder and the knee and the water surface. These two angles were measured on two occasions representing beginning (1) and middle (2) of a cycle. Firstly, in the last underwater cycle/kick: 1) feet in the highest position, 2) feet in the lowest position; and secondly in the transition cycle/stroke: 1) arms separation, 2) arm(s) in the shoulder plane. Results: Females showed higher trunk inclinations 2 ( $\delta$  2.44  $\pm$  0.79 degrees, F = 8.60, p = 0.004, ES = 0.03) and also higher body inclinations 2 ( $\delta$  2.63  $\pm$  0.90 degrees, F = 9.64, p = 0.002, ES = 0.03) during transitioning movements.

**Discussion:** This suggests that males better handle constraints associated with transition movements. The present finding is not in accordance with previous studies which stated that active torque (angle of attack or active body inclinations) depends exclusively on swimmers' technical skills and not on gender differences (Kolmogorov et al., 1997, Clarys 1979).

**Key words:** *swimming, body inclinations, transition, males, females*

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## VISUAL-MOTOR INTEGRATION IS RELATED TO GROSS-MOTOR COORDINATION IN NORMALLY DEVELOPING CHILDREN AGED FIVE

Ivan Šerbetar, Ivana Nikolić, Predrag Zarevski

Faculty of Teacher Education Zagreb, Croatia

### Abstract

This study explored the relation between a gross motor coordination and visual–motor integration (VMI) in normally developing preschool children. One hundred and fifty-five children (78 boys and 77 girls) aged 5 years ( $\pm 0.3$ ), were assessed with 4 items measuring *gross motor coordination* and 1 item measuring VMI. ANOVA with motor ability (*low, average, high*) as a between group factor showed significant main effect ( $F [2, 152] = 13.88, p < .001$ ) on VMI as a dependent variable, which indicated performance increase in VMI from *low* to *high* motor ability group. All motor items were also significantly correlated with BMGT. Results are discussed in terms of mutual neural structure related to both performances.

**Key words:** *fine motor abilities, gross motor coordination, preschool children, visual motor integration*

### Introduction

Every time we move in our environment or perform some motor skill like kicking a ball or when we simply reach for a cup of tea or make a drawing on paper, it demands significant brain and muscle organization in time and space named as motor coordination. Motor actions using large muscles of the body are known as gross motor skills and include movement patterns like walking, jumping or climbing. On the other hand, movements executed by the hand and fingers, and produced by small muscles of the hand, fingers and the forearm represent fine motor skills (Payne and Isacs, 2002). Performance of gross motor skills requires the *multilimb* or *whole-body coordination*. Movement or motor coordination implies bringing together components of muscle-skeletal, perceptual and central nervous system and it may be defined as “patterning of body and limb motions relative to the patterning of environmental objects and events” (Turvey, 1990, p. 938). In the preschool development, fine motor skills are important in a child’s academic, but also social functioning. Fine motor skills seem to be substantially influenced by visual-motor integration (VMI) — the ability of the eyes and hands to work together in smooth, efficient patterns (Sanghavi & Kelkar, 2005). VMI involves visual perception and eye-hand coordination, and that requires the ability to translate visual perception into motor functioning which incorporates motor control, motor accuracy, motor coordination and psychomotor speed (Sanghavi & Kelkar, 2005). Visual perception may be comprised from object/form perception and spatial perception, object/form perception could be further divided into form consistency, visual closure and figure-ground perception (Schneck, 2010). All those abilities are very important for motor actions in which size or position of the objects should be determined, in changing environments, or when the object should be extracted from background or located in space (Schneck, 2010).

Studies have shown that VMI contributes to development of executive functions (McDonald et al., 2016), self-regulation, and in later school success (Carlson et al., 2013). Visual-motor skills were also linked with social behaviors but also with the object control skills (Pagani & Messier, 2012; Tepeli, 2013). There is also large body of research where VMI and motor coordination were related to handwriting (Kaiser et al., 2009) neurological impairment (Van Horn et al, 2010), or certain pathologies like DCD (Tsai et al., 2008) or ADHD as well as to the others.

The study by Bonifacci (2004) evaluated the relationship between motor skills, perceptual ability and visual-motor integration, including general cognitive functioning, in a sample of children at the lower and upper bounds of motor abilities within a non-pathological population. Significant correlation between loco-motor abilities and visual-motor integration was found. Moreover, significant difference between high and low motor ability were established in VMI, pointing to the progressive performance decrease from the high to the low motor ability groups.

Nevertheless, how VMI is related to gross motor skills and incorporated in gross motor coordination in normally developing children is still not enough understood, hence the current study is intended to explore the specified relations.



## Methods

The sample consisted of 155 children (78 boys and 77 girls) aged 5 yrs ( $\pm 0.3$ ). All the children were healthy and without known physical, mental or neurological impairments. Signed consent was obtained from all the parents.

Gross motor coordination was evaluated with five items from the test battery *Psychomotor abilities of the youngest* (Rajtmajer, 1994). As stated in the manuals, in the initial development of the test, more than 1000 children were tested and separate percentile norms were derived for each subsample, including the subsample of five to five-and-half-year-olds. According to the test manuals, reliability and validity have been thoroughly analyzed, several different measures of reliability were computed – i.e. retest reliability ranged from  $r=.91$  to  $r=.99$ . The following motor items, measuring gross motor coordination, were chosen for the present research:

*Ball rolling around the hoop* - the hoop is lying on the floor and the child is instructed to roll the ball around the hoop three times in clockwise direction.

*Crawling backwards through the hoops* - a child is required to crawl backward through three hoops (63 cm in diameter), fixed vertically on the floor and distanced one meter one from another. The child is supposed to start in prone position and move backward, on their hands and knees. Before the start, the hands are placed near the start line, which is one meter away from the first hoop.

*Jumping over and crawling under the bench* - the test requires specially made bench 1-meter-long and 32 cm high. At the beginning of the test, the child is positioned by his or her side of the body near the bench and has to jump over and crawl under the bench three times.

*Crawling with the ball* - the child has to crawl on the mat for four meters carrying the ball in one hand. Rolling the ball is not allowed.

*Running after rolling* - a child is required to make two rolls laterally on the mat, starting from a lying supine, stand up quickly and run forward as fast as he or she can for four meters.

All the items are measured in tenths of the seconds and repeated three times.

*Bender Visual Motor Gestalt Test* - visual motor integration was assessed using *Bender Visual Motor Gestalt Test* (BMGT; Koppitz, 1975). According to Reynolds and Kamphaus (2003, p. 330), BMGT “is perhaps the best known and most widely used visual–motor assessment procedure available today”. In BMGT the child is asked to reproduce by drawing ten geometrical shapes, which become more and more difficult. The test score is represented by the number of errors made, and the lower the score the better the VMI. Except visual association, the tasks requires motor coordination, and the ability to integrate perceptual and motor skills to achieve accurate reproductions. BMGT was traditionally used to assess an individual’s constructional praxic skills, and provides an evaluation of motor integration employed in the execution of complex learned movements (Hartlage & Golden, 1990).

## Results

Descriptive data are presented in Table 1. With the exception of one motor item (*crawling with the ball*), where the boys were quicker than the girls ( $t=-2.43$ ,  $p=.02$ ), no other gender differences, neither in visual-motor nor in coordination tasks, were found. The intraclass correlation coefficients of the individual coordination items ranged from .723 to .842. To ensure that all the motor tasks represent the same motor ability, principal component analysis was performed, showing that all the test items loaded on one factor with eigenvalue of 2.56, which explained 51.19 % of variance.

Table 1. Descriptive data

Test	high ability group (n=44; 28.4%)	average ability group (n=69; 44.5%)	low ability group (n=42; 27.1%)
	Mean (SD)	Mean (SD)	Mean (SD)
BMGT	8.86 (4.16)	11.61 (4.04)	13.38 (3.85)
Composite motor score	53.02 (5.66)	37.48 (4.90)	23.60 (4.76)

The intercorrelations between motor items were also computed and they ranged from  $r=.25$  to  $r=.50$  (Table 2) and were all significant ( $p < .01$ ). All motor items were also significantly correlated with BMGT. The smallest correlation was found for *Jumping over and crawling under the bench* ( $r=.17$ ,  $p=.03$ ), while all others ranged from .26 to .37 ( $p < .01$ ). Motor task scores were transformed into standard scores based on norms provided in the test manuals, and they were further summarized into composite motor coordination score. Based on their summarized scores, children were subsequently divided into three groups. Those whose results fell in the lower quartile of the distribution represented *low coordinated* group, *high ability* group was comprised from scores which were in the upper quartile of distribution, while the children from the middle quartiles represented *average motor coordinated* group.

Table 2. Correlations between the variables

	BenchJ	RollRun	BallCrawl	CrawlHoop	BallRoll
RollRun	.38**				
BallCrawl	.37**	.38**			
CrawlHoop	.25**	.40**	.50**		
BallRoll	.32**	.45**	.45**	.38**	
BMGT	.17*	.39**	.28**	.27**	.26**

\*\* Significant at the 0.01 \* Significant at the 0.05; BenchJ - jumping over and crawling under the bench / RollRun - running after rolling / BallCrawl - crawling with the ball / CrawlHoop - crawling backwards through the hoops / BallRoll - ball rolling around the hoop / BMGT – bender motor gestalt test

This classification left 42 (27.10%) children in the *low ability* group, 69 (44.52%) were in the *average* and 44 (28.39%) in the *high ability* group. ANOVA with motor ability (*low, average, high*) as a between group factor was computed on the dependent variable BMGT, and significant main effect was found ( $F [2, 152] = 13.88, p < .001$ ). Bonferroni post-hoc test showed that the *high ability group* significantly differed from both the *low* ( $p = .001$ ) and the *average* ( $p = .002$ ) ability group. The *average* motor ability group was also found to be better in VMI than the *low* ability group, but the difference did not reach statistical significance ( $p = .078$ ).

## Discussion

The aim of the present study was to establish the relationships of visual motor integration and gross motor coordination in typically developing preschool children. The study also intended to find whether the children with differently developed visual motor integration differ in gross motor coordination. The results clearly showed that VMI was strongly related to the gross motor coordination in this particular sample. The groups, divided on the basis of their motor performance, significantly differentiated in VMI, with clear progressive performance increase in VMI from the low to the high motor ability group. Similar results were obtained in study by Bonifacci (2004) but the author explained them in a terms of atypical brain development. However, the authors of the current study believe that the observed relations are influenced by contribution of visuo-spatial processing to both performances, fine and gross motor. In other words, inadequate visual-spatial perception may lead to decreased motor performance.

Visual-motor integration is the process of transfer of visual-perceptual input into motor output.

As such it is crucial for motor skills which include object control like in the ball sports, where eye-hand or eye-foot coordination is required (Wilson & Falkel, 2004).

Beery (2004) defined VMI as a coordination between visual perception and movement of fingers, and stated that VMI depends largely on visual perception and eye-hand coordination which is important for fine motor control. However, in broader perspective, VMI may be comprehended as the ability of the sight to guide the movement, thus, VMI is also important for performance of gross motor skills. In other word's VMI may be as common to the motor organization on both, the small and gross motor plan. In that regard, functioning of related neural substrates should be considered.

Jeannerod (1997) stated that rapid and efficient processing of afferent information in the central nervous system is a prerequisite for smooth and accurate performance of motor actions. For example, for a movement to be completed, afferent information about positions of limb segments (proprioception) is necessary prior, as well as during movement performance. However, proprioceptive information must be integrated with visual information about the body or the limb in the space (Jeannerod, 1997). Thus, vision plays an important role in the development of coordinated movements and often acts as the dominant perceptual modality for every-day movements (Armstrong et al., 2013). It is believed that one of the areas which control visuo-motor coordination is *parietal cortex* because it receives both visual and motor-related informations (Beloozerova & Sirota, 2003). Milner and Goodale (1995) even argued that parietal cortex cells are neither motor nor sensory cells but rather *sensorimotor* because they transform retinal input (sensory) in motor coordinates and thus serve as a medium for transposing input from perceptual source into action of motor system.

Human neuroimaging studies and primates single cell recording studies have revealed that posterior parietal cortex codes for the position of body parts relative to one another and to the external world, and also takes part in planned movements in external space (Anderson, 1987). That is very important for drawing but also for multilimb coordination. Lesions of posterior parietal cortex result with prominent spatial perception and orientation deficits (Heilman & Valenstein, 1979). It has also been proposed that damage of parietal cortex may affect "*allocentric*" representation of space, i.e. how external objects are related in space between themselves, which is in contrast to "*egocentric*" representation, i.e. how external objects are related to the body. In the present motor tasks allocentric representations dominate because the subjects need to constantly relate body position and orientation to the objects in their surroundings, compute distances between them, heights from the ground, inclinations and many others.

Drawing and other fine motor, but also gross motor skills, are complex activities which demand activation of multiple brain regions. In further studies the role of *basal ganglia, cerebellum* and *motor cortices* should be highlighted. Authors

are aware of some limitations of the study, i.e. this is a correlational study, and correlation does not imply causality, therefore further behavioral studies may benefit from involvement of imaging technology. On the other hand, the study may direct practitioners' attention to the awareness of different level of efficacy of visual perceptual functioning among the children which should be incorporated in motor skill teaching.

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# Management of Sport

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## TOURISTS' PARTICIPATION IN OUTDOOR ACTIVITIES ON THE ADRIATIC: WATER BASED VS. OTHER SPORTS

Snježana Boranić Živoder, Sanda Čorak, Zrinka Marušić

*Institute for tourism, Croatia*

### Abstract

Although Croatia throughout history has been recognized as a 'sun and sea' destination, nowadays it is developing various tourism products in line with the emerging market trends. Many of these tourism products are based on natural resources, and one of the important ones is sport tourism. This paper examines the characteristics of tourists engaged in water-based activities vs. those that are more inclined towards land-based sports and adventure. The paper is based on the results of a visitor survey that was conducted on a sample of 5,950 respondents in 67 destinations along the Adriatic coast. Results showed that it is necessary to adjust the offer of sports to specific target groups. Tourist age is among the most important discriminating variables, although an offer of many sports can be modified according to needs of specific age groups. It is necessary to further investigate possibilities for better collaboration between tourism and sport sectors and offer a plenty of possibilities to create new products which are based on natural resources and meet the demands of modern tourists.

**Key words:** *tourists' activities; water-based sports; land-based sports; adventure sports; Adriatic Sea; visitor survey*

### Introduction

Croatia has been developing tourism for more than a century. Its tourism history began at the end of the 19th century on the Adriatic coast. Although Croatia is recognized by its 'sun and sea' tourism product, its history relied on health tourism and many different sport activities (Vukonić, 2005). As tourism market is highly competitive and Croatian tourism life-cycle was interrupted by wars (Čorak, 2006), last 20 years illustrates the efforts of all tourism stakeholders to improve the quality and to differentiate their products and develop new ones. Among the identified 30 tourism products in Croatia, about half include some kind of sport activity (Strategy of Croatian tourism development until 2020, 2013). The development of various types of special interest tourism (including sport tourism as well) is seen as a possible solution to prolong short tourism season (June to September) and attract new segments of tourism consumers (Bartoluci, Škorić & Starešinić, 2016). Furthermore, by developing sport tourism products Croatian tourism is also adapting to the emerging social megatrends as the world population becomes more urbanized and more concerned about the health issues, particularly in Europe, suggesting the benefits of outdoor recreation (Bell, Tyrvaainen, Sievanen, Probstl, & Simpson, 2007).

According to the longitudinal TOMAS Summer visitor survey, the share of tourists along the Croatian Adriatic coast and islands during the summer months who are motivated by engagement in sport activities is rapidly growing during the last decade, from 7% in 2014 to 20% in 2017 (Marušić, Čorak & Sever, 2015, 2018). Developing sport tourism, both, tourism industry and sport community benefit through tourists spending, and promotion, as well. The main aim of this paper is therefore to analyze tourist participation rate in outdoor activities and to draw conclusion on possible differences between those engaged in water-based activities vs. those more inclined to other sports (adventure and land based sports). The results, in light of the current trends towards more active holidays, give basis for developing promotional strategies and innovating the existing tourism products.

### Methods

The analysis presented in this paper is based on TOMAS Summer Survey 2017 (Marušić, Sever, & Čorak, 2018), the only longitudinal visitor survey in Croatia, conducted regularly from 1987. In 2017 the survey was conducted on a stratified random sample of 5,950 tourists in hotels, campsites and family owned accommodation (rooms, apartments) in 67 destinations along the Adriatic. Data were collected by method of personal interview, from July to October 2017. Both domestic and foreign guests from the main generating markets for Croatia were interviewed. The survey results are weighted by 2017 data on tourists' overnights on a county level, according to the type of accommodation facility and country of tourist's origin. Tourist participation rate in sport activities while staying in destination was analysed in relation to tourist's age (up to 29 years of age, 30 to 49 years, and older than 50 years of age), travel party (with family

members, with partner only, with friends or acquaintances, and without travel party) and type of accommodation used (hotels, campsites and family owned accommodation). The sport activities were grouped as water-based, land-based and adventure sports, similar to classification used by Page and Connel (2006), where activities are divided into aviation-related, marine and land-based. Chi-square test was used to test the difference in participation rate among different segments of tourism demand. All tests were performed at the significance level  $\alpha=0.05$ .

## Results

One of the basic socio-demographic characteristics in tourism marketing is the age of tourists. For all those that are creating tourism packages it is important to match sport preferences of a specific group of potential tourists with an existing sport offer in a destination. Valek, Shaw, and Bednarik (2014) showed that four socio-demographic characteristics (gender, age, level of education, and income) significantly affect a tourist's choice of sport related travel, either locally, within Slovenia, or abroad. Research results confirmed the significant difference in participation rate with respect to age for the majority of sport activities (Table 1), in line with the international tourism trends that are showing differences in preferences and behavior between younger and older population. Research results confirmed also that 'swimming and bathing' is, as expected, the most important activity for tourists of all ages, followed by other water sports which attracted, with the exception of fishing, more younger and middle aged tourists. Fishing, on the contrary, attracted more those in '50+' group in comparison to other age groups. Land based sports can be considered of secondary importance for all age groups. Those older than 50 years of age, showed more interest for walking and trekking, opposed to younger tourists that showed higher participation rate in adventure sports. Interestingly, they were closely followed by tourists in middle age group.

Table 1. Tourists' participation in sport activities in holiday destinations by age of tourists

ACTIVITIES		Total		Up to 29 years		30 to 49 years		50+ years		p-value*
		Rank	%	Rank	%	Rank	%	Rank	%	
WATER SPORTS	Swimming and bathing	1	78.3	1	77.9	1	79.1	1	76.9	0.005
	Scuba diving	2	16.3	2	20.0	3	16.9	4	12.3	<0.001
	Sailing, surfboarding, water skiing	3	16.0	3	18.3	2	18.5	8	9.1	<0.001
	Fishing	9	7.7	9	4.5	9	7.2	5	11.0	0.001
LAND BASED SPORTS	Walking (trekking, Nordic walking etc.)	4	15.9	4	13.9	4	15.8	2	17.7	0.007
	Cycling and mountain biking	5	12.6	7	9.5	6	13.0	3	14.1	0.025
	Jogging/running	6	11.7	6	10.2	7	12.8	6	10.5	0.003
	Tennis	8	9.9	8	6.2	8	11.1	7	10.2	NS
	Hiking	10	3.9	10	3.9	10	4.0	10	3.9	NS
	Riding	11	3.5	11	2.5	11	3.9	11	3.6	NS
ADVENTURE SPORTS	Golf	12	2.2	12	2.7	12	2.1	12	2.3	NS
	Rafting, gliding, paragliding, free climbing, bungee jumping	7	11.1	5	13.4	5	13.1	9	5.4	<0.001

\* p-value for chi-square test; NS – not significant; source: Marušić, Čorak & Sever (2018)

Regarding the travel party, arrivals with family members or with a partner only are prevailing in Croatian summer tourism demand (Marušić, Čorak, & Sever, 2018). The survey results (Table 2) showed that participation rates in swimming and sailing were significantly different with respect to travel party. The highest participation rate in swimming was observed for those travelling with family members (86%), while sailing attracted most of those travelling with friends (23%). The significant differences in participation rates were also observed for the adventure sports and two of the land-based sport activities – cycling/mountain biking and jogging/running. Adventure sports were the most interesting for tourists travelling with friends. The highest participation rate in cycling was observed for those travelling with a partner only, while those travelling alone were more actively engaged in jogging/running in comparison to other groups.



Table 2. Tourist's participation in sport activities in holiday destinations by type of travel party

ACTIVITIES		Total		With partner only		With family members		With friends		Alone		p-value*
		Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	
WATER SPORTS	Swimming and bathing	1	78.3	1	75.0	1	85.9	1	76.5	1	53.2	<0.001
	Scuba diving	2	16.3	2	16.1	4	16.0	3	18.6	4	14.6	NS
	Sailing, surfboarding, water skiing	3	16.0	4	13.5	2	18.0	2	22.9	5	10.9	<0.001
	Fishing	9	7.7	9	8.8	9	7.0	9	6.6	9	4.1	NS
LAND BASED SPORTS	Walking (trekking, Nordic walking etc.)	4	15.9	3	14.1	3	17.8	4	15.8	2	19.7	NS
	Cycling and mountain biking	5	12.6	5	11.4	5	15.4	7	11.1	7	5.1	<0.001
	Jogging/running	6	11.7	7	10.4	6	12.6	6	11.2	3	18.6	0.006
	Tennis	8	9.9	6	10.7	8	9.5	8	7.8	6	9.7	NS
	Hiking	10	3.9	10	4.1	10	4.1	10	3.6	11	1.1	NS
	Riding	11	3.5	11	4.0	11	3.6	11	1.5	10	2.8	NS
ADVENTURE SPORTS	Rafting, gliding, paragliding, free climbing, bungee jumping	7	11.1	8	10.2	7	11.9	5	15.6	8	4.3	<0.001

\* p-value for chi-square test; NS – not significant; source: Marušić, Čorak & Sever (2018)

According to the previous research results (Čorak & Marušić, 2009), the type of accommodation is highly related to the choice of tourist's activities while staying in a destination. This research results (Table 3) confirmed the significant differences in participation rates in various sport activities between guests in hotels, campsites and household accommodation. The highest participation rates in all sports were observed for guests staying in campsites, although their participation in adventure sports and walking was not found to be significantly different in comparison to guests staying in other types of accommodation. High participation of campsites' guests in sport activities may also, in addition to their preferences, be the result of more accessible offer, especially the offer of water sports, as campsites are located close to the seashore. Furthermore, the pattern of participation in sport activities was more or less the same, regardless the type of accommodation – water-based activities were the first tourists' choice followed by land based and adventure sports. The only difference is observed in relation to cycling, as it is the second ranked activity for the guests in campsites.

Table 3. Tourists' participation in sport activities in holiday destinations by type of accommodation facility

ACTIVITIES		Total		Hotels		Campsites		Private accommodation		p-value*
		Rank	%	Rank	%	Rank	%	Rank	%	
WATER SPORTS	Swimming and bathing	1	78.3	1	74.1	1	83.8	1	77.6	<0.001
	Scuba diving	2	16.3	2	16.1	5	17.0	2	16.0	<0.001
	Sailing, surfboarding, water skiing	3	16.0	4	13.1	3	20.3	4	15.3	<0.001
	Fishing	9	7.7	9	3.7	9	11.3	8	7.8	<0.001
LAND BASED SPORTS	Walking (trekking, Nordic walking etc.)	4	15.9	3	14.9	4	17.8	3	15.4	NS
	Cycling and mountain biking	5	12.6	8	7.6	2	23.8	7	9.7	<0.001
	Jogging/running	6	11.7	5	9.5	6	15.5	6	10.9	<0.001
	Tennis	8	9.9	6	9.2	7	15.3	9	7.8	<0.001
	Hiking	10	3.9	10	2.8	11	4.9	10	4.0	NS
	Riding	11	3.5	12	2.3	10	6.4	11	2.8	<0.001
ADVENTURE SPORTS	Rafting, gliding, paragliding, free climbing, bungee jumping	7	11.1	7	8.3	8	12.8	5	11.5	NS

\* p-value for chi-square test; NS – not significant; source: Marušić, Čorak & Sever (2018)

## Discussion and conclusion

In order to become more competitive and to expand short tourism season along the Adriatic coast and on the islands, it is important to enrich the usual 'sun and sea' tourism destination product. Sport activities are among those that do not rely so much on the weather conditions. Because of climate changes and higher temperatures on average that have been observed last few years during May, September and October, even swimming and bathing season could be prolonged. Since the water-based sports are the most attractive for the guests coming to the Adriatic, the information about water temperatures should become available among other information usually prepared and offered in promotional materials. But, it is also necessary to adopt the offer of sports according to the needs of the specific target groups. The age of tourists is found to be among the most important variables, although many sports could be modified according to age groups. Customer trends worldwide point out (Euromonitor International, 2019) the differences between younger and other group of tourists, but also highlight the need to adopt the offer according to travel party as demographic changes are showing more differences in family composition (single parents, singles, women travelling alone). Creation of packages that offer combination of sport activities (water-based and land-based such as scuba diving and riding or sailing and Nordic walking including educational part and small groups) could help destinations to prolong the season and tourists to be more active during their holiday. Those 'sport packages' in destinations along the coast should capitalize on natural resources – sea and seashore to develop different sport activities, but also make efforts in discovering those land-based and adventure sports that are most attractive for their target groups and create new offer according to customer trends (Schwark, 2004). Combination of sport activities, fun and education in natural environment gives a plenty of possibilities for tourists (Radicchi, 2013).

In addition, it is important to keep in mind how trends are changing and how likely is that life chances in terms of economic access interact with lifestyles and influence the probability that an individual will have the desire to choose a sport related vacation (Gibson, 1998:165). In the context of sustainable tourism development (UNWTO, 2020) it would be necessary to investigate possibilities of better collaboration between tourism and sport sectors, as both have separate systems and offer a plenty of possibilities to create new products, especially those that offer interaction with the local community (races or other competitions in city centers, fun and sport in combination, etc.).

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## DEVELOPING SPORTS TOURISM FOR PEOPLE WITH DISABILITIES

Boris Bursać<sup>1</sup>, Danijel Knežević<sup>2</sup>, Kristina Bučar<sup>2</sup>

<sup>1</sup>*Taekwondo club Čigra, Croatia*

<sup>2</sup>*University of Zagreb, Faculty of Economics and Business, Croatia*

### Abstract

The international tourist market is ever-changing, but trends in the last decades have shown that sports tourism is one of the most important special interests of tourism. Within sports tourism, there is a growing segment of sports tourism for people with disabilities. People with disabilities want to be involved in sports because it allows them to develop all their abilities. Global awareness about this problem is growing and this segment of sports tourism is developing fast. Therefore, the tourism industry should adapt its offer for this category of tourist.

This paper focuses on the process of developing sports tourism for people with disabilities in Istria, the most visited Croatian tourist region. The purpose of this paper is to explore the adjustment to people with disabilities in hotels in the five most visited tourist destinations in Istria. This research has shown that hotels in those tourist destinations have adapted their facilities for people with disabilities very poorly and they hardly think about developing sports tourism for physically disabled individuals at all.

**Key words:** *tourism, sports tourism, people with disabilities, Istria, Croatia*

### Introduction

Tourism is one of the most important economic activities in the world due to the involvement of large numbers of people each year in these trends (which in 2019 amounted to 1.4 billion people) (UNWTO, 2021). More and more people are also engaging in sports activities during their tourist trips, regardless of whether it is their main motive for travel or just an additional tourist activity (UNWTO, 2020). This special interest of tourism thus has a share of 10% in the total number of tourist trips and according to projections made before 2020, it was expected to grow approximately 6% per year in the period from 2019 to 2024 (VynZ, 2020). Within this special interest of tourists, people with disabilities are becoming a growing category (McCormick, 2004). According to the World Bank, one billion people, or more precisely 15% of the world's population, have some form of disability (Worldbank, 2021).

According to UN estimates, the problem of disability is more widespread than previously thought, with at least one in ten people in each country having a form of disability, and therefore the availability of appropriate data on disability is a prerequisite for planning appropriate prevention measures and enacting programs for people with disabilities (HZJZ, 2021). Global awareness of the inclusion of persons with disabilities in society is continuously growing, while the United Nations Convention on the Rights of Persons with Disabilities (CRPD) promotes the full integration of persons with disabilities into society (Worldbank, 2021). People with disabilities need the excitement and satisfaction that sports tourism can offer just like the rest of the population (Darcy, 1998). Sports activities also motivate people with disabilities to regain their personality and to deal with the stigma of the disabled body (Martin et al., 1995). People with disabilities do not perceive their disability as a limitation but seek the opportunity to participate in the creation of sports policies and the implementation of sports activities (Darcy, Lock & Taylor, 2017). Sport changes people with disabilities by empowering them to ultimately reach their full potential and develop independence, teaches them how to communicate effectively, the importance of teamwork and collaboration and drives change in society as well (UN, 2021).

The importance of sports tourism for people with disabilities is the focus of this paper, which aims to evaluate the accessibility of sports tourism for people with disabilities in Croatia's most visited tourist region, Istria. In 2019, it accounted for around a quarter of Croatia's overall tourist market (DZS, 2021). Istria is also worth considering because, in addition to holiday tourism, it has prioritized the development of special interests of tourism, such as sports tourism (Škorić, 2008).

The research is divided into two parts. The scientific and professional literature related to the research topic is examined in the first section of the paper. The primary research was conducted among hotels in five tourist destinations in Istria in the second part.

## Literature review

Sport is becoming an increasingly important part of modern tourism, and an increasing number of visitors are selecting their travel destination based on the tourist facilities available. Sports tourism has no clear definition, but it is considered a phenomenon that allows the interaction of space, people and activities, whether it includes active or passive participation in sports (Weed and Bull, 2004; Van Rheenen et al., 2016; Businesswire, 2019). Bouchet and Sobry (2019) consider sports tourism “a range of original unusual activities showing ruptures with the usual practices of tourism and sports, yet also a mix of both sports and tourism.” It is often emphasized that sports tourism includes not only major sports events but also implies a form of tourism that offers tourists a variety of sports facilities in the destination (Gammon & Robinson, 2003).

The development of sports tourism can bring many positive effects to destinations, such as extending the tourist season, creating positive promotion and the image of a tourist destination which then attracts new tourists who often stay longer than when it comes to other categories of tourists (WST, 2020; UNWTO, 2020a). Therefore, tourist destinations show a desire to develop sports tourism even though it is a rather complicated process because of the involvement of a large number of stakeholders (Businesswire, 2019; UNWTO, 2020a). Apart from being an increasingly important factor in tourism supply and demand, sports and leisure facilities have thus become a biological requirement as a result of the new way of life, which is characterized by less movement than in previous times (Bartoluci, 2006; Čavlek et al., 2011). It is especially challenging to adapt the sports tourism offer to different categories of tourists who differ in age, gender, their sports abilities, and sports facilities are especially important for people with disabilities, because physical activity in people with disabilities is crucial for effective rehabilitation (Businesswire, 2019; Kaganek et al., 2017). However, the inclusion and participation of persons with disabilities in sports tourism is a much more complex issue than in the case of able-bodied individuals, as they often face a number of barriers to participation in tourism, such as access to accommodation, sports facilities, parking and general tourist offers (Kaganek et al., 2017).

Countries across Europe have taken action to adapt cultural, sporting, tourism and leisure activities for people with disabilities (Tatic, 2015), and in addition to these activities, awareness of the importance of sports activities for people with disabilities has increased, technological advances have made it easier for people with disabilities to engage in sports, and a large number of volunteers have become involved in helping people with disabilities, making sports activities increasingly accessible to them (Martin et al., 1995). Poland is one of the countries that has prescribed minimum requirements that hotels must meet in adapting for people with disabilities, such as the need for special accommodation units equipped with handrails, special signalization in elevators adapted for the blind, partially sighted and people with hearing impairments, the installation of equipment at a level adjusted to people in wheelchairs, etc. (Lipianin-Zontek & Szweczyk, 2019).

However, despite the growing trend of accessibility in tourism, people with disabilities continue to face many challenges when traveling abroad, especially athletes with disabilities who face the same challenges as non-athletes with disabilities and potentially additional challenges related to their sporting activity (Suursalmi, 2015).

## Methodology

The primary research was conducted to determine how much the most visited tourist region of Croatia has adjusted its offer for people with disabilities, with an emphasis on sports. It is divided into two parts. The analysis of available data on websites in the first part of the research reveals the degree of hotel adaptation for people with disabilities in the five most visited tourist destinations in Istria (Rabac, Pula, Rovinj, Umag and Poreč). A questionnaire was sent to each of the 56 hotels as the second part of the primary research. In 2019, those five tourist destinations in Istria accounted for 55% of all tourist visits in the country (DZS, 2021).

## Results and discussion

The first part of the research looked at a total of 56 hotels to see if they had the following infrastructure elements listed on their websites (Table 1). Research has shown that over half of the observed hotels (55%) do not have adjustments listed on their websites, 39% have access for people with disabilities, 27% have disabled or accessible parking and 23% have facilities for people with disabilities, while other adjustments are in the range from 2% to 4%, which corresponds to one or two hotels (Table 1).

Table 1. Hotel accessibility in Istria for people with disabilities

	Number of hotels	In relation to the total number of observed hotels
Any adaptation for people with disabilities	31	55%
Access for people with disabilities	22	39%
Disabled or accessible parking	15	27%
Facilities for people with disabilities	13	23%
Elevator	2	4%
Toilet bowl with handles	2	4%
Elevated toilet bowl	1	2%
Accessible pool or adapted for people in wheelchairs	2	4%
Emergency switch	1	2%
Lowered sink	1	2%
Special lift for entering the pool	1	2%

Source: author's work

Among the 56 hotels examined, there are 4 hotels (7%) with 2 stars, 19 hotels (34%) with 3 stars, 29 hotels (52%) with 4 stars and 4 hotels (7%) with 5 stars. The hotels with the fewest adjustments are those with two stars, where 75% or three of them do not have any. In the 3-star hotel category, 68% (13 of 19 hotels) do not have any adjustments, while in the 4-star hotel category, 52% (15 of 29 hotels) do not have any adjustments. All four hotels in the five-star hotel category have some form of adjustment for people with disabilities (Table 2).

Table 2. Number of adjustments for people with disabilities in hotels, categorized by star rating

	2 stars	3 stars	4 stars	5 stars
0 adjustments	3	13	15	1
1 adjustment	1	2	1	
2 adjustments		2	5	
3 adjustments		2	7	3
4 adjustments			1	
...				
7 adjustments				1

Source: author's work

18 of the 56 hotels observed belonged to the small hotel category (32%), 10 hotels to the medium-sized hotel category (18%), 22 (39%) to the large hotel category and for 6 hotels authors were unable to find data about the size (11%). Hotels were categorized using Galičić's (2017) modified classification, which he claims is one of the most common in the Republic of Croatia: 0 to 50 rooms - small hotel, 51 to 200 rooms - medium hotel, and 201 and more - large hotel). In the small hotel category, 13 of them (72%) do not have any adjustments listed, while in the medium-sized hotel category, 4 of them (40%) do not have any adjustments listed and 10 of the 22 large hotels (45%) have no adjustments listed (Table 3).

Table 3. Number of adjustments for people with disabilities in hotels, based on hotel size

	Small hotels	Medium hotels	Large hotels
0 adjustments	13	4	10
1 adjustment	1	2	2
2 adjustments	1	1	4
3 adjustments	2	3	5
4 adjustments	1		
...			
7 adjustments			1

Source: author's work



In the second part of the research, an online questionnaire with a total of 15 questions was sent to all 56 hotels and 12 hotels (21%) responded. Of the 12 hotels that participated in the survey, 10 said they had some of the accommodations for people with disabilities. 7 plan to focus their offer on people with disabilities in the future, mostly because they consider socially responsible business to be extremely important, then to be able to operate out of season (all year round) and to create positive image and promotion, and at least because the policy of local government encourages the development of the tourist offer in that direction and for other reasons. However, only 2 hotels stated that they plan to focus part of their tourism offer on sports tourism for people with disabilities, primarily because they see the possibility of filling capacity out of season and because of the growing trend of inclusion of people with disabilities in sports activities.

In 2019, Croatia welcomed 21 million tourists, and the tourism sector accounts for 19% of the country's GDP (DZS, 2021). Croatia should consider sports tourism as one of the most significant special interests of tourism, as well as its comparative advantages over other countries, in order to continue to improve tourism and remain competitive in the international tourism market (Petrović, Knezović and Todorović, 2017; Hendija and Vuković, 2019). Because of the above, hotels and other tourist accommodations in the Republic of Croatia should keep up with the times and change their accommodations and sports facilities to accommodate people with disabilities.

## Conclusion

For the first time, the results provide insight into the state and adjustment of accommodation facilities and additional activities for athletes with disabilities in the Republic of Croatia and Istria and can serve as a basis for further actions aimed at developing sports tourism adapted for people with disabilities in Croatia. Poreč, more than any other city in Istria, is the primary choice for sports preparations, conferences and contests with a domestic or international character. Although Istria is Croatia's most visited tourist destination, hotels have relatively poorly adjusted their facilities for people with disabilities. Hotels should adapt to trends in the international tourism market, where sports tourism is becoming an important special interest of tourism, and the same is true for sports tourism for people with disabilities. Although the research addresses a topic that has received little attention in the scientific literature, the paper's limitations are evident in the fact that it was done only in one tourism region of Croatia and only in a few tourist locations, implying that future research should cover a larger research area and include additional questions.

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## STRATEGY AND PERFORMANCE OF THE YOUTH FOOTBALL ACADEMIES

Katija Kovačić<sup>1</sup>, Eli Marušić<sup>2</sup>, Duje Petričević<sup>3</sup>

<sup>1</sup>Ministry of Defence, Croatia

<sup>2</sup>University of Split, Faculty of Maritime Studies, Croatia

<sup>3</sup>University of Split, Faculty of Kinesiology, Croatia

### Abstract

This paper explores the relationship between a chosen strategic orientation of Youth Football Academies (YFAs) and their business performance. Changes are occurring in the global football market, forcing clubs to adjust strategic positions. The rapid increase of the players' market value represents both an opportunity and a threat to the overall profitability and achievement levels of significant sports results. The share of player transfer costs in clubs' budgets is increasing. Consequently, the role of YFAs, as core organizational units within football clubs, responsible for player development, is rising. The results of the research allow us to determine the strategic type of YFAs examined and how this reflects on the overall performance of Football Clubs (FC), concerning their competitors.

**Key words:** *Strategy, youth football academies, football clubs, business performance*

### Introduction

A large number of FCs have limited resources, which are in direct contradiction to the amounts required, needed to employ high-value players, who ultimately enable them to achieve international competitiveness and ensure both sport and business success. Player transfer rates have increased significantly during the last ten years, within the overall, growing share of growing revenues and expenses of FCs budgets (Poli et al., 2019). Player transfer revenues can reach amounts of over 100 million Euros (www.transfermarkt.com). Player development and management is the backbone of a successful FCs' business operation. Football academies developing talented players into players that are competitive on the player market exert a significant influence on both the on-field and off-field club performance. Particular FCs build up their brands by organizing football academies throughout the World while developing younger players into prospective first-team squad members. At the same time, many FCs, especially those in economically underdeveloped countries, use the income generated by transfers of younger, football academies' players to invest in infrastructure and finance various other sport and business endeavors. Therefore, the FCs are beginning to focus on their academics, regardless of the ultimate business purpose, be it creating their future first-team squad members or transferring the players to wealthier clubs when they reach good market value.

### Theoretical background

The organizations operating within the sports industry are continually facing dynamic changes, uncertainty, and growing competition, which ultimately creates a challenge to their market survival and success (Marušić et al., 2014). Football clubs compete in one of the most profitable and most dynamic sport industry segments. To maintain or enhance their current market position, they are forced to identify and adapt to changes in their business environment constantly. Strategic orientation refers to a specific organizational behavior pattern related to the shifts in the business environment (Marušić et al., 2014). The variations in strategic organizational behavior while adapting to environmental changes have thus been theoretically recognized and empirically tested (Slater et al., 2006). Two dominant theoretical frameworks have consequently been established (Slater et al., 2006; Hambrick, 2003) - Miles and Snow's typology (1978) and Porter's typology (1980). Within the sport management field, as optional FCs strategic courses, there exist five distinct strategies: success circle, transfer, commercial, synergy, and "L'art pour l'art" (Szabados, 2003). Andras & Havran (2015) analyzed and refined this latter classification of strategic options.

The typology of Miles and Snow (1978) is used in research on the strategic behavior of various organizations worldwide (e.g., Conant et al., 1990; Shortell & Zajac, 1990; Zahra & Pearce, 1990; Slater et al., 2006; Hambrick, 2003). Miles & Snow suggest that business-level strategies generally fall into one of four categories: prospector, defender, analyzer, and reactor. Table 1 showcases these concerning their respective football industry applications.

Table 1. Characteristics of the four business-level strategies, for the football industry

<p>Football Club type Defender</p> <ul style="list-style-type: none"> <li>• process standardization</li> <li>• high level of operational efficiency</li> <li>• football academy with a classical training program for talented players or “a limited range of products and services”</li> <li>• focus on local and national markets (competitions) or “narrow target markets”</li> <li>• player transfers as a key source of income for the club</li> <li>• strong connection with the local community</li> </ul>	<p>Football Club type Analyzer</p> <ul style="list-style-type: none"> <li>• efficiency and market penetration in the existing product-market domain (local and national FYC)</li> <li>• effectiveness and growth in new product-market domains (ex. USA, China, Saudi Arabia, and Brazil as new markets)</li> <li>• innovation through talent identification, development, and management; new products/services development</li> <li>• business cooperation with corporations globally (ex. Manchester City)</li> <li>• recognizable and brand building globally</li> <li>• setting the balance between the operational efficiency and market effectiveness</li> </ul>
<p>Football Club type Reactor</p> <ul style="list-style-type: none"> <li>• less successful FC focused on market survival,</li> <li>• investments only when changes threaten their survival</li> <li>• less focused on strategic issues and more focused on operational affairs</li> <li>• lack of branding and profitability</li> <li>• training of young players is not systematic</li> <li>• lack of efficiency and effectiveness</li> </ul>	<p>Football Club type Prospector</p> <ul style="list-style-type: none"> <li>• differentiated marketing and brand building globally</li> <li>• innovation leaders in identifying and developing talent, management and developing new products/services</li> <li>• sports and business activities on other continents (ex. China, USA, etc.)</li> <li>• business cooperation with corporations globally (for ex. Manchester City)</li> </ul>

Over the years, Miles & Snow's typology has been validated by numerous researchers, dealing with the relationship between strategic orientation and organizational performance (Conant et al., 1990; Zahra & Pearce, 1990; Hambrick, 2003; Slater et al., 2006; Marušić et al., 2014). Therefore, it presents a useful framework for research on strategic orientation and football club performance. Based on the latter, the research objectives in this paper are to determine the strategic orientation of YFAs, as well as the relationship between strategic types of YFAs and overall FCs business results. Therefore, the research hypothesis is as follows: adopting different strategic types generates distinct revenue and cost levels incurred from player transfers.

## Methodology

On a sample of 36 football clubs worldwide, this paper examines the type of football academies' strategies, as well as its impact on the overall business performance. Data on FCs have been collected from the site [www.transfermarkt.com](http://www.transfermarkt.com), concerning the financial influx by player transfers within the U20 category. The previously mentioned financial results showcase the success of the development and transfer of players from their respective YFAs. The sample includes clubs that, during the last five years, had the highest level of transactional revenue and cost (revenues exceeding EUR 40 million, costs exceeding EUR 50 million), for players under the age of 20 (U20). Additionally, two Croatian football clubs, exhibiting the highest level of financial performance concerning transfers, have been included, as well as similar clubs from other continents (five clubs from USA, China, Uruguay, and Mexico).

Strategic orientation has been operationalized using three distinct variables: product-market domains, standardization, and innovation. Additionally, two auxiliary variables were employed, the marketing message content (which can be in accordance with the tradition or not) and branding perspectives (which can be nationally or globally oriented). For example, YFAs with strong practices that nurture traditional values never neglect the existing product/market domain and generally follow strategic types of defenders or analyzers. Global or local branding strategy also points to the strategic type of YFAs. Defenders try to empower the brand within their existing product/market domain. Prospectors focused on growth and new product/market domains. In the particular case, the existing product-market domains are often associated with national markets and the new product-market domains with global markets. In that case, branding nationally / globally is an indicator of the strategic type of YFAs.

Utilizing the Delphi method, football industry experts (n = 6) evaluated the strategic orientation of YFAs, based on the predefined variables. The experts were provided with statements which they utilised in order to assess the product-market domain (whether the FYA showcases a narrow/wide breadth of the product range & markets), innovation (FYA applies/does not apply innovative methods in training, organisation and management), standardization (whether or not the FYA standardized the business processes in training, organisation and management), tradition (whether or not the FYA accentuates tradition in it's marketing communication as a clear competitive advantage, as conceptualised by Evens,T., Iosifidis, P., Smith, P., 2013), and branding (FYA brands on the national or the global stage). The resulting strategic orientation is determined on the basis of strategic type characteristics, as formulated by Miles & Snow (1978). Experts were asked to assess research variables based on personal competencies and experience independently. Thus, all the responses obtained were subjective opinions, gained by utilising the Delphi method. The evaluation process was repeated through three (3) stages, with the final result representing a joint assessment of the strategic orientations of the YFAs, by all of the experts. Using the classification method, YFAs are further classified according to the strategic type of YFAs and the corresponding level of performance achievement. All of the variables showcased in Table 2 were obtained utilising the Delphi method (except expenditure and income categories').

## Results

The survey results (Table 2) show that, within the sampled football academies, the most represented strategic type is a defender (43%), followed by the analyzer (38%) and prospector (19%). Not a single football academy adhering to the reactor strategy was identified within the sample. All of the variables in Table 2, except the expenditure and income category, were gathered via the Delphi method. In Table 2, strategic types (SOs) are indicated by the following capital letters: D - Defender, A - Analyzer, and P - Prospector. Furthermore, YFAs following the SO analyzer have broad products markets domains, simultaneously combining it with elements of business process standardization (BPS) and innovation. The wider product markets domain indicates the breadth of the product range: standardized football academy programmes and innovative complementary content, such as e-sports.

Furthermore, analyzers are present in traditional, local as well as emerging global markets, they emphasize traditional values and strive to build the brand globally, by opening football schools and camps. The results show that YFA defenders are focused on narrower product-market domains, standardizing processes, and emphasizing the importance of tradition. Defenders are generally focused on local and national markets, offering football academy services. Traditional YFAs are part of FCs with a history not under 30 years. Ultimately, the YFAs prospectors are the minority within the sample and are just partially differing in terms of the products market domain. Their distinct characteristic is the relatively large investment in innovation, as a part of their overall budget. They are focused on growth and opportunity in relatively new product-market domains. Typical examples of football prospectors are YFAs from China and the USA.

Table 2. Strategic Orientation of Football Academies

YFA	Expenditure Category	Income Category	Products Markets Domain	Tradition: Yes/ No	BPS Yes/ No	Innovations: Yes/ No	YFA Branding: National/ Global	SO
YFA 1	Medium	High	Wide	Yes	Yes	Yes	Global	A
YFA 2	High	High	Narrow	Yes	Yes	No	Global	D
YFA 3	Medium	Low	Wide	No	No	Yes	Global	P
YFA 4	High	Low	Wide	Yes	Yes	Yes	Global	A
YFA 5	Low	Medium	Narrow	Yes	Yes	No	National	D
YFA 6	Low	Medium	Narrow	Yes	Yes	No	National	D
YFA 7	Low	Medium	Narrow	Yes	Yes	No	National	D
YFA 8	Low	Medium	Narrow	Yes	Yes	No	National	D
YFA 9	Low	Medium	Narrow	Yes	Yes	No	National	D
YFA 10	Low	Medium	Narrow	Yes	Yes	No	National	D
YFA 11	High	Medium	Wide	Yes	Yes	Yes	Global	A
YFA 12	High	Medium	Wide	Yes	Yes	Yes	Global	A
YFA 13	High	Medium	Wide	Yes	Yes	Yes	Global	A
YFA 14	High	Low	Wide	Yes	Yes	Yes	Global	A
YFA 15	High	Medium	Wide	No	No	Yes	Global	P
YFA 16	High	Low	Narrow	No	No	Yes	National	P
YFA 17	High	Low	Wide	Yes	Yes	Yes	Global	A
YFA 18	Medium	Medium	Narrow	Yes	Yes	No	National	D
YFA 19	Low	Medium	Narrow	Yes	Yes	No	Global	D
YFA 20	Low	Low	Wide	No	No	Yes	National	P
YFA 21	Medium	High	Wide	Yes	Yes	Yes	Global	A

Table 3 showcases the link between YFAs strategic orientation and the overall FCs' financial performance. The data shows that different strategic types incur specific combinations of costs and revenues. Expenditure/income has thus been classified into three categories, as follows: low (less than 2 million Euro annually), medium (2 to 10 million Euro annually), and high (more than 10 million Euro annually). Defenders generally spend less on transfers and generate annual average revenues ranging from 2 million Euros to 10 million Euros. The results show that YFAs who compete exclusively with their players or U20 players, brought at lower costs, are unable to generate above-average revenues. Defenders YFAs, investing higher amounts of money in incoming player transfers, and selling their players to more profitable FCs do achieve higher income levels. On the other hand, both the analyzers and prospectors, invest in incoming U20 player transfers more than defenders. Still, their outgoing transfer revenue varies depending on their strategic goals and on-field

performance. Analyzers, aiming for the highest level of on-field performance, rarely or never transfer their quality U20 young players to competing clubs. The revenue/cost data for player transfers within the U20 category for YFAs with SO prospector characteristics vary, requiring further research.

Table 3. Strategic Orientation of Youth Football Academies

Player transfers U20 category		STRATEGIC TYPES			
EXPENDITURE	INCOME	“D”	“A”	“P”	“R”
low	low			1	
low	medium	7			
low	high				
medium	low			1	
medium	medium	1			
medium	high		2		
high	low		3	1	
high	medium		3	1	
high	high	1			

## Discussion

Within the football market, player transfer rates have increased significantly during the last decade. Total investment in player transfers for the Big Five league clubs risen from 1.542 million Euros in 2010 to 6.622 million Euros in 2019 (Poli and et., 2019). Football academies, as player makers, have become increasingly and strategically important. The research results on YFAs and performance strategies indicate the diversity of YFAs strategy type used and the link between football academy strategies and their off-field performance levels. Based on the results of the sampled football academies, the most common is the strategic type defender (43%), followed by a strategic type analyzer (38%) and strategic type prospector (19%). Not a single football academy followed the reactor strategy. According to the results, YFAs can be classified into two distinct groups: those that produce players and transfer them to richer clubs (defenders) and those that produce players for their globally competitive teams (analyzers). The YFAs that follow SO defender focus on the local and national markets and offer standardized content and programs. YFAs with SO prospector is focused on innovation and growth. YFAs with SO analyzer seek to strike a balance between existing and new products/market domains, as well as between the standardization and innovation of sports-business processes. Analyzers are equally emphasizing traditional values and the need to brand globally.

Furthermore, the relationship between the strategic type of YFAs and performance, investigated through the prism of cost/revenue ratio, as it relates to the incoming/outgoing transfers of players under 20 years of age, indicates several conclusions: (1) YFAs with SO defender generally earn revenue through player transfers, and YFAs with SO prospector and analyzer incur losses; (2) defenders who invest more in player transfers usually generate more revenue from player sales; and (3) analyzers and prospectors who invest above average sums in player transfers (more than 10 million Euros per annum), earn revenue following their chosen strategic orientation: analysers transfer those players to their main team, while prospectors sell them to more affluent clubs.

## Conclusion

The results of the research indicate that YFAs with the strategic orientation of defender and analyzer is the most represented within the overall structure. Additionally, the share of YFAs following SO prospector is small and refers mainly to YFAs from China and the USA. YFAs with SO reactor in the sample were not present. Furthermore, the results also show that YFAs with different SO have different cost and revenue structures, generated within the U20 player transfer market. This research contributes to a further understanding of the relationship between SO and performance, examining their connection in a specific segment of the sports market - the YFA market. Additional research is needed, focusing on further research and development of YFAs' strategic type model proposed in this paper, as well as examining the relationship between YFAs' strategies and off-field / on-field performances on a larger YFAs sample.

This research contributes to a further understanding of the relationship between SO and performance, examining their connection in a specific segment of the sports market - the YFA market. Practically, the sport club management should follow a specific strategic orientation, one based on available resources and realistic goals, for the alternative frequently leads to mindless experimentation and ends in economic decline.

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## MACRO AND MESO INDICATORS OF SUCCESS OF EUROPEAN COUNTRIES IN ELITE TRIATHLON FROM 2009 TO 2017

Mario Kasović<sup>1</sup>, Bruno Škrinjarić<sup>2</sup>, Ivan Ivezić<sup>3</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Institute of Economics, Zagreb, Croatia

<sup>3</sup>Triathlon club Petar Zrinski, Croatia

### Abstract

There are many studies on the success of nation in sports where researchers try to determine why a nation is more successful in sports than the other by comparing economic wealth, population, land area, nationality and political systems. Indicators are usually divided into three basic levels: micro, mezo and macro level. This research focuses on triathlon and macro and mezo indicators of the success of European countries in triathlons' elite competition system. The purpose is to identify macro and mezo indicators that have the greatest effect on the success of nations in elite triathlon from 2009 to 2017. This research uses on World Triathlon Series (WTS) data and country's economic data. Two models were designed: shortened and expanded (Version 1 and Version 2, respectively); where the effects of indicators were estimated using multiple linear regression method. Results show that one of the most dominant success indicators is the number of athletes on the highest level of sports performance. The wealth of country has statistically significant role in Version 1 model but loses its importance in expanded model. The most important indicator in expanded model is the number of people employed in sports. Results indicate that the nations' success depends primarily on clearly set goals in long term strategy of sport system development and support provided to coaches who play essential roles in detecting, motivating and attracting talents, selecting, planning and programming, organizing and ensuring the implementation of the training system, all that in order to achieve top quality results.

**Key words:** success indicators, triathlon, Europe

### Introduction

There are many studies on correlation between success in elite sports and social, economic or geographic factors (Clumpner, 1994; Chalip, 1995). Many scientists try to answer these questions: *Why is some nation more successful in elite sports than other?* or *What should we do that we haven't done already, to be in the top?* Factors usually studied include economic wealth, number of inhabitants, land area, nationality and political systems (Baimbridge, 1998; Dolowitz & Marsh, 2000; De Bosscher, De Knop & Heyndels 2003; Shibli 2006).

Many countries and their governments invest enormous amounts of money so that their top athletes could be competitive in sports arenas, achieve top-level achievements and be better than their competitors from other countries. This politics may be rooted and find justification in patriotic beliefs, but there is not enough evidence that such sport policy can affect improvement of results in top sport. This means that, to date, there is no statistically significant relationship between state area and economic development, and successes in elite sports (Colwell, 1981; Condon et al., 1999). Furthermore, the self-generated question is: *What performance indicators to observe and how to define them? How to define top sport and what reference values to consider?*

The definition of success indicators in sports is very complex and variable. It requires complex understanding and knowledge on genetics, life environment and the influence of environmental factors on people (Seppänen, 1981; De Bosscher, De Knop, van Bottenburg & Shibli, 2006; Kuper & Sterken, 2003). Indicators are usually categorized into three basic levels: micro, meso and macro level. The correlation of the above indicators is very strong and each indicator must be observed in relation to other. Their cohesion is manifested in all social and cultural levels of a particular country. Macro indicators are most frequently studied in scientific research due to accessibility of public databases (Gillis, 1980).

Indicators on macro level cannot be altered and these usually include: geographic position of a country and its climate, economy and population size, political and cultural system and development of urban system. Examples of macro indicators most commonly used by scientists are: population, land area and GDP (Den Butter & Van der Tak, 1995; Hoffmann, Ging & Ramasamy, 2002; Tcha & Perchin, 2003; De Bosscher, De Knop & Heyndels, 2003)

Meso level indicators are influenced by political system and its sensitivity towards sport, i.e. sports policy. Sports policy is related to national politics, which is subject to structural changes, so mezo indicators can be influenced and changed according to changes in national politics and attitudes. This level is not sufficiently studied and leaves many doubts. By reviewing science literature, it is concluded that results are not compatible and that there are no clearly defined indicators of this level (Douyin, 1988; De Bosscher, De Knop, van Bottenburg & Shibli, 2006).

Indicators on micro level include athlete's individual characteristics and his/her immediate environment (family, club, coach, school, friends, etc.). Some of the indicators on this level can be controlled and influenced by, for example, technique and tactics. Some others, such as genetics, cannot (Greenleaf Gould & Diefen, 2001; SIRC, 2002; Gibbons et al., 2003; SPLISS, 2004; Chelladurai, 1987).

The subject of this research is sport triathlon and macro and mezo indicators of success of certain European country in elite competition system. Triathlon is a modern multisport activity and olympic-recognized sport that consists of three sports disciplines – swimming, cycling and running – performed on different distances and in various time limits, in a predefined order (Friel & Vance, 2013). It is highly technologically advanced sport that combines athlete's preparation and control technology, high technological achievements of sports equipment, latest knowledge in psychological preparation and science of sports nutrition (Shepard, 1992). It can be said that triathlon reflects technological advancement and development of society and as such is unique. Triathlon consists of eight variations and more than twenty different disciplines, with the most important and the most respected discipline being olympic triathlon, which includes 1500 m of swimming, 40 km of bike ride and 10 km of running. Sprint triathlon discipline is also very important (750 m of swimming, 20 km of cycling and 5 km running) (Dengel et al., 1989; Sleivert, 1993; Bernard & Busse, 2000). The International Triathlon Union (ITU) presented in 2009 a new elite competition format called World Triathlon Series (WTS). The primary goal of this format is to bring together the best triathletes from all over the world, as well as to raise the level of quality and visibility of triathlon. The most important part of this system is five competitions in olympic-distance disciplines and, from 2018 onwards, three sprint triathlon-distance competitions are introduced (Triathlon Media Guide, 2016).

In WTS series competitions, there are 65 competitors in the men's and women's races, in finals 75 competitors in both races. With a \$ 2.5 million fund, the WTS is one of the richest and most respected forms of triathlon competitions in the world. The scoring and ranking system is based on scores from the finals and five top WTS results. 1250 points are awarded to the winner / winners of the finals, and 1000 points for winning each other WTS event. Each of the following positions is reduced by 7.5% points. Competitors must be within the cut-off time to win the points, which will be determined by adding 5% to the winner's time in the men's event and 8% in the women's event (ITU World Triathlon Series Ranking, 2017; Vleck, Bentley, Millet, Bürgi, 2008; Meur et al. 2009).

## Methods

This study used data on respondents ranked in ITU's WTS series competitions. The ranking is used to determine the best season triathletes and the final ranking is obtained by summing up the five best WTS races and points achieved at Grand Finals of WTS.

WTS data includes 5 basic indicators for male and female competitors, and is amended with 7 variables from EUROSTAT (Statistical Office of the European Union). The statistical analysis covers period from 2009 to 2017 because 2018 statistics are not yet available on EUROSTAT for all economic indicators used. Only respondents from the European continent are included, primarily because of the availability of all relevant data on triathlon, accessible through EUROSTAT. Respondents outside the European Community are excluded from statistical considerations due to lack of data.

## Variables

12 variables (indicators) used in this study were collected from the WTS ranking data and the country's economic data according to EUROSTAT. These variables belong to macro and mezo groups of indicators. A detailed description of the variables is given in Table 1 (De Bosscher, De Knop, van Bottenburg & Shibli, 2006)<sup>1</sup>.

<sup>1</sup> Unless stated otherwise, all tables and figures are made by authors.

Table 1. Description of variables in the study

No.	Variable	Description
Dependent variable		
1.	<i>PTS</i>	Average number of points scored by a state on WTS competitions in a given year. It is calculated as the ratio of the total number of points achieved by its national representatives and the total number of participation in WTS races.
Triathleets characteristics		
2.	<i>ATH (macro)</i>	The total number of triathletes of a countries that have participated on at least one WTS competition in a given year
3.	<i>AGE (meso)</i>	The average age of all contestants on WTS competitions of a country in a given year
4.	<i>GENDER (meso)</i>	Gender ratio of natjecatelja contestants on WTS competitions of a country in a given year.
Country economic indicators		
5.	<i>GDPpc (macro)</i>	Real (2010 USD) GDP per capita of each state (whose representatives participate at WTS competitions) in each year (counted at constant rates from 2010 in US dollars).
6.	<i>VAsport (meso)</i>	The value added of the industry "Sporting activities and entertainment and recreational activities" (NKD2007 sector 93) in the total added value of all the industries of a country whose representatives participate in WTS competitions.
7.	<i>TRADE (meso)</i>	Trade share (import and export) relating to sports goods associated with triathlon - swimming, cycling and running equipment: 1) general physical activity equipment, gymnastics or athletics, sports and outdoor games, swimming pools and paddling; 2) Bicycles, not motorized; 3) bathing suits, ski suits, sport gloves; 4) sport footwear.
8.	<i>EMP (meso)</i>	Share of employees in sports activities of a country
9.	<i>HHcons (meso)</i>	Share of total average household expenditure of each country on sports goods and services
Geographic and time indicators		
10.	<i>SEA (macro)</i>	Binary variable – sea exit of a country (whose representatives participate at WTS competitions) (1 = Yes, 0 = No).
11.	<i>YEAR</i>	Binary variable for a given year (if data is available)
12.	<i>NATION</i>	Binary variable for a given country (if data is available)
13.	<i>Population (macro)</i>	Indirect variable found in GDPpc

Note: The source of all data for economic factors is EUROSTAT, except for GDPpc, whose source is online World Bank database. The source of the score on WTS competitions is the ITU online database.

The observation unit in our analysis is the whole country and purpose of this research is to determine which factors affect success of a particular country in a top triathlon. Success is defined by the average number of points achieved by competitors from each country at WTS. Factors affecting success are divided into three groups: 1) characteristics of the competitor; 2) economic wealth of a particular country; and 3) geographical features of a particular country.

Dependent variable, the average score of a country (*PTS*) on WTS competitions, is calculated as the ratio of the total score of all the contestants of a country and the total number of WTS participation of the same country, for each year. This indicator approximates the quality and orientation of each system to top results in the triathlon.

Characteristics of the contestants constitute the first group of factors and include the following variables: total number of individual country contestants (*ATHs*), average age of all competitors (*AGE*) and the proportion of men in all contestants (*GENDER*). The logic behind choosing these variables is the following. Greater total number of WTS contestants of a particular country implies that triathlon is already at a significant level of development in that country and therefore positive effects of this variable on the success in triathlon can be expected. This indicator also approximates the quantity or breadth of the system that shows the investment in a greater number of triathletes. Younger triathletes should be at an advantage in events of this type, because WTS competition is one of the most difficult and challenging in the triathlon world over olympic- and sprint-distance (Kreider et al., 1988; Thoden, 1991; De Vito et al., 1995). This is also supported by the fact that as athlete grows older, endurance increases but the explosion and speed drop (O'Toole, Douglas & Hiller, 1989; O'Toole & Douglas, 1995). Consequently, it is expected that a state with the younger triathletes on average will have more success. The average age of triathletes in a state is an indicator that also shows strategic planning and investment in young athletes, i.e. whether it is a short-term or long-term strategy for sport development (Lepers & Maffioletti, 2011). Finally, the percentage of men shows gender distribution in WTS events of a certain country and thus shows consciousness for gender equality. However, there are more men than women in triathlon, so in theory, it should be easier for women to win more points. For this reason, we expect that countries with a higher percentage of women in the WTS triathlon will have a higher number of average points.

Indicators that fall within the second group of factors are economic wealth of a state and economic factors associated with triathlon. Ideally, the analysis would include the national triathlon federation budget of each country, which would be direct measure of investment in triathlon. However, due to inavailability of this data, the investment and importance of triathlon were measured by other available indicators. As a country's general wealth, GDP per capita (*GDPpc*) was taken,

expressed in USD for 2010. The assumption here is that more financially secured and wealthier society will spend more time and money on quality of life through sport, including triathlon. Although GDP per capita is a rather rough estimate of wealth (e.g. it does not take into account the distribution of this wealth), it is expected the wealthier countries will be able to provide more resources for triathlon and thus achieve better results. But even if some country is wealthier, it does not necessarily mean that much money will be invested in sports. For this reason, added value of the industry “Sports and Entertainment and Recreational Activities” (National Classification of Economic Activities, 2007, sector 93) in total added value of entire economy ( $VAsport$ ) was taken into account. In this way sports industry is measured in the overall economy of a country. This indicator serves as an approximation of development of sports industry in individual country, which shows how much people are engaged in sports. In addition, in order to separate public and private expenditure on sports goods and services, share of household expenditure on sports goods and services in total household expenditure ( $HHcons$ ) was measured. It approximates how much an individual invests in sports equipment compared to some other activities. A variable of employment in sports activities – the share of employees in sports activities over the total number of employees – ( $EMP$ ) was also introduced. This indicator shows how many professional experts (professional staff) work in the sports system of a particular country and how many countries are aware of the importance of education in sport. Finally, we define the trade share (import and export) of sports goods typically associated with triathlon – swimming, cycling and running equipment. Namely, for each country trade share for the following groups of goods ( $TRADE$ ) are: 1) general physical activity equipment, gymnastics or athletics, sports and outdoor games, swimming pools and paddling; 2) Bicycles, not motorized; 3) Swim suits, ski suits, sports gloves; and 4) sports footwear. This indicator approximates the expenditure on specific triathlon equipment. For all of these factors, it is expected to have positive impact on the success of a state in the triathlon.

The final group of factors are geographical and annual economic factors. The first of them is sea exit ( $SEA$ ). Most of the major international triathlon competitions take place in open water or in the sea, so it is also assumed that the development of triathlon system will be greater in countries that have the geographic advantage of sea exit. Also, the ability to organize a training and competition system throughout the year should be an advantage for this country. Economic effects of a single year ( $YEAR$ ) were also examined (e.g. the financial crisis at the end of 2008 had a much greater impact on sports in 2009 or 2010 than in 2014) through a set of binary variables as covariates in the analysis for every year. Also, this is an indicator of feasibility of strategy and support in the development and long-term periodization.

For the analysis of factors affecting the success of a state in triathlon, empirical model of the following form (shown in the form of linear equations) was used:

$$PTS_{ct} = \alpha + \beta_1 ATH_{ct} + \beta_2 AGE_{ct} + \beta_3 GENDER_{ct} + \gamma_1 GDPpc_{ct} + \gamma_2 VAsport_{ct} + \gamma_3 TRADE_{ct} + \gamma_4 EMP_{ct} + \gamma_5 HHcons_{ct} + \sum_{t=1}^{T-1} \delta_t YEAR_t + \epsilon_{ct} \quad (1)$$

Model/Equation 1 was evaluated by multiple linear regression method (*engl. Ordinary least squares*, further: OLS), which is standard method for this type of research (Škrinjarić, Budak & Žokalj, 2018). Descriptive statistics of variables used in the Model 1 is given in Table 2. The analysis covered 27 European countries that had at least one representative at WTS competitions from 2009 to 2017: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Hungary, Ireland, Israel, Italy, Luxembourg, Monaco, Netherlands, Norway, Poland, Portugal, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland and Ukraine. The total number of country-year observations is 194. The average country in our dataset obtained 212 WTS points, with a total of 5 WTS contestants with an average age of 26 with a slightly higher share of men (52%) versus women. The average real GDP per capita is about 40,000 USD with an extremely large variation range of over 140,000 USD. In average state, only 0.43% of added value is achieved in sports activities, although the approximate trade of “triatlonic goods” accounts for almost two thirds of total commodity exchange (60.6%). Furthermore, only 0.77% of all employees are employed in sports activities, while the average household spends 3.34% of their household budget for sport activities.

Table 2. Descriptive statistics of variables from Model 1 (at European level)

Variable	N	Mean	St. dev.	Min.	Max.
Average number of points	194	212.88	102.48	13.78	590
<i>Triathletes characteristics of a certain country</i>					
Total number of triathletes	194	5.03	4.48	1	22
Average age of the triathletes	194	26.34	2.88	17	34.5
Men	194	0.52	0.33	0	1
<i>Country economic indicators</i>					
(ln) real GDP per capita	194	39,723.34	24,816.20	2,828.89	146,149.37
% of sports VAa in total VA	162	0.43	0.14	0.23	0.82
Trade in triathlon goods	171	60.6	15.53	16.46	90.07
Employed in sport	171	0.77	0.33	0.29	1.6
Household expenditure for sport	158	3.34	1.62	0.89	6.58
<i>Geographic indicators</i>					
Sea exit	144	0.74	0.44	0	1

## Results

Estimation results of Model/Equation 1 are shown in Table 3. The model is estimated in two versions - in the first version only GDP per capita as a measure of the wealth of a country is used, as it is most frequently used in science literature, while the second version includes other covariates related to the importance of sport in a particular country (which is also one of the scientific contributions of this research).

From the results of the analysis according to Version 1, significant variables are “total number of triathletes” and “real GDP per capita”, i.e. these variables are statistically significantly different from zero in explaining the variation in the dependent variables (the average number of points in a country at WTS competitions). Two significant results are interpreted in the following way: if the total number of WTS triathletes of a state is increased by one triathlete, leaving all other variables constant (*ceteris paribus* assumption), the average number of points achieved by a country increases by 8.4 points, on average. Interpretation of GDP per capita estimate is similar – if GDP per capita is increased by 1 percentage point, leaving all other variables constant, the average number of points achieved by a country will increase by 26.0 points, on average. All other variables are not statistically different from zero and thus are not interpreted.

In Version 2 of the Model we added variables that approximate the importance of sport as activity in a particular country. The total number of triathletes of a country has remained very significant for the country’s success - the magnitude of the effect has only slightly decreased. On the other hand, within this specification, the effect of GDP per capita disappears, and is replaced by the positive effect of the share of people engaged in sporting activities with even greater magnitude of effect on the average number of points in a country. Finally, the results show that age and gender of countries’ triathletes are not related to the country’s success in the WTS triathlon.

Table 3. Estimation Results of Equation 2 by OLS Method

Variable	Version 1		Version 2	
	Estimate	S. e.	Estimate	S. e.
Number of triathletes	<b>8.367***</b>	(1.457)	<b>8.044***</b>	(1.691)
Average age	-3.198*	(1.819)	-1.847	(2.486)
Men	5.617	(20.07)	0.868	(24.39)
(ln) real GDP per capita	<b>26.04***</b>	(5.059)	10.23	(8.238)
% of sports VA <sup>a</sup> in total VA			34.64	(60.36)
% trade in triathlon goods			0.896	(0.547)
% employment in sports			<b>96.57***</b>	(29.97)
Average HH <sup>b</sup> sports consumption			-5.253	(5.982)
Sea	5.376	(14.44)	6.886	(18.99)
Observations	194		158	
Adjusted	0.874		0.875	
Adjusted	0.865		0.860	
Year effects	YES		YES	

Note: \* p-value < 0.1, \*\* p-value < 0.05, \*\*\* p-value < 0.01. Standard errors in parentheses. Year effects are omitted as they are not the focus of our research and for presentation purposes, but are available on request. <sup>a</sup> VA denotes “value added”. <sup>b</sup> HH denotes “households”.



## Discussion and Conclusion

By observing the most commonly used indicators of success, this research has shown that one of the most dominant indicators of a nation's success in triathlon is the number of athletes of the highest level of sport performance. In both the abbreviated version (Version 1, 8.367, p-value <0.01) and the extended version of our model (Version 2, 8.044, p-value <0.01) estimated coefficients are statistically relevant. Background of this indicator is far more complex than the number itself. Such result can not be reached overnight and by chance. It is a product of clearly set goals in a long-term strategy for the development of a nation's sport system, which implies investing in athletes from the youngest age groups and sexes. The aforementioned results also suggest that investing not just in triathletes but also in teams of professionals will have synergistic effects in creating positive competition atmosphere within individual national teams, which will ultimately result in a greater number of average WTS points.

Wealth of a country has statistically significant role (26.04, p-value <0.01) in the success when GDP is observed independently, as in the Version 1 of the model. In expanded model, its importance decreases, and most important indicator, as this research suggests, becomes the number of people employed in sports (96.57, p-value <0.01), which is an indirect part of GDP. This indicator should be implemented in long-term strategy and systematic development of sport in a particular nation. Coaches are the most important sports employees and the link in the training process who trigger, detect, motivate and attract talents, carry out selection, planning and programming, organize and ensure the implementation of the training system, all in order to achieve top results. Coaches should have resources to gain and apply new scientific and professional knowledge, because success in sport is dependent on it. Thus, investment in their education should be permanent.

This research has shown great technological requirements of triathlon through the scoring system at the highest level but also its sensitivity as any other sport. Individual indicators in elite triathlon, not covered in this study, will be observed in future research.

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## CZECH FOOTBALL LEAGUE DEVELOPMENT

Adam Kyselica, Tomáš Sedláček

Masaryk University Brno, Faculty of Sports Studies, Czech Republic

### Abstract

The aim of this paper is to analyse the overall situation in the Czech professional football leagues and their development since gaining their independence in 2016. We have analysed attendance in the stadiums in the seasons from 2014/2015 to 2019/2020 and compared two years under FAČR, two years under LFA and two years under LFA with a new game system. We have also studied the total and average attendance development and the market value of the league and its development. Moreover, we have prepared a questionnaire to create a profile of an average football fan in the Czech Republic. We have found a steadily growing improvement in all the studied areas. Most of the clubs have improved their stadium capacity utilization; furthermore, the club values are constantly growing.

**Key words:** Czech football, League Football Association, Stadium capacity utilization, Football matches attendance

### Introduction

Football is a fairly conservative game in terms of various changes. While football is changing, it is neither very often nor very dynamically. The exact origin of the game is hard to detect. The first similar game appeared in China and its name was tsu-chu (Van Dalen & Sasajima, 1965). We can find similar games in historical sources in Europe as well – a Greek game called episkyros or a Roman game called harpastum or calcio later on (Giossos, Sotiropoulos, Souglis & Dafopoulou, 2011). Thomas Arnold understood that sport can make students tired and it became an effective education tool in the 19<sup>th</sup> century in England when first student clubs were founded and started to compete (Radnedge et al., 1996). In the 1890s, football began to develop in the area of the Czech Republic as well. After his return from England, Josef Rössler-Ořovský is considered to be the founder of modern football in our country as he translated the rules (Macho, 1996).

The independent history of the Czech football league started in 1993/1994 as our country separated from Slovakia. Since that time, the biggest problems of the Czech football league have been connected with bribery affairs, which have had a negative impact on attendance, especially in the years 2004 and 2010 (Racek, 2016).

When we focus on attending football matches, there are many studies interpreting different ideas but mostly they agree on the factor of the uncertainty of the result (Szymanski, 2003). El Horidi and Quirk (1971) point out the fact that the strength of the team does not have to correspond with their economic situation. Benz, Brandes & Franck (1998) studied attendance in connection with the uncertainty of the result and they point out the advantage of home teams in the situation when club is able to fill the stadium. The development of live broadcasts has a negative impact on attendance in Czech stadiums together with bribery affairs, bad results and many other leisure activities (Racek, 2016). Mourão and Cima (2015) deal with the balanced competition in which clubs have a similar number of talented players and they have invested in the talent development in connection with the profit after their future sale.

As for the Czech football league, Racek (2016) divided match attendees into three groups in connection with their motivation to attend a football match and with different points of view of men and women. Racek found out that women in all the age categories have the motivation to attend a football match if they can meet their friends and also if the quality of the opponent is interesting to them. These factors are identical in all categories. As for men, the first category (fans attending 7 matches per season max) are mostly interested in the quality of the opponents while the second group that attends 8 to 15 matches is interested mostly in the pride and the support of the club. The third group attends away matches as well and pride is the most important to them.

The season 2016/2017 was the turning point for Czech professional football. Since June 2016, the League Football Association (LFA) has been officially managing the first and the second football league and has separated itself from lower leagues that remain under the control of the Football Association of the Czech Republic. Since July 2018, LFA has been controlling the business and marketing side of professional leagues. LFA has started new projects such as video referees (2018) or transparent league (2016) to attract new partners and a new gaming system comprising an extra part of the season after finishing the main part. The study from KPMG (2016) shows a huge potential for the growth of Czech football. The main areas to improve are for example the attractiveness, trustworthiness, and cultivation of the league.

## Methods

The data for the analysis were collected from internal sources of the League Football Association, official website of the first football league and a specialized server for the club value estimation.

The data analysis is based on the long-term data collected for a complete analysis in the LFA and they will be used as percentage indicators of attendance during the studied seasons and as indicators of the average attendance during the studied seasons. 20 clubs and their development in the seasons from 2014 to 2020 have been studied. We have analysed every single team in each season and calculated an average percentage of the stadium capacity utilization. In the 2018/2019 season SFC Opava (OPA) played 6 home matches in the stadium in Brno before their stadium was renovated; we have counted the average stadium capacity utilization only at their own stadium since 7th home match. Moreover, during the seasons in which the teams were relegated to the second league their attendance has not been counted into the average and is marked as FNL. The season 2019/2020 was affected by COVID-19 and between 2 to 4 matches took place without attendees; therefore, we have calculated average numbers from the matches during which people were allowed to be in the stadium. The last source of data for this paper is the transfermarkt.com server where the data for the value of the clubs during the studied seasons have been collected. We have used the total values at the end of complete seasons and the continuous values for the autumn part of the season 2019/2020.

## Results

The overall situation in the league is described in the tables and graphs below. As first we have studied the attendance in the stadiums in the seasons 2014/2015 – 2019/2020. We have included the seasons 2014/2015 and 2015/2016, which were the last two seasons under the complete control of FAČR, as a starting line of the changes in Czech football.

Table 1. Development of the stadium capacity utilization 2014 - 2020

	19/20	18/19	17/18	16/17	15/16	14/15	Ø utilization	Capacity
BNO	FNL	FNL	40%	42%	45%	40%	42%	10,785
BOH	73%	69%	65%	69%	73%	70%	70%	6,300
CEB	71%	FNL	FNL	FNL	FNL	46%	59%	6,681
DUK	FNL	35%	34%	27%	32%	31%	32%	8,150
HKR	FNL	FNL	FNL	35%	FNL	45%	40%	7,000
JAB	49%	47%	53%	42%	46%	62%	47%	6,108
JIH	FNL	FNL	68%	65%	70%	71%	68%	4,500
KAR	72%	65%	74%	80%	FNL	FNL	58%	4,833
LIB	44%	49%	50%	45%	49%	48%	47%	9,900
MBL	68%	59%	58%	67%	66%	62%	64%	5,000
OLO	30%	38%	43%	FNL	37%	FNL	30%	12,474
OPA	48%	40%	FNL	FNL	FNL	FNL	44%	7,550
OVA	58%	71%	52%	FNL	30%	44%	42%	15,123
PLZ	78%	77%	82%	86%	91%	93%	83%	11,700
PŘI	33%	40%	FNL	27%	33%	34%	33%	9,100
SLA	73%	67%	64%	60%	46%	34%	62%	19,370
SLO	53%	55%	56%	76%	59%	56%	60%	8,000
SPA	61%	61%	60%	44%	54%	49%	56%	18,887
TEP	27%	12%	24%	56%	25%	26%	29%	18,221
ZLN	63%	96%	71%	57%	73%	FNL	72%	5,898

In the season 2014/2015 only 5 clubs reached 60% or more in the index of the stadium capacity utilization. The highest average stadium capacity utilization was achieved by Viktoria Pilsen with 93%, followed by Jihlava (JIH) with 71%, Bohemians Prague (BOH) with 70% and Jablonec (JAB) and Mladá Boleslav (MBL) both with 62%. In the season 2015/2016 only 5 clubs reached 60% or more in the index of the stadium capacity utilization as well; one club reached close to this number. The highest average stadium capacity utilization results were achieved by Pilsen (PLZ) with 91%, followed by Bohemians Prague (BOH) and Zlín (ZLN) both with 73%, Jihlava (JIH) with 70% and Mladá Boleslav (MBL) with 66%. With 59%, Slovácko (SLO) reached the edge of the limit.

The season 2016/2017 was the first one under the control of the League Football Association (LFA) which changed the general partner of the league as well as the broadcasting rights contracts and invested more money in the clubs. LFA came with many changes and goals that would lead to attracting more fans, partners and other football stakeholders. As we can see in Table 1, the number of clubs that reached 60% or more in the index of the stadium capacity utilization grew to 7 and 1 club got close to the limit. Viktoria Pilsen (PLZ) reached the highest average index with 86% again, followed by the newcomer to the league Karviná (KAR) with 80%. Slovácko (SLO) reached 76%, Bohemians Prague (BOH) 69%, Mladá Boleslav (MBL) 67%, Jihlava (JIH) 65% and Slavia (SLA) 60% of the stadium capacity utilization. Zlín (ZLN) was on the edge of the limit with 57%. The second season under LFA – 2017/2018 – continued with a higher number of the teams that reached 60% or more in the index of the capacity utilization. The number of the teams which succeeded in this observed index is again 7 with 1 being on the edge. Viktoria Pilsen (PLZ) was first again but its percentage constantly decreased to 82% in this season. The last year's newcomer – Karviná (KAR) – was the second with 74%, followed by Zlín (ZLN) with 71%, Jihlava (JIH) with 68%, Bohemians Prague (BOH) with 65%, Slavia Prague with 64% and Sparta Prague with 60% of the stadium capacity utilization. Mladá Boleslav (MBL) was on the edge with 59% in this season.

2018/2019 was the first season with an extra group stage after the end of the usual table with 30 matches. In this study, we have included only the first 15 home matches in our calculations as in the seasons before. The number of teams having reached over the 60% limit index is the same as the year before – 7 teams with one more on the edge. This season was the most successful for Zlín (ZLN) which reached 96% of the stadium capacity utilization, followed by Viktoria Pilsen (PLZ) with 77%, Baník Ostrava (OVA) with 71%, Bohemians Prague (BOH) with 69%, Slavia Prague (SLA) with 67%, Karviná (KAR) with 65% and Sparta Prague with (SPA) 61%. Mladá Boleslav (MBL) was on the edge with 59%.

The last observed season is the season 2019/2020 which was affected by COVID-19. As the last rounds too place without the attendance of fans, we have calculated a coefficient using the matches which fans were allowed to attend. A new record was set in this season with 8 teams over 60% limit and one on the edge. Viktoria Pilsen (PLZ) retook its first place with 78% of the stadium capacity utilization, followed by Bohemians Prague (BOH) with 73%, Slavia Prague (SLA) with 73%, Karviná (KAR) 72%, České Budějovice (CEB) with 71%, Mladá Boleslav (MBL) with 68%, Zlín (ZLN) with 63% and Sparta Prague with 61%. Baník Ostrava (OVA) came close to the edge with 58%.

Moreover, a constant growth can be seen in the total attendance during the main part of the season (the play-off parts of the seasons 2018/2019 and 2019/2020 are not counted). The only exception can be seen in the season 2015/2016 in which Viktoria Pilsen reached 91% of the stadium capacity utilization index and, hand in hand, raised its number of the total attendance.

Table 2. Attendance during the whole season in the Czech football league.

	19/20	18/19	17/18	16/17	15/16	14/15
Total attendance	1,071,065	1,332,584	1,331,016	1,176,091	1,219,698	1,136,767
Average attendance	5,689	5,552	5,546	4,901	5,082	4,737

The total club value is an estimated value of the market price of the players and regular results of the club during the season (in the complete ones).

As we can see in the last table of this study, there are three clubs with a significantly higher total value than all of the others (AC Sparta Praha, FC Viktoria Plzeň and SK Slavia Praha). Another common indicator is the constantly growing price of the clubs in complete seasons (except for the season 2015/2016). The greatest progress was detected in the value of SK Slavia Praha which has grown from an average value to the second most valuable club in the Czech first football league. We can also see that the teams promoted from the second league are constantly growing in their value.

Table 3. Comparison of club values during studied seasons 2014 – 2020.

Club	2019 - 2020	2018 - 2019	2017 - 2018	2016 - 2017	2015 - 2016	2014 - 2015
AC Sparta Prague	42 800 000 €	42 830 000 €	50 630 000 €	35 430 000 €	32 730 000 €	34 100 000 €
FC Viktoria Pilsen	26 500 000 €	32 600 000 €	23 950 000 €	28 030 000 €	24 750 000 €	25 780 000 €
SK Slavia Prague	37 900 000 €	40 700 000 €	36 800 000 €	19 400 000 €	13 800 000 €	11 050 000 €
FK Jablonec	12 750 000 €	13 500 000 €	11 100 000 €	12 900 000 €	12 700 000 €	13 130 000 €
FC Slovan Liberec	11 030 000 €	12 100 000 €	11 980 000 €	12 430 000 €	12 850 000 €	12 200 000 €
FK Mladá Boleslav	9 500 000 €	16 000 000 €	17 330 000 €	11 580 000 €	13 600 000 €	12 280 000 €
FK Teplice	8 050 000 €	8 930 000 €	10 900 000 €	8 650 000 €	9 380 000 €	9 730 000 €
FK Dukla Prague	FNL	7 780 000 €	7 930 000 €	7 850 000 €	9 350 000 €	8 480 000 €
1.FK Příbram	6 680 000 €	5 880 000 €	FNL	7 330 000 €	7 200 000 €	8 550 000 €
FC Bohemians 1905	8 150 000 €	10 450 000 €	7 450 000 €	7 030 000 €	7 080 000 €	6 400 000 €
FC Zbrojovka Brno	FNL	FNL	7 980 000 €	6 750 000 €	4 100 000 €	5 730 000 €
1FC Slovácko	9 280 000 €	8 130 000 €	7 280 000 €	6 650 000 €	5 400 000 €	5 700 000 €
MFK Karviná	5 880 000 €	9 330 000 €	7 700 000 €	6 450 000 €	FNL	FNL
FC Vysočina Jihlava	FNL	FNL	8 330 000 €	6 430 000 €	6 180 000 €	7 330 000 €
FC Fastav Zlín	8 050 000 €	8 900 000 €	11 130 000 €	6 180 000 €	3 830 000 €	FNL
FC Hradec Králové	FNL	FNL	FNL	4 830 000 €	FNL	6 730 000 €
SK Sigma Olomouc	9 100 000 €	10 650 000 €	7 280 000 €	FNL	10 550 000 €	FNL
FC Baník Ostrava	10 680 000 €	10 280 000 €	10 180 000 €	FNL	6 700 000 €	7 330 000 €
Slezský FC Opava	5 380 000 €	5 900 000 €	FNL	FNL	FNL	FNL
SK Dynamo České Budějovice	7 380 000 €	FNL	FNL	FNL	FNL	5 530 000 €
Average	13 694 375 €	15 247 500 €	14 871 875 €	11 745 000 €	10 184 375 €	10 449 375 €
Total	219 110 000 €	243 960 000 €	237 950 000 €	187 920 000 €	162 950 000 €	167 190 000 €

## Discussion

The overall situation in the first football league in the Czech Republic is slowly moving towards the goals that were set by the League Football association before the season 2016/2017 such as making the competition more interesting for fans, spectators, players and partners. As we can see from the results of the analysis in the Table 1 comparing attendance during six seasons in the top Czech football league, the total figures of the teams are increasing; however, at the same time the top figures of stadium capacity utilization are still decreasing. We could discuss the varied percentages of utilization of the clubs' stadiums; let us take the two most successful clubs in utilizing the stadium in the 2014/2015 season (PLZ and JIH) as an example: FC Viktoria Plzeň achieved the average of 93% of stadium capacity utilization in the season which means on average 10,867 attendees out of the stadium capacity of 11,700; this is corresponding to the results of the team in the season and the participation in the European Cups. On the other hand, Jihlava finished in the second part of the league table but the average stadium capacity utilization was 71% of the stadium – the stadium capacity is 4,500 attendees and the average attendance was 3,208 people per match. We can see that it is important for the clubs in the Czech football league to stay realistic and see what is possible for their club. There are also clubs which have to face the problem of low attendance such as FK Dukla Prague (DUK) and FK Teplice (TEP) with an average of 31% and 26% stadium capacity utilization respectively and average attendance of 2,516 (DUK), 2,479 (PŘI) and 4,759 (TEP). All these clubs have stadium capacities which are not compatible with their current attendance rates (DUK – 8,150; PŘI and TEP – 18,221). The reason for this could be found in some historical evidence of the previous successes of these clubs or their long-lasting traditions but nowadays these clubs are not able to fill the stadiums and it is a matter of a further analysis to find out where the main problem is.

An improvement can be seen in utilizing the stadiums during the first part of the season 2019/2020 if we talk about the number of clubs. Before COVID-19 closed the stadiums for the fans, there were five clubs with average stadium capacity utilization of more than 70% (KAR 72% of the stadium capacity of 4,833; CEB with 71% of the stadium capacity of 6,681; BOH with 73% of the stadium capacity of 6,300; PLZ with 78% of the stadium capacity of 11,700; SLA with 73% of the stadium capacity of 19,370). It was the first time in the observed seasons that this had happened. Slavia has also an average attendance of 14,089 per match and during every home match the stadium capacity utilization reaches 62% and more. All these clubs benefit from their steady results and their strong tradition. As for the opposite side of the average attendance rates, there are again 1.FK Příbram and FK Teplice alongside SK Sigma Olomouc. All these three clubs have the same long-term problem with utilizing the capacity of their stadiums.



Total attendance is still constantly growing and a new record can be expected at the end of the spring part of the season. The average of 4,725 from the season 2014/2015 has grown to 5,652 in the season 2019/2020 although there were some regulations in the systems of how to count the attendees in connection with the problem of significant differences between the given number and the real attendance. The total number of attendance during seasons is constantly growing with an exception in the season in which we can see an individual growth thanks to Viktoria Pilsen's successful season (the lowest attendance was 84% and 9,833 attendees).

The final analysis compares the total values of the clubs caused by their players' value and results during the season. A significant difference can be seen between seasons 2016/2017 and 2017/2018. This can be connected with the new financial partnerships that the League Football Association had established which is why the clubs obtained higher amounts of money for the season and were therefore able to spend it for better players and facilities. We can see that the total value of the league clubs is constantly growing and it will probably continue doing so at the end of the season 2019/2020 due to the successes of Slavia Prague in the Europa League and also due to the extra group stage of the league.

## Conclusion

We have come to the conclusion that the Czech Football League has been constantly growing in all the studied areas since the League Football Association took over the leadership of the professional football leagues in the Czech Republic before the season 2016/2017 and we can see a significant difference after the seasons under FAČR (2014/2015 and 2015/2016). The average stadium capacity utilization has grown from 51% of the average stadium capacity and the average of 4,896 people per match in 2014/2015 to the current rate of 56% of the average stadium capacity and the average of 5,639 people per match before COVID-19. Total attendance has been growing as well. The season 2014/2015 saw 1 136 767 attendees in the stadiums whilst the season 2019/2020 saw 1,071,065 attendees; this could lead to total attendance exceeding 1,332,584 at the end of the main part of the season and setting a new record. The average attendance per match confirms this projection with increasing the number from 4,737 (2014/2015) to 5 689 (2019/2020). As for the total market value, a significant difference can be also seen between the seasons 2016/2017 and 2017/2018 between which the value grew from 167,190,000 € to 219,110,000 € and therefore we can see an increasing tendency there.

To summarize the situation, although the overall situation has been improving, there are still many clubs which have problems with utilizing their stadium capacities and attracting people in their area to support their clubs. Both the attendance and the financial situation show an increasing tendency which can be positive; nevertheless, there are still several clubs that are not able to use the overall growth to their advantage. We are currently facing the COVID-19-related restrictions that do not allow fans to come to the stadiums but we can expect a huge hunger for the sports experience after reopening the games to people.

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## RELATIONSHIP OF PUBLIC FINANCING OF SPORTS PROGRAMS WITH ATHLETES' ACHIEVEMENTS - THE CITY OF ZAGREB - CASE (STUDY)

Janja Ricov

Zagreb Sport Association, Croatia

### Abstract

Public funding in top-level sports is present worldwide and is being promoted on the world sports stage through athletes' achievements. Its funding is provided at national and local levels. The basis of this is in community sports, city, region and the nation, but the consideration here been given to the financial investment at the local level. The purpose of this research is to determine the connection between public funding of sports programs and athletes' achievements in 17 Olympic sports in the City of Zagreb, Croatia. Using correlation analysis, the correlation between the allocation of funds for the costs of sports facilities, coaches' salaries, athletes' competitions expenses and youth development, with the number of top athletes of the I., II. and III. category, and the sums of the pondered number of categorized athletes, as well as the number of active athletes with the number of clubs and the number of top athletes, has been determined. Spearman's correlation rank coefficient  $r_s$ , indicates the correlation between the number of top athletes in the III. category (the higher national and lower international level of results) and financing of sports facilities ( $r_s=0.451$ ); coaches' salaries ( $r_s=0.676$ ); competition expenses ( $r_s=0.704$ ), youth development ( $r_s=0.543$ ),  $p<0.05\%$ . For I. and II. category of top-level athletes, (the high international level) the correlation is weak and negative. The number of active athletes is also correlated with the number of top athletes of III. categories ( $r_s=0.452$ ),  $p<0.05\%$ . The number of top-level athletes of the III. category is correlated with every independent variable, meaning that more investment in each of the expenses will result in a higher number of 3<sup>rd</sup> category athletes.

**Key word:** Targeted funding, Local sport, Top-level athletes

### Introduction

Research has shown that many governments and national sports organizations are spending more and more money in pursuit of their country's International Olympic success (Green and Houlihan 2005; Houlihan and Green 2008; De Bosscher et al. 2006, 2010, 2015, 2017), but, at the same time, (according to De Boscher et al. 2018a), little attention has been given to the allocation of sports budgets under the responsibility of governing structures in sport. Consequently, as pointed out by De Bosscher et al. (2015), there is no guarantee that if more money is invested, that more invested money results in more success. According to Matros and Namoro (2004), an effective sport management policy can result in more Olympic medals, and more successful athletes, in economically less developed countries, or countries with lower populations. De Bosscher et al. (2006) classify the factors that influence (factors influencing) country's international sporting success into three levels: *macro*, *meso*, and *micro* level, and they are all inter-related. They point out that *macro* and *micro-level* factors (i.e. population, country's wealth, athletes' genetic traits, etc.) cannot be greatly influenced, except for *meso-level* factors, which are the responsibility of sports and state policies (public budgetary support). They were grouped into nine key areas or pillars. Studies of Clumpner (1994); Green and Oakley (2001); Larose and Haggerty (1996) formed the basis for the creation of a universal factor model for explaining international sporting success at the *meso* level. The answer to this question is how state and sports policies can make a comparative advantage to athletes of one country over the athletes from other countries, through their decisions about the amount of money they will spend on top-level sports, as well how much they will invest into, giving increasingly similar models to national systems (e.g., Matros and Namoro, 2004; Green and Houlihan, 2005). They concluded that increasing global competition is driving an increasing number of countries to adopt strategic approaches in the development of top athletes. The creation of top athletes begins in clubs and schools, and they are partially financially supported through city public budget in which they operate. The success is the result of everything that takes place in the early stages of selecting and developing talented athletes who want to reach the zenith of their sporting performances (Sotiriadou and De Bosscher 2017). The contribution to sporting success coming from the local level is clear, but its measurement in scientific research is scarce, primarily due to the difficulty of obtaining statistical data (De Bosscher 2018). City budget funds are dispersed among other things, to the professional work of coaches' salaries, sports facilities, expenses of preparation and participation in competitions in at World and European Championships, and Olympic Games as well in other sports events, athlete's career development, and more.

The City of Zagreb's allocation of public funds for sports has averaged 5.2% over all four years of this study, with a slight tendency to increase. The total direct budget Zagreb's expenditures are approximately at the level of HRK 7.2 billion, over a four-year period, with the population of 789,655 according to the 2011 census. About 42% of those funds are earmarked for sports programs, while 58% is intended for the functioning and maintenance of sports facilities as well, partly for the re-payment of construction loans. This research falls into the meso-level, looking at the policies of city governing bodies and sports association leaders who decide on the priorities and structures of funds for sports programs, and each one at its own level.

The aim of this research was to determine the association between the investment of public funds of the City of Zagreb and the sports achievements of athletes, measured by the number of top athletes in the 17 most successful Olympic sports (out of a total of 65), in 4 observed years.

Study's hypotheses: H1: There is a statistically significant correlation between the allocation of funds from the budget of the City of Zagreb for the programmatic use of sports facilities, professional work, competitions, youth development programs and parameters of sports quality, measured by the number of top athletes of I., II. and III. categories and sums of pondered categorized athletes. H2: There is a statistically significant correlation between the mass of sports measured by the number of registered athletes, the number of observed sports clubs, and the sums of pondered categorized athletes and the number of top athletes (in categories I. II., III.). The research was conducted as a pilot project with the simplest correlation method. The aim was to establish a basis for further research in which sophisticated methods would be used.

## Methods

The sample includes appropriations of funds for four years (2015 to 2018), allocated to clubs and city federations of summer Olympic team sports (football, basketball, handball, water polo and volleyball), martial arts (boxing, wrestling, judo, karate, taekwondo) and individual sports (athletics, gymnastics, kayaking, swimming, tennis, shooting and rowing), which are at the very top of sports in the City of Zagreb.

*Variables:* *Predictor variables* comprise of financial resources for specific types of expenditure: (sports facilities, coaches' salary, cost of competitions and development programs for young athletes), and *criterion variables* are the number of top athletes (categories I, II, III) and the sum of the ponders of all categorized athletes. In addition, the number of registered athletes in competition systems and the number of clubs in relation to categorization was observed. Data of the allocation of financial resources and all others was collected from the archives of the Zagreb Sports Association. Pondering of categorization was done according to the model of multiplying the number of categorized athletes by number of points, where: I. category = 4 points (because it lasts 4 years), II. categories = 2.5 points (because it lasts 2 years) and III. category = 1 point (because it lasts 1 year), all in accordance with the Rulemakin book on the Categorization of Athletes of the Croatian Olympic Committee.

Top athletes of the I. category achieved a ranking from 1<sup>st</sup>-8<sup>th</sup> place in the Olympic Games (OG) & World Championships (WC) and 1<sup>st</sup>-6<sup>th</sup> place in the European Championships (EC). Top athletes of the II. category achieved lower placements (9<sup>th</sup>-16<sup>th</sup> place in OG and WC and 7<sup>th</sup>-12<sup>th</sup> place in EC). Top athletes in the III. categories most commonly reached finals of the Croatian Championship (CC) in individual sports, while in team sports this is the ranking up to 6<sup>th</sup> place. At the international level, this is lower ranking than those mentioned above or participation in the OG, WC and EC. Juniors and cadets can only earn lower grades, if they are medal winners, in the WC and EC (in summary).

Statistica and SPSS software packages were used to process the collected data. Basic statistical parameters (min, max, arithmetic means, standard deviations) were calculated and the normality of frequency distribution (Shapiro-Wilk test) for all variables were examined as well. Spearman's rank correlation coefficient was used to calculate the correlation between the variables, because the frequency distributions of the observed variables were not normally distributed.

## Results and discussion

Data changes in the independent and dependent variables varied over the observed four years. No variable, in any one year, is normally distributed, because all Sig. Are <0.01%. Therefore, the results by years were analysed, but for all years together, because there is no statistically significant difference between the observed years, since the significance of Asymp.Sig is > 25.0%. Data of basic statistics for all variables are provided in Table 1.

Table 1. Basic statistical indicators of all variables (with expenses indicated in HRK 1€~7.4HRK)

Variables	MIN	MAX	A	$\sigma$	Shapiro-Wilk
Facilities	273.000	13.846.400	2.458.483,21	3.204.119,95	0,000
Coaches' salary	372.861	9.649.861	1.822.440,10	2.003.563,61	0,000
Coaches temporary	0	1.996.053	256.517,14	338.105,39	0,000
Coaches Total	432.861	10.343.461	2.078.957,25	2.174.451,69	0,000
Competitions	20.000	7.171.380	1.348.619,47	2.073.044,19	0,000
Young Development	20.000	4.544.480	643.836,57	1.113.969,65	0,000
Active Athlete	250	19.638	2.243,13	4.255,01	0,000
Clubs number	4	143	24,76	30,79	0,000
Sum ponder	13	166.50	49,69	32,82	0,000
1 <sup>st</sup> category =4	0	96	21,76	20,38	0,000
2 <sup>nd</sup> category =2,5	0	42,50	9,78	9,742	0,000
3 <sup>rd</sup> category =1	0	67	18,15	15,82	0,000
Top Athlete 1st cat.	0	24	5,44	5,09	0,000
Top Athlete 2nd cat.	0	17	3,91	3,90	0,000
Top Athlete 3rd cat.	0	67	18,15	15,82	0,000

Testing the first hypothesis about the correlation of predictor variables (financing costs) on categorization (criterion variables), it follows that Spearman's correlation rank coefficient showed the correlation between number of top athletes III. categories (higher national and lower international level scores) and financing: sports facilities ( $r_s=0.451$ ); the salary of the coach ( $r_s=0,676$ ); financing of competitions ( $r_s=0.704$ ), financing of development of young athletes ( $r_s=0.543$ ),  $p<0.05\%$ . For I and II. category of top athletes (high international level) is weak and negative. The number of active athletes is only related to the number of categorized athletes III. category  $r_s$  is 0.452 with a significance level of 0.05%. Number of top athletes III. category of medium to strong is related to all independent variables, which means that the more invested in sports facilities, especially the salaries of coaches, competition and development programs of young athletes, give a more of top athletes III. categories. The sum ponders has a poor correlation with the salaries of coaches ( $r_s=0.258$ ) and competitions ( $r_s=0.279$ ), so it follows that a better overview of the correlation is visible for each category separately (showed in Table 2.)

Table 2. Correlations between independent and dependent variables.

Variables	Sum ponders Spearman Sig.		Athletes I. cat. Spearman Sig.		Athletes II. cat. Spearman Sig.		Athletes III. cat. Spearman Sig.	
Facility	0,098	0,426	-0,196	0,108	<b>-0,357</b>	0,003	<b>0,451</b>	0,000
Coaches' salary	<b>0,258</b>	0,034	-0,091	0,458	-0,172	0,160	<b>0,676</b>	0,000
Coaches temporary	0,075	0,542	<b>-0,248</b>	0,041	<b>-0,319</b>	0,008	<b>0,462</b>	0,000
Coaches Total	0,231	0,058	-0,129	0,293	-0,202	0,098	<b>0,657</b>	0,000
Competitions	<b>0,279</b>	0,021	-0,150	0,223	-0,198	0,105	<b>0,704</b>	0,000
Young Development	0,100	0,415	-0,223	0,067	-0,204	0,095	<b>0,543</b>	0,000
Active Athletes	0,112	0,365	-0,134	0,276	<b>-0,274</b>	0,024	<b>0,452</b>	0,000
Clubs Number	-0,235	0,054	<b>-0,332</b>	0,006	<b>-0,442</b>	0,000	0,025	0,839

To test the second hypothesis about correlations of the variables of number of active athletes and number of clubs on the categorization of athletes, it follows that the number of active athletes is related to the number of top athletes III. categories because  $r_s=0.452$ . Higher number of active athletes has the effect of increasing the number of top athletes III. categories. There is no correlation between the number of clubs and the number of athletes III. categories (but correlation of I. and II. category is weak and negative). Many scientific studies seek to find a link between investment funds and top-level athletes at state levels. This research has demonstrated the link between financial investments in full-time coaches' salaries, the costs of competitions and the costs of developing young athletes with the number of top athletes III. categories. Since this is a local-city level survey, this result is expected, because the purpose of the local level is to create conditions for the development of young athletes, with conditions for sports as wide range of athletes as possible. It also creates the support for a smaller number of top athletes for high international achievements. When an athlete demonstrates the quality of a national level, he/she is recognized by his coach and the coach of the national team. Then

the care of his further trainings and funding is taken-over by the national sports authorities (De Bosscher et al. 2017). The number of top athletes I. and II. category (represents the top international level) is expectedly smaller in the view of rigorize international competition, and this level requires high financial investments. This research, based on allocating funding to individual sports programs at the local level, confirms previous scientific research by a group of authors (De Bosscher et al. 2015, 2017) was done at the state level. According to this research, the salaries of full-time coaches, the allocated of funds for the performance of athletes in domestic and international competitions, as well in the development of young athletes, is strongly correlated with top sports achievements.

## Conclusion

This research shows the connection between financing sports facilities, salaries of coaches; competitions, development of young athletes and number of top athletes III. categories corresponding to higher national and lower international level of results, while for I. and II. category of top athletes (high international level) the correlation is very weak and negative. The number of active athletes is only associated with the number of top athletes of the III. categories. Considering the correlation between the number of top athletes of the III. category, and all independent variables, it means that there will be more of these athletes when invested in each of these costs. Given that it is local funding, most athletes of the national quality level, are naturally expected.

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## **CORRELATION OF ECONOMIC, GEOGRAPHICAL AND DEMOGRAPHIC CHARACTERISTICS OF THE WORLD COUNTRIES WHICH HAVE WON MEDALS AT THE WORLD AND OLYMPIC ROWING CHAMPIONSHIPS**

**Antonela Sinković, Valent Sinković, Dragan Milanović**

*University of Zagreb Faculty of Kinesiology, Croatia*

### **Abstract**

The aim of this research is to determine the correlation between the economic, geographical, and demographic characteristics of a country and medals won at the World Rowing Championships and the Olympic Games from 1992. to 2019. Sample size consisted of 45 countries and correlation analysis was conducted. The aim of the correlation analysis was to determine the relationships between total number of medals won at World Rowing Championships and Olympic Games with the geographic, economic, and demographic characteristics of the observed countries. The results indicate that there is a correlation between the demographic characteristics of a country and the total number of medals won at the world biggest rowing regattas, and no correlation between the geographic and economic characteristics of a country and the total number of medals won at the world biggest rowing regattas. Therefore, we can conclude that the results of a given country depend on the number of potential athletes being selected for rowing. However, financial aspect and total surface area of a country do not represent an important factor in rowing successfulness of that country.

***Key words:** rowing, world championships, olympic games, GDP per capita, total area, population*

### **Introduction**

Rowing is a sport which is very popular in the world. It gathers attention from the big number of potential athletes and experts, which try to incorporate their professional knowledge and scientific information into sport equipment technology to ensure the highest sport achievements at the World Rowing Championships and the Olympic Games (Milanović et al., 2011). Countries try to provide optimal conditions in terms of logistics, finance, sport facilities and other conditions which enable development of talented athletes which in the long-term process go through very demanding training plans and competitions (Korner, Schwanz, 1989). Also, many countries in the world have a long rowing tradition. Therefore, both countries with high and low GDP levels are trying to get funds so they can enable the best conditions for their rowers. However, a premise that wealthier countries are achieving better results at big competitions than the less developed (poorer) ones, should be further analysed (Secher, Volianitis, 2007). Moreover, the more populous countries have larger number of potential athletes, therefore more rowers go through rigorous selection criteria. Thus, we can assume that more populous countries have better chance of achieving the best results at rowing competitions than the less populous ones. A positive correlation between the population size and the surface area of a country has already been confirmed (Sinkovic et al., 2019). Consequently, positive correlation between the surface area of a country and success in rowing of that country at the world stage could be assumed and expected. It is exactly in the mentioned premise, that the main issue of this research can be found, defining its goal, and setting.

Research has shown that in the early days of modern rowing, larger, more populous, and wealthier countries dominated (Secher, Volianitis, 2007), while poorer and smaller countries started achieving better results after the World War II. A number of studies analysing the factors that affect a country's performance at the Olympics has been conducted (Scalles et al., 2020.). In the research of Bernard and Busse (2004), the hypothesis that winning medals is proportional to the number of inhabitants was rejected. The obtained results show that income and population have a similar effect on the number of medals won at the Olympics, while GDP seemed to be the best predictor of results at the Olympics. A similar study was conducted by Vagenas and Vlachokyriakou (2012) who included both the household variable and the number of registered athletes and found a significant correlation for both variables with the total number of medals won at the Olympics. Analysing the factors influencing the total number of medals won at the Olympics, Forrest, Sanz and Tena (2015) took into account the level of public spending on recreational, cultural and religious affairs on household at the next Olympics and found that both variables have a positive impact. However, Blais-Morrisset, Boucher and Fortin (2017) found that the level of public spending on recreational, cultural, and religious affairs is better indicator of a country's performance at the Olympics than GDP per capita.



Despite a large number of studies that analysed the success factors of each country at the Olympics, we found no such papers concerning rowing. Therefore, the aim is to determine the relationship between countries' geographical, economic, and demographic characteristics with medals won at world's largest rowing competitions from 1992 until 2019. Based on the mentioned aims, we set the following hypotheses:

H1: There is a correlation between countries' GDP per capita and the total number of medals won at the world biggest rowing regattas.

H2: There is a correlation between countries' surface area and the total number of medals won at the world biggest rowing regattas.

H3: There is a correlation between the population (number of inhabitants in a certain country) and the total number of medals won at the world biggest rowing regattas.

## Methods

In this paper, a sample of by 45 world countries which have won medals in rowing at World Championships and Olympics from 1992 to 2019 was analysed. Data concerning won medals was collected from World Rowing Federation's official site. In this period, Germany has won the most medals (256 medals).

The study tested the correlation between the following variables:

- dependent - total number of medals won;
- independent - population in millions, area in km<sup>2</sup> and GDP per capita in dollars which represents GDP (Gross Domestic Product) represents the degree of wealth of the country expressed in dollars per capita (Mankiw, 2006).

The size or area of the country determines the total territory of a country. It is measured in km<sup>2</sup> (square kilometres) and includes the land and water territory of a country (Wikipedia, 2020).

The population is the total number of people in a country. It is determined by its location, density, census-based movement, natural growth, spatial mobility, composition and other features in space and time (Nejašmić, 2005).

Statistica 13.5 program was used to analyse the data. The characteristics of the sample were analysed by the descriptive statistics method and are shown in Table 1. First, central dispersive parameters were determined, then three independent and one dependent variable were determined. This was followed by simple correlation analysis to determine the level of correlation between the analysed variables. An important part of the analysis relates to the statistical correlation between independent variables and dependant variable which is defined by the total number of medals won. Also, a significance level of 95% was applied ( $p < 0.05$ ).

Table 1. Descriptive statistics

Variables	Descriptive Statistics				
	Valid N	Mean	Minimum	Maximum	Std.Dev.
Total of medals (number)	45	46	1,000	256	61
GDP per capita (in thousands of dollars)	45	50	3,592	859	125
Total area (km <sup>2</sup> /1000)	45	1660	1092	17075	3680
Population (in millions)	45	40	1,326	331	62

## Results

In this study, a series of independent variables (GDP, surface area and population) and a dependent variable (total number of medals won in rowing at the World Rowing Championships and the Olympic games) were compared using the correlation matrices method and we got the coefficients of correlation shown in Table 2.

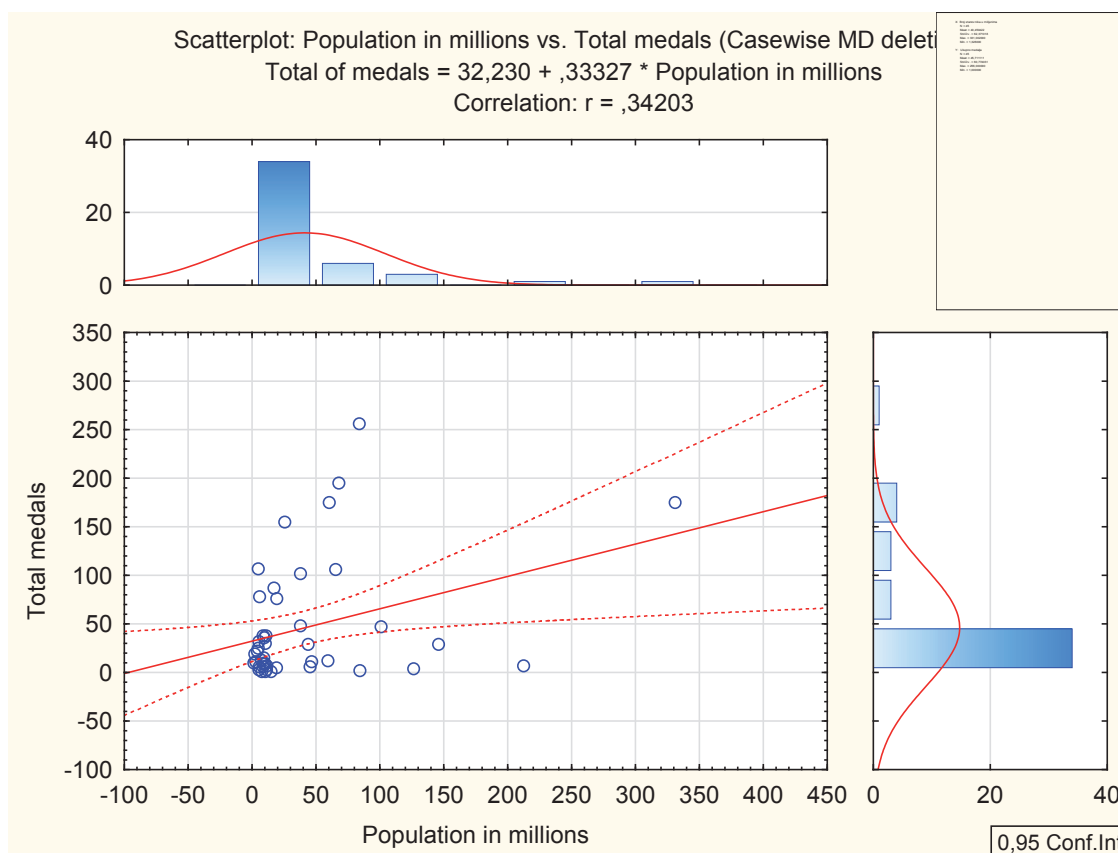
Table 2. Correlation analysis of independent variables and dependent variable of the number of won medals in rowing

Variables	Correlations (Spreadsheet8) Marked correlations are significant at $p < ,05000$ N=45 (Casewise deletion of missing data)			
	Total medals (number)	GDP per capita (in thousands of dollars)	Total area (km <sup>2</sup> /1000)	Population (in millions)
Total medals (number)	1			
GDP per capita (in thousands of dollars)	-0,05	1		
Total area (km <sup>2</sup> /1000)	0,19	-0,06	1	
Population (in millions)	0,34*	-0,06	0,65*	1

$p < 0.05^*$



Based on the conducted analysis, it was determined that the third hypothesis was confirmed and there is a correlation between the countries' population and the total number of medals won at the world biggest rowing regattas ( $r = 0.34$ ). This means that countries with a larger population are more likely to win medals at these competitions (Graph 1). However, correlation between the total number of medals won and GDP of a country ( $r = -0.05$ ), and total surface area of an observed country ( $r = 0.19$ ), was not found.



Graph 1. Correlation between population and won medals in rowing at the World Championships and Olympic Games from 1992 until 2019

## Discussion

The results indicate that only one out of three hypotheses can be accepted. The reason for this stems from the obtained correlation coefficient which shows statistically significant relationship between the total number of medals won at world competitions in rowing and population size. On the other hand, there are no statistically significant relationships between the total number of medals won and countries' wealth measured by the level of GDP, and its total surface area. The obtained results are not in line with previous research that analysed the factors of a country's performance at the Olympics (Bernard et al., 2004., Blais – Morriset et al., 2017., Forrest et al., 2015). A possible reason for such results is the fact that previous research did not take into account exclusively rowing but all Olympic sports. In addition, rowing is a specific sport in which tradition comes to the forefront. Therefore, it is extremely popular in some countries, such as the United Kingdom, while in some other countries it is not represented, so despite having great wealth, countries do not allocate funds for this sport. Also, rowing is still classified as an amateur sport which does not require significant financial resources. Therefore, even the countries with much lower GDP (poorer) can equally compete with their rivals which have higher GDP (wealthier nations) on the biggest rowing regattas, and even win medals. Finally, it should be emphasized that simple correlation analysis was used when processing data, while other studies used regression analysis. This is also a limitation of this research, so more complex statistical methods should be applied in the future.

Additionally, genetic predispositions and individual qualities of an individual should be considered, because even despite small financial spending of their country they still manage to continuously win medals at the biggest rowing regattas (Secher, Volianitis, 2007). The relationship between the total number of medals won and countries' GDP, surface area of and population size, should be also considered from the aspect of rowing tradition in each country. Tradition has a significant influence on young athletes which engage in rowing based on the previous successful achievements of the country. Population size affects the total number of medals won because the larger number of people will have different interests which will be directed towards different sports, and some of them in rowing.

Besides the already mentioned factors it is inevitable to mention favourable influence of climate conditions and availability of natural resources (river, lakes), air temperatures, wind, rainfalls, etc. on development of rowing (Secher, Volianitis, 2007). Therefore, a country that lacks these favourable factors, despite its big surface area will not be suitable for rowing as a sport activity.

## Conclusion

In this paper a significant correlation between demographic factors of a country and its total medal count at biggest rowing competitions was found. Therefore, we can conclude that the results of a certain country depend on the number of potential athletes being selected for rowing. However, financial aspect and total surface area of a country do not represent an important factor in rowing successfulness of that country. Due to popularity of rowing in the world it is important to note that the number of people in each country is an important factor in rowing successfulness at the biggest rowing competitions of that country. The world and relationships between countries are in constant change. Additionally, smaller countries are emerging which are achieving significant rowing results. Therefore, for the future studies we suggest investigating demographic, economic and geographic factors in this Olympic sport more deeply and using more complex methods that will point not only to the existence of a connection but to its structure as well.

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## DIFFERENCES IN EXPENDITURE ON SPORTS PRODUCTS AND SERVICES BETWEEN STUDENTS OF FACULTY OF KINESIOLOGY ZAGREB

Lucas Šaravanja<sup>1</sup>, Sanela Škorić<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, doctoral studies, Croatia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The aim of this paper is to analyze the differences in expenditure on sports products and services between male and female students of the Faculty of Kinesiology University of Zagreb. Since they are defined as a selected sports population and have a direct impact on the trainees, it is important to explore their consumer habits in a world in which we see a strong expansion of the sports industry. The sample included 484 students and 373 questionnaires were taken into the final analysis. The results show that female students spend more on sportswear, footwear and monthly membership fees (etc. gyms, sport clubs), while male students spend more money on sports betting, nutrition supplements, and tickets for sport events ( $p \leq 0.05$ ). In conclusion, the identified differences in expenditure between students on particular categories of sports products and services may serve as a great basis for further research in this area. In future research, it is necessary to further examine the background of the differences in expenditure.

**Key words:** *sports marketing, sports market, expenditure on sports, sports economics*

### Introduction

In recent years, we have seen a strong expansion of the sports industry globally. In such a socio-cultural context it is very important to investigate consumer habits in order for sports clubs and organizations to be as successful as possible. In the literature review, there is a clear lack of papers researching into expenditure of students on sports products and services. Additionally, there is no clear definition of sports products and services. Some researchers have only taken into account products and services related to active participation such as sportswear, footwear, membership fees etc., and others included products and services related to passive participation such as sports betting and tickets for sports events, as well. Also, there are some common problems such as different samples (households, competitive athletes, recreational athletes etc.), and in some of them expenditure was not divided in subcategories (Wicker, Breuer & Pawlowski, 2010). Nevertheless, research results have not been consistent when gender differences are in question. Research of López & Rapún-Gárate (2005) included general population and found that statistically significant factors that are affecting expenditure were: gender, education and income, and men with higher education, and higher income spend more money on sport products and services. Similar results were obtained by Breuer and Schlesinger (2006) in Germany (general population). Again, men spend more money on sports products and services. Variables found to positively affect expenditure are education and income, but not age. On the other hand, sport club members in Germany show somewhat different characteristics (Wicker et al., 2010). In the study, women with higher income, lower level of education and more hours weekly spent in sport are the biggest spenders. Additionally, the biggest expenditure was documented in sports like equestrian, sailing and golf, while the lowest was in volleyball, table tennis and badminton. On a specific sample of cyclists in Belgium, authors Thibaut, Vos, Lagae, Boen and Scheerder (2011) concluded that the largest consumers in the study were MTB cyclists, then competitive cyclists, while recreational cyclists spend the least. Generally, male cyclists, competitors, with higher educational status, greater involvement (week frequency) spend more on average on sports than others. When it comes to specific categories of sports products and services, studies have shown that men spend more on sportswear, sports footwear, sports betting, membership fees and tickets (Baggio et al., 2018; McCarthy et al., 2018; Salonen et al., 2018; Scheerder et al., 2011). There was a methodological difference in results in the category of dietary supplements. In the big population studies in which nutritional supplements were defined solely as multivitamins and/or multimineral, it has been proven that women spend more on dietary supplements (Bailey et al., 2011; Burnett, et al., 2017; Kofod et al., 2015). On the other hand, the research that was applied on the specific population (respondents involved in resistance training) and in which the concept of nutritional supplements was extended (e.g. protein powder has been included) shows that men spend more in relation to women (Austin, et al. 2017; Bianco et al., 2014).

From the literature review there are no studies that have addressed the student population expenditure on sports products and services. So, the novelty of this study is to investigate these differences in the student population. Precisely, the aim of this paper is to research into differences in expenditure of male and female students who participate in sports and

recreational activities beyond the obligatory curriculum of Faculty of Kinesiology, University of Zagreb. In this research there is a clear terminological distinction between the terms physically active and physically inactive student. The term physically inactive student refers to a student who does not participate in sport activities outside the obligatory curriculum of Faculty of Kinesiology (i.e. besides attending classes and preparing for exams). Following hypothesis were tested:

H1 – There are no statistically significant differences between male and female students in terms of socio – economic variables

H2 – Male students spend more money on sportswear, sports footwear and membership fees

H3 – Male students spend more money on sports betting, nutritional supplements and tickets for sporting events

## Methods

The research was conducted at the Faculty of Kinesiology, University of Zagreb during the summer semester of academic 2018/2019. year, and sample included 484 undergraduate and graduate students in all study years. A total of 111 questionnaires were omitted from the sample (66 due to an incorrectly filled survey, and 45 students declared themselves “physically inactive”).

For the purpose of the research a specific questionnaire was developed in accordance with the previously mentioned papers in literature review. The questionnaire contained questions in four categories: 1. Demographic characteristics, 2. Socio-economic characteristics, 3. Sport characteristics (lifestyle) and 4. Expenditure on sports products and services. Expenditure estimates for sports products and services were on an annual basis and referred to the period from January 1st, 2018 to December 31st 2018. In this research, expenditure on sports products and services included products and services related to active (sportswear, sports footwear, gym memberships etc.) and passive participation (sports betting and tickets for sporting events).

The data has been edited and grouped in a Microsoft Excel 2016 for Windows PC. The IBM SPSS Statistics 19 for PC software package was used for statistical analysis. Descriptive and inferential statistics methods were used in the analysis. Descriptive statistics included arithmetic mean, mode, standard deviation, minimum and maximum values. T - test for independent sample determined statistical significance of differences between male and female respondents ( $p \leq 0.05$ ).

## Results

Majority of students still live with their parents (34,31%), earn income through combination of their own work and the help of their parents (31,90%), and are fourth year students (24,66%). There is a higher relative proportion of students engaged in recreational sport activities (66.49%) compared to those engaged in competitive sports (33.51%), and distribution according to gender was in favour of males (63,54%).

Table 1. Descriptive statistics in quantitative variables AGE, MI, YSS, WF, WH, SPW, SPF, SPGA, SPEQ, SPTE, SPNS, SPMF, SPBE, SPTS, OE and TE

VARIABLE	N	AM	MIN	MAX	SD
AGE (Age – continuous variable)	373	21,70	19,00	31,00	1,89
MI (Monthly income- continuous variable)	373	2080,16	250,00	6500,00	1155,43
YSS (Years spent in sport - continuous variable)	373	8,11	0,08	23,00	5,54
WF (Weekly frequency – discreet variable)	373	4,02	1,00	11,00	1,61
WH (Weekly hours – continuous variable)	373	7,30	1,00	26,00	3,70
<b>EXPENDITURE ON SPORT PRODUCTS AND SERVICES (all continuous variables)</b>					
SPW (sportswear)	373	1473,54	0,00	8000,00	1222,162
SPF (footwear)	373	1167,96	0,00	5000,00	773,90
SPGA (gadgets)	373	395,62	0,00	4000,00	723,39
SPEQ (equipment)	373	329,40	0,00	5000,00	541,87
SPTE (tickets for events)	373	236,18	0,00	4000,00	385,15
SPNS (supplements)	373	357,17	0,00	4500,00	601,77
SPMF (membership fees)	373	719,27	0,00	31200,00	1848,75
SPBE (betting)	373	306,68	0,00	7500,00	940,57
SPTS (therapeutic services)	373	316,27	0,00	12000,00	1043,66
OE (Other expenditure)	373	221,72	0,00	60000,00	3160,39
TE (Total expenditure)	373	5523,80	400,00	67500,00	5027,80

Legend: AM – arithmetic mean, MIN – minimum value, MAX – maximum value, SD – standard deviation

Table 1 clearly shows big differences between the minimum and maximum values, as well as the values obtained by the standard deviation. Such results are expected given that the concept of the sport product and service in this research is defined extensively. Statistically significant differences were not found in the variables AGE, MI, YSS, WF, SPEQ, SPGA, SPTE, OE and TE.

Table 2. Descriptive statistics for male and female students in variables with statistically significant differences

Group statistics (T-test for independent sample)					Levene's test		T – test for Equality Of AM	
GENDER	N	AM	SD	SEAM	F/Sig.		t/df/Sig.(2-tailed)	
WH	Male	237	7,580	4,0151	0,2608	Equal variances assumed	6,760/0,010*	1,946/371/0,052
	Female	136	6,809	3,0191	0,2589	Equal variances not assumed		2,099/344,872/0,037*
SPW	Male	237	1294,23	1057,890	68,717	Equal variances assumed	9,223/0,003*	-3,808/371/0,000
	Female	136	1786,03	1415,872	121,410	Equal variances not assumed		-3,525/222,299/0,001*
SPF	Male	237	1097,26	695,919	45,205	Equal variances assumed	5,989/0,015*	-2,343/371/0,020
	Female	136	1291,18	882,985	75,715	Equal variances not assumed		-2,199/231,57/0,029*
SPTE	Male	237	280,23	443,131	28,784	Equal variances assumed	6,833/0,009*	2,946/371/0,003
	Female	136	159,41	236,924	20,316	Equal variances not assumed		3,429/369,429/0,001*
SPNS	Male	237	413,78	626,861	40,719	Equal variances assumed	6,306/0,012*	2,414/371/0,016
	Female	136	258,53	543,581	46,612	Equal variances not assumed		2,508/314,797/0,013*
SPMF	Male	237	496,19	795,689	51,686	Equal variances assumed	10,718/0,001*	-3,112/371/0,002
	Female	136	1108,01	2841,087	243,621	Equal variances not assumed		-2,457/147,256/0,015*
SPBE	Male	237	473,23	1146,881	74,498	Equal variances assumed	59,004/0,000*	4,637/371/0,000
	Female	136	16,43	69,068	5,922	Equal variances not assumed		6,112/238,976/0,000*

AM – arithmetic mean, SD – standard deviation, SEAM – standard error of arithmetic mean

It is important to note that on average, women spend more on sportswear (HRK 1786.03) compared to men (HRK 1294.73). That difference is smaller when it comes to sports footwear. Women spend more than twice as much than men on membership fees for sports clubs, swimming pools, gyms, etc. (HRK 1108.1 versus HRK 496.19). On the other hand, we see a reverse situation in the sports betting segment. Men spend far more than women (HRK 473.23 versus 16.43 HRK). In addition, men spend more on dietary supplements and tickets for sport events. When it comes to the number of hours spent in sports and recreational activity on a weekly basis, men participate more than women.

## Discussion

Literature review has presented results in which men spend more than women on sports clothing and footwear, but also generally for sports products and services (Breuer & Schlesinger, 2006; Lera-López and Rapún-Gárate, 2005; Thibaut et al., 2011). On the other hand, in this research, it was revealed that female students spend statistically significantly ( $p \leq 0.05$ ) more money than male students on sportswear, footwear and membership fees. These contradictory findings can be attributed to sample characteristics. In the previous papers, men spent more which was related to their higher income levels and the degree of active participation in sports. In this research no statistically significant difference in income between male and female students was found. The reasons can be found in the fact that a larger number of female students still live with parents and earn income solely with the help of their parents in comparison with male students. In addition, a smaller number of female students earn income only from their own work (9.56%) as opposed to male students (18.57%). When it comes to earning through parents help just 20.68% of male students earn income this way versus 27.21% of female students. If respondent receives monthly income exclusively from its own work, it is understandable that respondent will better estimate the monthly income. Wicker et al. (2010) unlike other researches, found that women with lower levels of education and higher monthly income spend more on sports products and services. This was explained by the fact that these women are very likely in marriage or other form of community with partners who have higher monthly incomes. Furthermore, as expected, male students spent more on sports betting, tickets for sports events and nutrition supplements. Research suggests a higher prevalence of men who participate in sports betting and gambling (Baggio et al, 2018; McCarthy et al., 2018; Salonen et al., 2018). Finnish researchers have concluded that men with lower education, lower income, unemployed, and those who play different types of gambling spend more money on a weekly basis and relative to their incomes (Salonen et al., 2018). Although studies to date find that there is a higher prevalence of women consuming dietary supplements (Bailey et al. 2011; Burnett et al., 2017; Kofoed et al., 2015), it should be emphasized that in these experiments only multivitamins and/or multiminerals have been included. On the other hand, studies that



included a more extensive definition of nutritional supplements and/or sample of the subjects engaged in resistance training, consensus state that men spend more money (Austin et al., 2017; Bianco et al., 2014). Since this is a population of Faculty of Kinesiology, it is more convenient to compare results of this study with previous studies on specific population.

## Conclusion

The goal of every successful organization is to meet the needs and desires of consumers in such a way that they do it faster and better than their competitors. Analyses have shown that female students spend more on sportswear, footwear and membership fees, while male students spend more on sports betting, tickets and nutrition supplements. There are some limitations in this study. First, there is no clear definition of sports products and services. Some studies included only products and services related to active participation (sportswear, sports footwear etc.), and others included only ones related to passive participation (sports betting, nutritional supplements etc.) or combination of two previously mentioned. Also, it is recommended for future researches to include categorization by sports. Assumption is that categorization will lead to better results. Secondly, the sampling method is also an issue. Sample of students were not randomized and it is impossible to make any conclusions that are applicable to general population. In conclusion, the identified differences in expenditure between students on particular categories of sports products and services may serve as a great basis for further research in this particular area. In future research, it is necessary to further examine the background of the differences in expenditure.

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## PREFERRED LEADERSHIP STYLES AMONG CROATIAN AND SERBIAN STUDENTS

Sanela Škorić<sup>1</sup>, Nebojša Maksimović<sup>2</sup>, Radenko Matic<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>University of Novi Sad Faculty of Sport and Physical Education, Serbia

### Abstract

The topic of leadership has always attracted the attention of researchers from management, as well as other points of view. Leadership is one of the management functions, which means that every manager conducts this function. However, not every manager is a good (successful) leader implying that there are some characteristics that distinguish between two types of managers – those exhibiting these characteristics opposed to ones that do not. The role of leaders and their characteristics in achieving (sport) organizations goals, and satisfaction of employees has been confirmed in number of research. Transformational style of leadership has been found to be best suited for 21<sup>st</sup> century business characterized by constant changes. Students studying at kinesiology faculties are future employees and potential managers and leaders of sport organizations, making them a relevant sample for research. The sample consisted of 272 students from Croatia (121) and Serbia (151). Their vision of managers does not necessarily include managers with emphasized leader characteristics, and preferred leadership style is transactional.

**Key words:** *transactional leader, transformational leader, sport, management*

### Introduction

Although leaders are found outside formal organisations as well, implying that it is much broader term than management, it nevertheless represents one of the management functions. It can be regarded to as the “only true management function” since it cannot be delegated to others (see Sikavica, Bahtijarević-Šiber, Pološki Vokić, 2008). The topic of leadership has been one of the most researched management topics (Lussier, Kimbal, 2014, p. 373), but has remained a term difficult to explain. It has been defined as a process, influence, and most often through leadership traits (see Bhaskar, 2009, Sikavica, Bahtijarević-Šiber, Pološki Vokić, 2008). In its essence, leaders “influence people to work to achieve the organization’s objectives” (in Lussier, Kimball, 2014, p. 373), and it comes down to people relations. Leaders cannot exist without followers, i.e. leadership process consists of two basic elements: leader traits and behaviours, and followers i.e. their perceptions, in a particular context (different organizational settings, environment, as well as economic activity) (Antonakis, 2006). Since every manager conducts all management functions he/she implements the leadership function as well. However, every manager is not a good (and successful) leader. In other words, there are some differences between managers and leaders, which can be summarized as follows: managers “do things in the right way”, and leaders “do the right things” (Sikavica, Bahtijarević-Šiber, 2008, p. 93). Some of the characteristics of managers are that they are rational, consulting, persistent, problem solving, adamant, analytical, structured, thought-out, have formal authority, while leaders are visionary, passionate, creative, flexible, encouraging, innovative, brave, imaginative, initiates change, has personal power (see Sikavica, Bahtijarević-Šiber, Pološki Vokić, 2008, p. 465). Leaders traits and behaviour have proven to be of utmost importance for organizational success (Antonakis, 2006), and sport is no exception (see Burton, Peachey, 2009; Coleman, 2012; Ghezelsefloo, Ashouri, 2017; Rowold, 2006; Soebbing, Washington, 2011; Wheaton, 2012). Traits of effective managers have been studied since early 1900s and several theories can be distinguished (more in Lussier, Kimball, 2014; Sikavica, Bahtijarević-Šiber, Pološki Vokić, 2008). Of interest for this paper are characteristics of transformational and transactional leaders. Transformational leadership appeared as a reaction to changes in global environment including high levels of uncertainty, competitiveness, as well as constant change, and transformational leaders are 21<sup>st</sup> century leaders (Sikavica, Bahtijarević-Šiber, Pološki Vokić, 2008, p. 509). Sport has been no exception, and a number of challenges associated with globalization, technology, ethics and social responsibility issues, facing sport organizations can be identified (more in Škorić, 2018). In order to face these challenges, manager with strong leader characteristics is needed. One with clear vision and power to influence others to accept and follow that vision. Leading in these circumstances more and more takes on a characteristics of transformational leader, as opposed to transactional one. According to Bass (1996) characteristics of transformational leaders can be summarized as charismatic leadership or idealized influence (they are role models for their followers), inspirational motivation (they motivate and inspire followers by providing meaning and challenge to their work), intellectual stimulation (encourages innovation and creativity with

followers), and individualized consideration (act as coaches and mentors, giving special attention to each individuals' needs). On the other hand, transactional leaders are characterized by contingent reward (setting performance goals and rewards for achieving them), management by exception (active or passive – actively monitoring or waiting passively for deviances, mistakes and errors to occur and then taking corrective action if necessary) and laissez-faire (avoidance or absence of leadership).

Croatia and Serbia are two countries coming from similar surroundings and are referred to as “young democracies” (Podrug, Filipović, Stančić, 2014). As a part or the same country until 1990s, similar backgrounds can be attributed to both countries. According to research of Podrug, Filipović and Stančić (2014), both have shifted towards individualism, have high uncertainty avoidance, are masculinity and short-term oriented (Podrug, Filipović, Stančić, 2014).

The purpose of this paper is twofold. First to find out the opinions of future employees in sport, possible drivers of change, regarding their understanding of the term manager in sport (do they attribute characteristics of managers or leaders to their understanding of the term manager in sport), i.e. do they expect managers to be leaders as well. Secondly, what is their preferred leadership style, transactional or transformational. Additionally, differences between two groups of students (Croatian and Serbian students) were analysed. Based on previously mentioned findings, as well as results of some previous research indicating that “basic management functions” prevail with sport managers in Croatia (Škorić, 2009) and comparison of leadership styles of managers in sports (Maksimović, Matić, Milošević, & Bjelica, 2011; Matić, Maksimović, Milošević, Vuković, & Jakšić, 2016), following hypothesis were tested:

H1 – students do not expect managers to be leaders as well (they do not assign characteristics of leaders to managers)

H2 – students prefer transactional style of leadership

H3 – there are no statistically significant differences in opinions between Croatian and Serbian students regarding specific characteristics in chosen leadership style.

## Methods

A questionnaire developed by Sikavica, Bahtijarević-Šiber (2008) was adopted to suit the needs of this research, and distributed to fourth year students at Faculty of Kinesiology Zagreb and Faculty of Sport and Physical Education Novi Sad. Population consisted of all students enrolled into subject Economics and Management of Sport in Zagreb and subject Sport Management in Novi Sad. In total, 272 questionnaires were analysed (121 from Zagreb and 151 from Novi Sad). Zagreb sample consisted of 83 male and 38 female students, which were 22 years of age ( $M=22,30$ ;  $SD = \pm 1,37$ ). Novi Sad sample consisted of 92 male and 59 female students with also average age of 22 ( $M=22,27$ ;  $SD = \pm 1,02$ ). Questionnaire consisted of 14 questions, and 2 are analysed in this paper. In both questions students were asked to choose between two offered statements: 1) regarding characteristics of managers or leaders, and 2) that are specific for transactional or transformational leadership style. Respecting current management philosophies, we used the concept of transactional-transformational leadership. According to many authors, this leadership approach responds to the needs of contemporary working groups, which seek to be inspired and empowered to succeed in times of uncertainty. Transformational leadership is not only based on gaining followers, but it involves shifts in the beliefs, desires and values of followers. It presents itself as the ability to influence people in order to change, progress and direct them (Hall, Johnson, Wysocki, Kepner, 2008).

## Results

In first question, statements regarding characteristics of managers or leaders were given (Table 1), and in second statements that are specific for transactional or transformational leadership style (Table 2).

Table 1. Characteristics of managers and leaders

CHARACTERISTICS OF MANAGERS				CHARACTERISTICS OF LEADERS			
	Novi Sad	Zagreb	Total		Novi Sad	Zagreb	Total
Focuses on achieving goals	118	87	205	Focuses on following a goal	10	7	17
Optimally combines production resources	52	47	99	Keeps people together and directs them towards set goals	78	47	125
Cares about procedures and results	78	51	129	Cares about personal interaction	52	43	95
Focuses on getting the job done	85	49	134	Focuses on determining direction of changes	51	45	96
Focuses on mastering complexities	61	43	104	Focuses on mastering change	59	51	110
Strives to hold a certain position in an organization	47	32	79	Strives to achieve employees' satisfaction	79	62	141
Gets results	84	45	129	Enforces change	43	49	92
<b>TOTAL</b>	<b>525</b>	<b>354</b>	<b>879</b>	<b>TOTAL</b>	<b>372</b>	<b>304</b>	<b>676</b>

When choosing between two offered statements, in four cases students chose statements specific for managers, and in three cases the ones specific for leaders. Also, students chose a higher number of statements that explain characteristics of managers (879) as opposed to ones attributed to characteristics of leaders (676), i.e. first hypothesis cannot be rejected. Similarly, Jurak and Bednarik (2010) research found that the leadership of Slovenian sports organizations is generally “blind” to the importance of leadership. These finding however, are not in line with Sikavica and Bahtijarević-Šiber research (2008) where managers characterized themselves as having leader characteristics. However, their research included managers from various businesses and not sport, and they were asked to evaluate themselves.

Secondly, there were eight statements describing behaviour characteristic for transactional and eight for transformational leaders. In general, students did not prefer either leadership style, since the chosen number of cases in which statements describing transactional leadership style was the same as for the transformational leadership style, i.e. four. Nevertheless, in total, students chose greater number of statements describing transactional leader (1096) opposed to transformational leader (900) implying that preferred leadership style is transactional. Therefore, second hypothesis cannot be reject. Although this research did not incorporate satisfaction of employees, or fulfilment of set goals, research of Burton and Peachey (2009) reveals that transformational leadership was the preferred leadership style for satisfaction with the leader. Ghezelsefloo and Ashouri (2017) obtained similar results indicating that “transformational management styles in comparison with in-effective management inspire influences and motivate employees towards higher performance, through their job” (p. 16). However, Rowold (2006) research with students in martial arts reveals that transactional leadership was significantly related to leaders’ effectiveness. The research asked for assessment of coaches, indicating that results might depend on the context, i.e. each discipline is specific. Similarly, the research of Maksimović, Matić, Milošević, and Bjelica (2011) showed the highest values in transactional leadership, and special in one factor - potential reward.

Table 2. Characteristics of transactional and transformational leadership styles

TRANSACTIONAL LEADER				TRANSFORMATIONAL LEADER				$\chi^2$
	Novi Sad	Zagreb	Total		Novi Sad	Zagreb	Total	
Decisions are made based on sufficient amount of information	103	93	196	Decision are made even without all needed information	23	28	51	0,626
Uses the process of elimination until a goal has been reached	71	58	129	Goes straight for the main goal	54	63	117	1,599
Focused on efficiency	66	52	118	Focused on effectiveness	67	69	136	0,875
Insists on fulfilling the given tasks	62	63	125	Inspires and wins over co-workers	71	58	129	0,551
Uses formal authority	49	40	89	Uses charismatic authority	80	81	161	0,464
Solves problems	93	76	169	Directs business	32	45	77	3,321
Handles complexity	34	46	80	Capable of dealing with change	96	75	171	3,534
Does things in the right way	102	88	190	Does the right thing	25	33	58	1,590
<b>TOTAL</b>	<b>580</b>	<b>516</b>	<b>1096</b>	<b>TOTAL</b>	<b>448</b>	<b>452</b>	<b>900</b>	

## Discussion

As the main topic in sport management, many types of research is oriented towards identifying the “right” leadership style in the sport. Research has shown that leadership style affects satisfaction of employees (Burton and Peachey, 2009; Judge and Piccolo, 2004; Yusof, 1998) and achieved results (Ghezelsefloo and Ashouri, 2017; Gould, Greenleaf, Chung and Guinan, 2002; Rowold, 2006). In majority of research transformational style of leadership has been connected with effective managers and higher job satisfaction. Nevertheless, some research pointed to relationship between effective leadership with at least one dimension of transactional style of leadership, i.e. potential reward (Judge and Piccolo, 2004; Maksimović, et.al., 2011). Maksimović, et.al. (2011) showed that top-level executives management of top football clubs in Serbia, often tend to achieve an agreement with a group about what kind of rewards followers will have, if the job is well done. Jurak and Bednarik (2010) research in Slovenia states that sport managers in non-governmental organizations most commonly use a teaching style (42%), followed by a supportive style (37%), a style of ordering (12%), and the least delegation style (9%). It seems that preferred leaderships style in these countries is transactional one. Building on that, it comes as no surprise that future employees “learn” from the current status.

Since transformational style has been connected with effectiveness and better job satisfaction, according to Yusof (1998) sports executives should be encouraged to “train” transformational leadership style. Therefore, sport management courses must put greater emphasize on the role of transformational leadership regarding all potential benefits, such as satisfaction, motivation, and performance of followers (Yukl, 1999). Additionally, Matić (2016) suggested that the most important thing for Serbian team sports is the development of leadership characteristics of human resources in sports organizations, with the special impact of transformational-transactional leadership. Nevertheless, Maksimović, et.al.

(2011) revealed that the key factors of the “right” style of executives in sports organizations according to the results are: 1) factors that are specific to the sports organization itself, 2) factors that are characteristic of leaders in the goal stimulating employees’ motivational needs and work expectations, and 3) personal and reference factors that are typical of different leadership styles, where skills, sensitivity, reasonableness and flexibility in working with people are key. This means that organizational culture plays a significant role, and leadership style among leaders and followers can be an obstacle if the leader has not developed an organizational culture that can facilitate organizational performance (Schein, 2010). Likewise, cultured dialogue with founded arguments (Kolar, Bednarik, Kovač, Jurak, 2010) can contribute to sports development as well. So, the future research can include an analysis of the organizational culture, which is a limitation of this study. Also, the obtained results represented a “picture” of the leadership of future employees, due to their lack of practical experience.

Finally, since cross-cultural research has found that “transformational leadership exists and seems to be effective regardless of the cultural context in which it is exhibited” (Rohmann, Rowold, 2009, p. 548), no differences in opinions between students in two countries were expected. Hi-square analysis reveals no statistically significant differences.

## Conclusion

As in sports organizations, budgets and human resources are often reduced and where leaders often need to do more with less resources, leadership’s ability to transform or inspire individuals to work in the best interests of the organization is vital. So, this research tried to explain the opinions of future employees related to characteristics of manager and leader, and detecting the preferred leadership styles among Croatian and Serbian students. Obtained results from respondents suggested two important respondent’s attitudes: firstly, that student’s vision of managers does not necessarily include managers with emphasized leader characteristics, secondly which revealed that preferred leadership style is transactional one.

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## APPRECIATION OF THE NUTRITION OF ADOLESCENTS FROM TWO HIGH SCHOOLS WITH SPORTS PROGRAM IN THE AREA OF MOLDOVA - ROMANIA

Adriana Albu<sup>1</sup>, Ionut Onose<sup>2</sup>, Raluca Mihaela Onose<sup>2</sup>, Beatrice Abalasei<sup>2</sup>

<sup>1</sup>Gr. T.Popa University Of Medicine And Pharmacy Iasi, Romania

<sup>2</sup>Alexandru Ioan Cuza University Of Iasi, Romania

### Abstract

nutrition is an external factor that plays an essential role in maintaining the health of young people, especially those who practice performance sports. Material and method: the study was conducted on a group of 212 students from 2 high schools with Sports Program in Moldova. A weekly frequency questionnaire was applied for the intake of milk, fish, animal and vegetable fats, sweets. The results were processed using the Pearson test. Results and discussions: the dominant milk intake is 1 time (35.84%) or 2-3 times (33.01%) per week with statistically insignificant differences by community and class ( $p > 0.05$ ). Fish is present in menus especially once a week (49.05%), with statistically insignificant differences by community and class ( $p > 0.05$ ). Animal fats are consumed mainly once a week (40.09%) as well as vegetable fats (34.90%) with significant differences per community (a  $p < 0.01$  and a  $p < 0.05$ ). Sweets are present in menus especially daily (35.37%) with insignificant differences by community and class ( $p > 0.05$ ). Conclusions: in the study group the food intake is constantly deficient, the differences obtained are often insignificant and lead to the existence of similar eating habits.

**Key word:** sports activity, balanced diet

### Introduction

A balanced diet is essential to support the performance of young people who practice sports intensively. The nutritional programs developed for the sports student must be coherent and adapted to the specifics of the age group and to the particularities of the nutrition in a certain geographical area. It is essential that these programs be guided by coaches and parents issues highlighted by students in the US. They consider that the advice of parents (82.5%) or coaches (80.0%) are essential for orienting food in the right direction (Partida, Marshall, Henry, Townsend, Toy, 2018).

Parents must have adequate information, but for the population of Moldova there is a special situation represented by a strong anchoring in family traditions, so it is not possible to adapt food to the special needs of a sports teenager (Albu, Moraru, Hodorca, 2015). In this context, the role of the coach becomes more and more important.

The collaboration between the coach and the parents is essential for stimulating the student's interest for the sports activity practiced in a systematic way and oriented towards the direction of obtaining the performances. Parents need to be actively involved in the physical training activity, in the competitive one, they need to know the progress made by their child but also the problems he faces, especially those related to nutrition (Lisinskiene, Sukys, 2016).

Unfortunately, coaches have too little information about nutrition in general and that of the sports student in particular. Coaches at fitness clubs in Shiraz have modest (73%) or even poor (27%) information about the specifics of a person who practices high-level physical activity (Feili, Sabet, Mokhtari, Hejazi, 2018).

Most US coaches evaluated by the National Athletic Trainer's Association (NATA) only sometimes have access to information about proper nutritional practices (43.5%) (Guidon, Winkelmann, Eberman, Games, 2018).

Unfortunately, we do not have information about the knowledge of coaches in Romania related to nutrition, but we suspect that they are not great. In a study carried out in Iasi on the students from the High School with Sports Program, there is a strong anchoring in traditions and a lack of adaptation of food to the increased needs of high school students (Albu, Grigoraş, Abalaşei, 2018).

The diet must be adapted to the age group but also to the specifics of the activity submitted. Thus, studies conducted in India highlight different needs depending on gender and body reactions. For boys hockey players, the need for carbohydrates is 60.6%, for proteins 16.6% and for lipids 22.7% of the total caloric intake, and for girls that of carbohydrates is 53.7%, protein 16.9% and lipids 20.2% (Hima, Meenu, Priti, 2017). For athletes in Poland, daily energy consumption during training varies from 612 to 1111 kcal / 24 hours for females and from 1025 to 1976 kcal / 24 hours for males (Fraczek, Grzelak, Klimek, 2019).

It is necessary to provide a diet that provides the body with all the mineral elements it needs. There are studies that insist on the need to provide calcium, zinc, magnesium, iron or selenium supplements, which would allow maintaining sports performance at an optimal level (Hefferman, Horner, De Vito, Conway, 2019).

*The objectives of the study:* to evaluate the diet of students who practice intensive exercise; reporting results to rational nutrition rules to assess mistakes that occur / do not occur; following the differences found between the nutrition of students from two high schools with a sports program; appreciation of the change in diet according to age and class because gradually the intensity of the effort required increases which requires ensuring an adequate diet.

## Material and methods

212 students from two High Schools with a Sports Program in the northern part of Moldova were interviewed. These are the High School with Sports Program from Suceava where 94 young people from grades aIX a - aXa- aXI a were examined and the High School with Sports Program from Botoşani where 118 students were examined. The study group consists of 72 young people from the 9<sup>th</sup> grade, 70 students from the 10<sup>th</sup> grade and 70 teenagers from the 11<sup>th</sup> grade.

A weekly food intake questionnaire was administered to these young people.

The consumption of milk, fish, animal fats, vegetable fats and sweets was insisted on. The response variants were: zero; 1 time; 2-3 times; 4-6 times a week; daily.

The processing of the results was performed using the Pearson CHI square test.

## Results

In this study we will insist on the eating habits of students from two high schools with sports program in the northern part of Moldova. We focused on consuming milk, fish, animal / vegetable fats and sweets.

Milk is present in menus especially once (35.84%) or 2-3 times a week (33.01%) result that does not correspond to the rules of rational nutrition (daily intake) (Table 1).

Table 1. Presence of milk in the menus of the surveyed students

Food contribution	Zero	Once/week	2-3 times/week	4-6 times/week	daily
	Results by communities				
Suceava Sports High School	10	34	33	8	9
Botoşani Sports High School	18	42	37	11	10
Total no.	28	76	70	19	19
%	13.20	35.84	33.01	8.96	8.96
	Distribution of answers by classes				
9 <sup>th</sup> grade	9	24	24	9	6
10 <sup>th</sup> grade	7	23	29	6	5
11 <sup>th</sup> grade	12	29	17	4	8

There are 13.20% negative results that are difficult to understand for sports students who do not have serious health problems. Such answers are present in both communities so that the calculated differences are statistically insignificant ( $p > 0.05$ ,  $f = 4$ ,  $\chi^2 = 1.167$ ). The differences calculated by classes are also statistically insignificant ( $p > 0.05$ ,  $f = 8$ ,  $\chi^2 = 8.005$ ) which leads to the existence of similar eating habits. It is a worrying result for 11<sup>th</sup> grade students whose physical demand is increasing but is not supported by adequate food intake.

Fish is a food with a special nutritional value but which is little consumed by the Romanian population. In the study group there is a dominant contribution once a week (49.05%), but there are also 33.49% students who mark the zero variant (Table 2).

Table 2. Weekly fish intake

Food contribution	Zero	Once/week	2-3 times/week	4-6 times/week	daily
Results by communities					
Suceava Sports High School	30	49	13	2	0
Botoșani Sports High School	41	55	14	5	3
Total no.	71	104	27	7	3
%	33.49	49.05	12.73	3.30	1.41
Distribution of answers by classes					
9 <sup>th</sup> grade	23	34	13	2	0
10 <sup>th</sup> grade	24	37	6	1	2
11 <sup>th</sup> grade	24	33	8	4	1

The calculated differences are statistically insignificant by communities ( $p > 0.05$ ,  $f = 4$ ,  $\chi^2 = 3,645$ ) and by classes ( $p > 0.05$ ,  $f = 8$ ,  $\chi^2 = 7,076$ ) aspect that must be in the attention of nutritionists because the same food mistakes are made.

Fats and sweets are essential for the sports student because they provide the body with the energy it needs. The fats studied are those of animal origin (butter, cream) and vegetable (oil, margarine).

Animal fats are present in menus especially once a week (40.09%) or 2-3 times (25.94%) totally inadequate result for a young athlete who should eat them daily but in moderate amounts (Table 3).

Table 3. Weekly consumption of animal fats

Food contribution	Zero	Once/week	2-3 times/week	4-6 times/week	daily
Results by communities					
Suceava Sports High School	17	42	30	5	-
Botoșani Sports High School	24	43	25	13	13
Total no.	41	85	55	18	13
%	19.33	40.09	25.94	8.49	6.13
Distribution of answers by classes					
9 <sup>th</sup> grade	12	29	20	8	3
10 <sup>th</sup> grade	12	29	20	6	3
11 <sup>th</sup> grade	17	27	15	4	7

By classes, the calculated differences are statistically significant at a  $p < 0.01$ , ( $f = 4$ ,  $\chi^2 = 15,731$ ) and draw attention to the students from the sports high school in Suceava where there is no daily consumption of animal fats. The differences calculated by classes are statistically insignificant ( $p > 0.05$ ,  $f = 8$ ,  $\chi^2 = 5,969$ ) so there is no adaptation of food to the increased needs of the body.

Vegetable fats can compensate for the deficient intake of animal fats but the result is not as expected. The dominant result is 1 time (34.90%) or 2-3 times (25.94%) per week, a situation that is not adequate for rational nutrition (daily intake) (Table 4).

Table 4. Frequency with which vegetable fats appear in menus

Food contribution	Zero	Once/week	2-3 times/week	4-6 times/week	daily
Results by communities					
Suceava Sports High School	27	32	25	9	1
Botoșani Sports High School	20	42	30	13	13
Total no.	47	74	55	22	14
%	22.16	34.90	25.94	10.37	6.60
Distribution of answers by classes					
9 <sup>th</sup> grade	19	22	19	7	5
10 <sup>th</sup> grade	12	25	19	10	4
11 <sup>th</sup> grade	16	27	17	5	5

The calculated differences are statistically significant at a  $p < 0.05$ , ( $f = 4$ ,  $\chi^2 = 11.318$ ) by communities but statistically insignificant ( $p > 0.05$ ,  $f = 8$ ,  $\chi^2 = 4.067$ ) by classes. Unfortunately, not much is compensated because the intake is deficient in both types of fats. The results are strange given that in animal fats there are 19.33% negative answers and in vegetable fats 22.16% such answers. These are not elderly people with health problems so the result is at least interesting if not worrying.

Sweets provide the energy needed for physical activity and the proper functioning of the nervous system. Students need sweets, the only aspect of the discussion is the one related to avoiding excessive consumption. The results obtained are not encouraging because an acceptable consumption (daily) is recognized only by 35.37% of students to which are added 21.22% young people with an intake of 4-6 times a week (Table 5).

Table 5. Presence of sweets in the daily menu of sports students

Food contribution	Zero	Once/week	2-3 times/week	4-6 times/week	daily
Results by communities					
Suceava Sports High School	4	11	32	22	25
Botoşani Sports High School	6	9	30	23	50
Total no.	10	20	62	45	75
%	4.71	9.43	29.24	21.22	35.37
Distribution of answers by classes					
9 <sup>th</sup> grade	4	5	24	18	21
10 <sup>th</sup> grade	5	9	16	17	23
11 <sup>th</sup> grade	1	6	22	10	31

The differences by communities are statistically insignificant ( $p > 0.05$ ,  $f = 4$ ,  $\chi^2 = 6,379$ ) as well as those obtained by classes ( $p > 0.05$ ,  $f = 8$ ,  $\chi^2 = 10,335$ ). similar eating habits appear that are not beneficial for the athletic student.

## Discussions

The study is focused on issues related to the nutrition of students in high schools with sports program. They need a diet adapted to the characteristics of age, sex but also to the specifics of physical effort.

The evaluation was carried out using a questionnaire on the weekly frequency of food consumption. It is a questionnaire of its own that takes into account the specifics of the food of the population in a certain geographical area. It is a method that allows the appreciation of the eating habits of the population and not the contribution of a certain day, being an important tool for population studies, especially those related to the nutrition of young people (Wadolowska, Hamulka, Kowalkowska, Kostecka, Wadolowska, Biezanowska-Koper, Czarniecka -Skubina, Kozirok, Piotrowska, 2018).

A first aspect to be studied is the one related to the absence of food consumption. It is a worrying situation because 13.20% of students mark the zero version for milk, 33.49% for fish, 19.33% for animal fats, 22.16 for vegetable fats and 4.71% for sweets. A question arises about these answers - do not have these foods or do not consume them for reasons of non-acceptance of taste. The idea of „I don't like it” appears but this situation is not a beneficial one for the sports student (Demirici, Toptaş Demirici, 2018).

Special attention should be paid to the absence of animal and vegetable fats in the diet that „fatten”. It has long been believed that the energy needed for muscle contraction is provided only by carbohydrate metabolism. At present, there is an emphasis on non-esterified fatty acids that are quickly assimilated. They are faster metabolized than carbohydrates so they provide three times more energy. The type of effort is important because in the aerobic one most of the energy is provided by fatty acids while in the anaerobic one carbohydrates are essential (Apfelbaum, Romon, Dubus, 2004).

Milk is a food with a special nutritional value given the high content of animal proteins and lipids, minerals (especially calcium) and vitamins (Apfelbaum, Romon, Dubus, 2004). However, consumption is modest only once (35.84%) or 2-3 times a week (33.01%) compared to the rules of rational nutrition that lead to a daily intake. among young people in Germany, the increased milk intake is recognized by only 27.8% of young people. The relation to the submitted physical activity is worrying because there are 28.6% students with an increased milk intake but with a less intense physical activity, 26.4% with a medium physical activity and even 29.1% with a high physical activity. There is no change in milk intake depending on the resulting physical effort which is alarming (Manz, Mensink, Finger, Haftenberg, Brettschneider, Lage Babosa, Krug, Schienliewitz, 2019).

Adolescents in Austria recognize an average weekly milk intake of  $2.2 \pm 1.1$  times a week, a result that highlights a modest consumption (Drenowatz, Greier, 2018).

Young people in Rawalpindi claim a dominant intake of milk once a day (44.9%) and there are 32.6% negative responses (Naseer, Mahmood, Fazil, Bilal, Kulsoom, Hamid, 2018). Among young people in Sudan, the dominant response is daily (37.1%) and there are 20.5% zero input responses (Misaa, Somya, Siham, 2018).

The fish is little consumed in Pomania, the dominant intake being once a week. A similar response is present in young people in Austria who report an average consumption of fish / eggs of  $1.8 \pm 1.2$ . Nor was a special question used for fish because it is not a widely consumed food (Drenowatz, Greier, 2018). The result is even more difficult for young people in Rawalpindi where the zero variant is recognized in 73.2% of situations, compared to those in Sudan for whom the dominant response is monthly (57.6%) (Naseer, Mahmood, Fazil, Bilal, Kulsoom, Hamid, 2018; Misaa, Somya, Siham, 2018). There are major differences from one population to another that need to be carefully studied.

Animal and vegetable fats must be present in the menus in appropriate quantities. There are many negative responses to the study group that are not adequate for sustained physical effort. Among young people in Rawalpindi, the zero variant is dominant (59.4%) in terms of butter intake. In a study conducted in Italy on healthy eating habits, the variant of lack of consumption of oil or fats is also mentioned, an aspect that is still debatable (Sogari, Velez-Agumedo, Gómez, Mora, 2018).

Sweets must be present in the diet but in adequate quantities. There are 4.71% students who choose the zero answer option which is not an encouraging one. In young women in Iraq, such a response occurs in 10.35% of cases and there are 18.72% input responses 5-7 times a week (Shahraki-Sanavi, Rakhshani, Ansari-Moghaddam, Mohammadi, 2017).

The results obtained are not encouraging so it is necessary to carry out adequate nutritional education programs. Adolescents in the US recognize the consumption of unhealthy foods when they are happy or upset, due to stress or in a certain social context (Abraham, Noriega Brook, Shin, 2018). There are aspects that nutritionists need to know and consider.

## Conclusions

The nutrition of sports students from the two studied communities raises many problems. There is no change in diet depending on the class, ie when increasing the intensity of physical effort required by training performed systematically.

In communities, the differences are only for animal and vegetable fats, otherwise the results are similar, which leads to a strong anchoring in traditions of the families of the students examined.

It is necessary the specialized intervention in the High Schools with Sports Program in order to ensure the maintenance of the health condition and the support of the sports performances.

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## DIFFERENCES IN THE LEVEL OF CARDIORESPIRATORY FITNESS IN RELATION TO NUTRITION STATUS OF CHILDREN IN PRIMARY EDUCATION

Marko Badrić, Leona Roca, Ivan Prskalo

*Faculty of Teacher Education University of Zagreb*

### Abstract

The aim of this study was to determine the level of cardiorespiratory fitness and differences according to the level of nutrition in primary education students. The study involved 212 students, of which 105 boys and 107 girls, aged  $9.77 \pm 0.69$  years. The sample of variables consisted of anthropometric measures: body height, body weight, upper arm skin fold, back skin fold, abdominal circumference, hip circumference and WHR index. Body height was measured using an anthropometer, and body mass was measured using an Omron BF500 Body Composition Monitor. Based on the calculated body mass index, using the tables recommended by the International Obesity Task Force (IOTF), the respondents were classified into three groups according to their nutrition status. Cardiorespiratory fitness was assessed by a multi-stage 20-meter running test - Shuttle run test. The significance of differences between sub-samples formed according to nutrition status (normal body weight, overweight and obese) and cardiorespiratory fitness in primary school students was tested by variance analysis - ANOVA test. A total of 62.26% of students showed unsatisfactory levels of cardiorespiratory fitness. The results of the variance analysis (ANOVA) show that there is statistical significance between the groups categorized by the degree of nutrition in the variable for cardiorespiratory fitness assessment ( $p = 0.00$ ). The results of cardiorespiratory fitness (maximum oxygen uptake-VO<sub>2</sub>max mL / kg / min) in surveyed boys were lower (45.06) compared to normative results (48.1) as well as the results in surveyed girls (44.36) compared to normative results (46.7). Normal body weight students have significantly better values of cardiorespiratory fitness than obese students. Also, overweight students have statistically significantly higher cardiorespiratory fitness scores than obese students.

**Key words:** *cardiorespiratory fitness, maximum oxygen uptake, nutrition status, primary school, students*

### Introduction

Insufficient physical activity, insufficient sleep, and excessive sitting are associated with higher risk of obesity and other adverse health effects (Carson et al., 2016; Chaput et al., 2016; Poitras et al., 2016). Scientific evidence suggests a direct correlation between decline in physical activity and appearance of overweight (Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012), with a decline in children's motor skills (Roth et al., 2010), which is a critical determinant of general child development (Piek, Baynam, & Barrett, 2006). Excess body mass interferes with participation in physical activity and therefore impairs the development of motor skills, especially locomotor systems (D'Hondt et al., 2011). Overweight and obesity are public health problems associated with mortality (Bjorntorp et al., 2000; Gaio et al., 2018). The proportion of overweight and obese population in most European countries is increasing (Gaio et al., 2018). Lifestyle factors have different effects on physical activity status, and it is therefore important to explore all elements of connectedness such as physical condition, sedentary lifestyle, or obesity status (Tambalis, Panagiotakos, Psarra, & Sidossis, 2019). Cardiorespiratory fitness refers to overall capacity of cardiovascular and respiratory systems as well as the ability to perform rhythmic and dynamic exercises involving large body muscles for a long time, its direct measure being aerobic functional capacity. It maintains the ability of numerous body organs, such as the heart, lungs, and muscles, to support energy production during physical activity and exercise (Lang et al., 2018a). Cardiorespiratory fitness can significantly affect health (Ross, 2016). A growing body of research has shown that cardiorespiratory fitness is negatively correlated with "metabolic syndrome" or obesity and diabetes (Church, 2011). Cardiorespiratory tests provide appropriate objective measures that can complement existing evaluation processes for intervention programs and strategies for physical activity. Cardiorespiratory condition is associated with a 13% reduction in cardiovascular disease and a 15% reduction in risk of death from various causes. Studies show that children and adolescents who have developed cardiorespiratory fitness often have better tolerance to glucose, cholesterol, triglyceride levels and lower blood pressure (Lang et al., 2018b). More importantly, cardiorespiratory fitness in childhood affects health in adulthood and provides a possible insight into future health status of the population (Ruiz, 2009). Because cardiorespiratory readiness is an important component of the metabolic syndrome and a strong predictor of premature death, recognizing changes in physical activity levels during the obesity epidemic may indicate the need for interventions that contribute to fitness of school children (Stratton et al., 2007). The aim of this study is to determine the level of cardiorespiratory fitness and differences according to the level of nutrition in primary education students.

## Methods

This research involved a stratified sample of respondents, taken from the population of primary education students attending third and fourth grades of primary school. The surveyed students were primary school students from the area of Petrinja who, because of their territorial but also sociological and demographic affiliation, could represent the sample in question. Students' age was  $9.77 \pm 0.69$  years. The total number of respondents in the survey was 212, of which 105 boys and 107 girls. Health status of all students was checked and it was a prerequisite for them to be healthy at the time of the research, and parental consent was obtained for their participation in the examination according to the Code of Ethics for Research with Children. The sample of variables consisted of anthropometric measures: body height, body weight, upper arm skin fold, back skin fold, abdominal circumference, hip circumference and WHR index. All measures were performed according to the International Biological Program (IBP). Body height was measured using an anthropometer, and body mass was measured using an Omron BF500 Body Composition Monitor. The skin folds were measured using Lange's Skinfold caliper. Cardiorespiratory fitness was assessed by a multi-stage 20-meter running test - Shuttle run test (Leger & Lambert, 1982). Body mass index (BMI) was obtained as the ratio of body weight and squared body height  $BMI (kg / m^2 = weight (kg) / (height (m))^2$  (Garow & Webster, 1985). Based on the calculated body mass index, via tables recommended by the International Obesity Task Force (Cole et al., 2000), respondents were classified into three groups according to their nutrition status: normal body weight, overweight, and obese. The following basic descriptive parameters were calculated for all the variables: arithmetic mean, standard deviation, minimum and maximum result, and skewness and kurtosis. The normality of the distribution of variables was tested with Kolmogorov-Smirnov test. The significance of differences between sub-samples according to degree of nutrition and cardiorespiratory fitness in primary education students was tested by analysis of variance - ANOVA test. Homogeneity of variance was tested by the Levene's test, the results of which showed that there was no statistical significance, so further analysis was made by variance analysis (ANOVA). The statistical significance of the arithmetic mean differences between the groups was determined via F-value. For variables where a statistically significant F value was obtained, a Scheffe's post hoc test was applied to determine the differences between arithmetic means of the groups, which is very accurate if large differences occur. Statistical significance of the differences was tested at a significance level of  $p < 0.05$ . Data were processed by STATISTICA version 13.5.0.17., TIBCO Software Inc.

## Results

Table 1. Descriptive indicators of anthropological characteristics in the total sample of third and fourth grade students ( $N = 212$ )

	M $\pm$ SD	Min	Max	Skew	Kurt	max D	K-S
Body height	144.07 $\pm$ 7.92	122.60	166.00	0.10	0.22	0.05	$p > .20$
Body weight	38.67 $\pm$ 10.37	23.00	87.50	1.37	2.73	0.11	$p < .01$
BMI	18.48 $\pm$ 4.09	12.27	41.60	1.94	6.29	0.14	$p < .01$
% Fat	19.99 $\pm$ 8.12	2.00	45.00	0.53	-0.10	0.08	$p < .20$
Back skin fold	11.18 $\pm$ 5.76	3.30	34.60	1.28	1.58	0.16	$p < .01$
Upper arm skin fold	15.96 $\pm$ 7.12	2.60	36.00	0.76	0.01	0.11	$p < .05$
Waist circumference	64.48 $\pm$ 8.93	45.00	105.00	1.14	1.98	0.14	$p < .01$
Abdominal circumference	78.17 $\pm$ 8.86	60.00	115.00	0.88	1.38	0.09	$p < .10$
Hip to waist ratio	0.82 $\pm$ 0.05	0.61	0.97	-0.15	1.00	0.04	$p > .20$
Maximum oxygen uptake-VO <sub>2</sub> max	44.71 $\pm$ 2.99	37.90	56.90	1.05	3.31	0.17	$p < .01$
Running distance - meters	374.67 $\pm$ 218.70	100.00	1540.00	2.31	7.48	0.19	$p < .01$

M=arithmetic mean; SD= standard deviation; MIN= minimum result; MAX= maximum result; K-S=Kolmogorov-Smirnov normality test

Results in Table 1 show descriptive parameters of the total sample of third and fourth grade primary school students with an average age of  $9.77 \pm 0.69$  years. It is evident that students had an average height of  $144.07 \pm 7.92$  centimeters and body weight of  $38.67 \pm 10.37$  kilograms. The percentage of fat (% Fat) is 19.99%, while Body Mass Index (BMI) is 18.48, which means that surveyed students are at a normal nutrition level. Kolmogorov-Smirnov test results show that for some variables there is a deviation from normality of distribution; while distribution asymmetry values are acceptable, the kurtosis of the distribution shows slightly higher values for some variables.

Table 2. Descriptive indicators of anthropological characteristics of third and fourth grade boys and girls

	M±SD Boys N=105	M±SD Girls N=107	Min Boys	Max Boys	Min Girls	Max Girls
Body height	144.53±7.72	143.61±8.11	124.00	166.00	122.60	163.00
Body weight	39.00±10.03	38.35±10.74	23.00	87.50	23.90	76.20
BMI	18.53±3.78	18.44±4.38	12.27	35.38	12.37	41.60
% Fat	19.99±7.15	19.99±9.00	5.30	37.90	2.00	45.00
Back skin fold	10.53±4.92	11.82±6.43	3.30	28.60	4.00	34.60
Upper arm skin fold	14.94±6.68	16.95±7.42	2.60	33.80	5.90	36.00
Waist circumference	65.48±8.78	64.13±9.07	45.00	105.00	50.00	97.50
Abdominal circumference	78.70±8.50	77.65±9.20	60.00	115.00	61.00	109.00
Hip to waist ratio	0.83±0.05	0.83±0.05	0.61	0.97	0.69	0.96
Maximum oxygen uptake-VO <sub>2</sub> max	45.06±3.13	44.36±2.83	40.30	56.90	37.90	56.00
Running distance - meters	396.95±242.86	352.80±190.70	120.00	1540.00	100.00	1300.00

M=arithmetic mean; SD= standard deviation; MIN= minimum result; MAX= maximum result

The results in Table 2 show descriptive parameters for the surveyed boys in third and fourth grades of primary school. The mean age was  $9.72 \pm 0.69$  years. It is evident that boys averaged  $144.53 \pm 7.72$  cm in height. This result is slightly higher than reference values at the level of the Republic of Croatia (Jureša, Kujundžić Tiljak, & Musil, 2011). Looking at the results for body weight ( $39.00 \pm 10.03$  kg), it is evident that surveyed students have higher body mass values than reference values at the level of the Republic of Croatia (Jureša et al., 2011). The percentage of fat (% Fat) is 19.99%, which classifies the boys in the study sample as normally fed respondents according to the reference values (McCarthy, Cole, Fry, Jebb, & Prentice, 2006). The body mass index values are slightly higher than the reference values for the Republic of Croatia (Jureša et al., 2011). The results of the descriptive parameters of the surveyed girls with an average age of  $9.81 \pm 0.69$  years shows they have an average height of  $143.61 \pm 8.11$  cm. This result is minimally higher than the reference values at the level of the Republic of Croatia (Jureša et al., 2011). Looking at the results for body weight ( $38.35 \pm 10.74$  kg), it can be seen that the surveyed girls had higher body mass values than the reference values at the level of the Republic of Croatia (Jureša et al., 2011). The percentage of fat (% Fat) is 19.99%, which classifies the girls in the study sample as normally fed respondents according to the reference values (McCarthy et al., 2006). The body mass index values are slightly higher than the reference values for the Republic of Croatia (Jureša et al., 2011).

Table 3. Results of the cardiorespiratory fitness test

	Number	Percentage %
Very low level	53	25
Low level	79	37.26
Moderate level	52	24.53
High level	15	7.08
Very high level	13	6.13

Table 3 shows the results of cardiorespiratory fitness levels. An unsatisfactory level of cardiorespiratory fitness was achieved by 62.26% of students. Moderate level was achieved by 24.53% of students, while only 13.21% achieved high levels of cardiorespiratory fitness.

Table 4. Results of variance analysis (ANOVA) according to nutrition level and cardiorespiratory fitness level

	SS effect	df effect	MS effect	F	p
Maximum oxygen uptake -VO <sub>2</sub> max	107.13	2	53.56	6.27	<b>0.00*</b>

F= coefficient of variance analysis; p=statistical significance at  $p=0,05^*$

According to the variance analysis (ANOVA) results in Table 4, there is statistical significance between the groups categorized according to the degree of nutrition. Students who were categorized into three groups according to their level of nutrition differed statistically significantly in the variable for assessing cardiorespiratory fitness ( $p = 0.00$ ) at the significance level  $p = 0.05$ .

Table 5. Scheffe's post hoc analysis results for determining differences between groups according to nutrition level

	M±SD	Scheffe's p-value
Normal – overweight	45.02±3.02 - 44.59±2.86	0.6794
Normal – obese	45.02±3.02* - 42.38±2.11	<b>0.0024</b>
Overweight - obese	44.59±2.86* - 42.38±2.11	<b>0.0281</b>

M=arithmetic mean; SD= standard deviation; \* p=0.05

Table 5 shows results of the post hoc analysis. Scheffe's test was used to analyze the variable which assesses cardiorespiratory fitness and in which statistical significance was determined. The results show that there is no significant difference in the level of cardiorespiratory fitness among students of normal weight and overweight students. Also, normal weight students were found to have significantly better values of cardiorespiratory fitness than obese students ( $p = 0.0024$ ) as well as overweight students having significantly higher cardiorespiratory fitness scores than obese students ( $p = 0.0281$ ).

## Discussion

According to the aim of the study, a statistically significant difference was found between groups categorized according to the degree of nutrition in the variable for the evaluation of cardiorespiratory fitness. In determining individual differences between the study groups, it is evident that there is no significant difference in the level of cardiorespiratory fitness of normal weight in comparison to overweight students. Normal body weight students have significantly better values of cardiorespiratory fitness than obese students. Also, overweight students have statistically significantly higher cardiorespiratory fitness scores than obese students. Similar results were obtained in other studies (Tokmakidis & Kasambalis, 2006; Tremblay et al., 2011; Badrić & Ravlić, 2015). The results show that over 60% of students studied have very low or low levels of cardiorespiratory fitness. The results of cardiorespiratory fitness (maximum oxygen uptake- $VO_{2max}$  mL / kg / min) in surveyed boys were lower (45.06) compared to normative results (48.1) as were the results in surveyed girls, which are also relatively lower (44.36) in comparison to normative results (46.7) (Tomkinson et al., 2016). Pojskic and Eslami (2018) obtained results showing that normally fed boys have higher levels of cardiovascular fitness than overweight and obese boys, while no significant differences were found in girls. Research (Winsley, Armstrong, Middlebrooke, Ramos-Ibanez, & Williams, 2006; Ara, Moreno, Leiva, Gutin, & Casajus, 2007) found that overweight respondents performed worse in cardiorespiratory tests than normally fed respondents. The results of the study conducted by Davidson, Mackenzie-Rife, Witmans, Montgomery, Ball, Egbogah, and Eves (2013) show that weight gain in children and adolescents is in significant correlation with a general decrease in lung volume, an increase in respiratory disease symptoms and decreased functional capacity. The Kondapalli, Devpura, Manohar, and Perakam (2019) study found that there was a statistically significant higher level of maximum oxygen uptake ( $VO_{2max}$ ) in normal-weight girls compared to overweight girls. Similarly, overweight female respondents obtained better results of maximum oxygen uptake ( $VO_{2max}$ ) than obese subjects. Demirkan, Can, and Arslan (2016) state that a higher percentage of body fat renders less effective cardiorespiratory performance.

## Conclusion

The results indicate that surveyed students have low levels of cardiorespiratory fitness and that respondents of normal nutrition level have significantly better cardiorespiratory fitness scores than overweight and obese students. Since poorly developed cardiorespiratory fitness and weight gain have been shown to be predictive of the development of various coronary diseases, improvements are expected in the design of intervention programs to promote daily exercise combined with activities that affect the development of cardiorespiratory skills in primary education students.

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## DIFFERENCES IN BODY COMPOSITION AND CARDIOVASCULAR SYSTEM PARAMETERS IN UNIVERSITY STUDENTS ACCORDING TO SELF RATED HEALTH STATUS

Marko Čule<sup>1</sup>, Ivan Milinović<sup>1</sup>, Davor Pavlović<sup>2</sup>

<sup>1</sup>Faculty of Economics and Business, Croatia

<sup>2</sup>Faculty of Forestry and Wood Technology, Croatia

### Abstract

The purpose of the present study was to investigate differences between poor and good self-rated group in body composition and cardiovascular system parameters. In this cross-sectional study, participants were 129 university students. Self-rated health was assessed by using single-item question: "How would you rate your health?" with five responses: (1) very poor, (2) poor, (3) fair, (4) good and (5) excellent. We categorized the outcome as "poor" or "good" health. Body composition parameters were assessed by using bioelectric impedance analysis. Differences between groups were analyzed by using Student t-test and Mann-Whitney U test. Significance was set up at  $p < 0.05$ . Roughly, 25% of participants reported having poor health. Group reporting poor health had higher % of fat-mass ( $p < 0.000$ ), visceral fat ( $p < 0.000$ ), heart rate ( $p < 0.005$ ) and body-mass index ( $p < 0.000$ ). Group with good health had higher values in % fat-free mass ( $p < 0.000$ ), lower values systolic blood pressure ( $p < 0.001$ ) but not and diastolic blood pressure ( $p > 0.05$ ). Our study shows that participants who reported having poor self-rated health had higher values in non-healthy body composition and cardiovascular system parameters compared with those reporting good health.

**Key words:** young adults, good health, poor health, systolic blood pressure, diastolic blood pressure, heart rate

### Introduction

Health is a state of complete physical, mental, and social well-being and not merely the absence of disease (World Health Organization, 1946). In today's modern and developed world, obesity or corpulence is a health problem of increasing magnitude, which many physicians consider to be on the top of the list of urgent problems related to human health. Obesity creates a substantial risk of developing hypertension, Type 2 diabetes, dyslipidemia, and heart disease (Sachdev et al., 2005), as well as of several kinds of tumors, and locomotion disorders (NCD-RisC, 2016). The growing trend of obesity affects not only adults but is increasingly found in young adults, especially students (Lowry et al., 2000). The BMI – Body Mass Index – although being the simplest method for determining the degree of obesity – is not reliable neither for various ethnic groups nor within a certain population. The BMI cannot define the body composition (Prentice and Jebb, 2001). The body composition and the obesity status should be assessed by other methods and instruments, which will provide more precise data both on the amount of fat in the body, and of non-fat mass. Young people, including students, are susceptible to various trends in society: insufficient exercise, poor nutrition habits, reducing physical activity, and various vices (smoking, alcohol, drug abuse). The results of recent research are deplorable. NCD-RisC (2016) reports in his paper that, from 1975 to 2014, the number of obese people in the population increased as much as tenfold.

Monitoring children and young adults is of crucial importance for creating adequate input for global obesity reduction programs. In this paper, based on several parameters of body composition and health status self-assessment, the connection of poor health status with increased percent of body fat, higher BMI, increased heart rate, and increased blood pressure values will be determined.

### Methods

#### Respondents

In this cross-sectional study, participants were 129 university students randomly selected from one faculty in the city of Zagreb, Croatia, aged 19.58 years in average (91 female and 38 male students). Also, they were told that the study was voluntary and they could withdraw at any time. The data collected in the study were anonymous and in accordance to the Declaration of Helsinki. The respondents were randomly chosen from the ranks of physical education classes.



## Variables

Self-rated health (SRH) was assessed by using single-item question: "How would you rate your health?" with five responses: (1) very poor, (2) poor, (3) fair, (4) good and (5) excellent. We categorized the outcome as "poor" health (responses very poor and poor) and "good" (responses fair, good and very good). SRH serves as a good predictor of mortality (Idler, Benyamini, 1997). Body composition characteristics: percentage of body fat – BF%, percentage of muscle mass – MM%, visceral fat - VF, were gathered using the bioelectric impedance method (Model TBF-310, Tanita Corporation of America, Inc., Arlington Heights, IL, USA; Tanita-BIA, according to Duerenberg (1991). The Body Mass Index – BMI – was calculated according to the formula: body mass in kilograms was divided by body height in m<sup>2</sup>. Body height – BH – was measured using the SECA stadiometer in centimeters, and the body weight – BM – using a calibrated SECA electronic scales, in kilograms. Blood pressure (diastolic – DBP – and systolic – SBP), as well as the heart rate – HR – were measured using the OMRON digital sphygmomanometer, on the left hand, after a 5 minutes rest period, while sitting down.

## Data analysis

Basic descriptive parameters were calculated. Using the Student t-test and Mann-Whitney U test, the differences in above variables between the two groups were categorized based on the SRH variable ("poor" and "good"), on the significance level of ( $p < 0.05$ ). The data were processed using the Statistica 13.0 software.

## Results

Table 1 contains the descriptive parameters of the respondents. It is evident that the arithmetic mean of the respondents in the BMI variable is 24.40, which situates the students in the desirable body mass category. According to the World Health Organization (2000) classification, indexes lower than 18.5 indicate malnutrition, between 18.5 and 24.9 designate ideal weight, from 25.0 to 29.9 point to being overweight, and higher than 30 signal obesity. The range of values measured is from 16.95 to 34.67. Considering the fact that the BMI is not an adequate and reliable measure, the more precise indicator definitely is the percentage of body fat, with a 29.18, and the percentage of muscle mass, which amounts to 29.69 on average. For a student population, these values are not satisfactory, as the percent of fat is too high, and the percent of muscle mass is low.

Table 1. Basic descriptive statistics of the results

Variable / N= 129	Mean	Min	Max	SD	Skew	Kurt
DOB	19.58	19	22	0.71	1.08	0.76
BH	170.87	155.00	193.00	10.33	0.38	-0.90
BM	71.63	46.90	111.90	15.93	0.43	-0.48
BMI	24.40	16.95	34.67	4.33	0.45	-0.80
FM%	29.18	13.60	41.20	6.88	-0.45	-0.57
VF	4.60	1	10	2.23	0,1	0.14
MM%	29.69	21.30	43.50	5.68	0.74	-0.22
SBP	123.21	92	149	13.73	-0.31	-0.66
DBP	77.14	55	92	9.14	-0.18	-0.85
HR	86.74	63	133	13.43	0.73	0.65
SRH	3.16	1	5	1.00	-0.08	-0.39

Legend: DOB-age, BH-body height, BM, body mass, BMI-body mass indeks, FM%-percentage of body fat, VF-visceral fat, MM%-percentage of muscle mass, SBP-systolic blood pressure, DBP-diastolic blood pressure, HR-heart rate, SRH-self rated health variable.

Table 2 contains the results of the analysis of the two groups, categorized according to their answering the question "How would you rate your health?" (the SRH variable). Out of 129 students, 32 rated their health status as very poor and poor, and 97 rated it as fair, good, and excellent. Using the Student t-test and the Mann-Whitney U test, we found statistically significant differences between the groups in six variables: BMI, HR, SBP, FM%, MM%, and VF, at the significance level of  $p < 0.05$ . Students who assessed their health as poor had higher percent of fat mass, as well as lower MM%. Of course, both the BMI and the amount of VF are higher in students who assessed their health status as poor.

Table 2. Differences between groups by using Student t-test and Mann-Whitney U test

Variables	Poor self-rated health (N=32)	Good self-rated health (N=97)	p-value
	Mean±SD	Mean±SD	
BMI	30.01±2.20	22.55±3.07	<0.000
FM%	34.57±2.98	27.41±6.89	<0.000
MM%	26.40±4.57	30.77±5.61	<0.000
VF*	6.91±2.01	3.85±1.73	<0.000
SBP	130.19±12.42	120.91±13.41	<0.001
DBP	78.22±9.81	76.78±8.93	0.443
HR*	90.91±11.50	85.37±13.79	<0.005

Legend: BMI-body mass indeks, FM%-percentage of body fat, VF-visceral fat, MM%-percentage of muscle mass, SBP-systolic blood pressure, DBP-diastolic blood pressure, HR-heart rate, \*Mann-Whitney U test.

## Discussion

The purpose of the present study was to investigate differences between poor and good self-rated group in body composition and cardiovascular system parameters. The findings from this research indicate that the self-assessment of health is related with the BMI, heart rate, systolic blood pressure, the percent of fat mass, visceral mass, and muscle mass. This is also being emphasized by health professionals and experts, who see obesity as a serious enemy of health, and as a pandemic that spreads relentlessly. In this age (19 years old), being overweight and having a high body fat percentage still may not have such frightening consequences, but in the future, their harmful influence will likely have an adverse effect on their health. This is corroborated by the values and differences between Poor self-rated health and Good self-rated health groups in their values of diastolic and systolic blood pressure. The systolic blood pressure in students belonging to the Good self-rated health is significantly lower, as well as their heart rate per minute. Štefan et al. (2017) reached similar conclusions while researching the association of life habits and body composition in young adults, i.e. female and male students of the University of Zagreb. They found strong and inverse association between the SRH with body weight, BMI, fat-mass percentage, blood pressure and heart rate and strong positive association with muscle-mass percentage. It is only recently that attention has been paid to relatively young and healthy populations, such as university students (Steptoe and Wardle, 2001; Vaez and Laflamme, 2003). Years at university might be associated with considerable demands that could affect health and health status of individuals.

There are several limiting factors in this research. The sample of respondents is not sufficient for any general conclusions about the whole population of students in the college where the research was carried out. Another problem is that male and female student population were not questioned separately, because the values of blood pressure, fat percentage and muscle mass percentage must be studied separately for each gender.

## Conclusion

The purpose of the present study was to investigate differences between poor and good self-rated group in body composition and cardiovascular system parameters. Based on the results of the research presented in this paper, we can conclude that there is a negative association of the SRH with the body weight, the percent of fat mass, and the BMI; also, there is a positive association with the percent of muscle mass.

In conclusion, the problem of obesity and the whole gamut of diseases this condition generates should be considered a national priority. Health professionals, teachers, parents and others need to make additional efforts to check this adverse trend and to change the way of living, both in children and in adults. Exercise should become an integral part of everybody's everyday life from early childhood; also, significant care should be taken in the area of healthy nutrition.

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## USE OF PLATELET-RICH PLASMA (PRP) IN TREATMENT OF MUSCULOSKELETAL INJURIES

Luka Davidović, Bruno Lovreković, Daniel Peškir

Croatia

### Introduction

Muscular injuries are the most common cause of keeping the athletes out of the game and are usually treated conservatively. Mechanism of the injury usually includes a forceful movement of the limb with a muscle strain or rupture as a result. In a case of a major blow to the muscle, consequential bleeding can occur, which, if excessive, can lead to a compartment syndrome of the extremity.

The aim of this study was to examine if PRP injections can expedite the “return-to-play” time in a non-professional sportsman.

We present you with a case of 24-year-old male non-professional futsal player who suffered a massive rupture of the peroneus longus muscle and was hospitalized under the suspicion of compartment syndrome.

### Methods

Platelet-rich plasma (PRP) is an autologous gel derived from patient’s own blood, consisting of high concentration of platelets and protein growth-factors. Development of PRP includes extraction of the patient’s blood, which is then centrifuged in a special device in sterile conditions.

After clinical and ultrasound examination have confirmed the rupture, we decided to treat the patient with serial applications of PRP under the ultrasound guidance. The treatment cycle included four applications of 5mL of PRP with one week interval in between each. An ultrasound examination was performed one week after each application for the purpose of monitoring the progress of treatment.

### Results

At the time of the injury, the rupture was 6 cm’s in length. During the treatment, the rupture started to decrease in size as it follows: 4,5cm in length after first injection, 3,5cm after second injection and only 1cm in length after the application of the third PRP injection.

Check-up examination was performed one week after the last PRP injection of the treatment cycle. Ultrasound examination showed fully recovered peroneus longus muscle with small effusion areas, but without clinical importance. Patient regained full range of active and passive movement in the surrounding joints.

The “return to play time” was shortened from the expected 5 weeks to 3 weeks.

### Conclusion

Although the exact role of PRP has yet to be confirmed, our work suggests that it could expedite the „return-to-play“ time in athletes.

**Key words:** *Platelet-rich plasma, compartment syndrome, return-to-play*

## THE IMPORTANCE OF PHYSICAL ACTIVITY FOR ADHERENCE TO MEDITERRANEAN DIET IN YOUNG ADULTS

Arunas Emeljanovas, Brigita Mieziene, Natalija Fatkulina, Rimantas Stukas

Vilnius University, Lithuania

**Introduction.** Many studies show positive contribution to the prevention of a series a favorable effect of the Mediterranean diet on cardiovascular (Rosato et al., 2019) and brain diseases (Psaltopoulou et al., 2013). Greater adherence to a Mediterranean diet is associated with a significant improvement in health status. However, it is also important that multiple health behaviors go together. The interrelationship of health-related Mediterranean diet with physical activity in non-Mediterranean countries is still understudied. The purpose of the study is to identify the compliance to healthy nutrition and to examine the prognostic value of physical activity for adherence to Mediterranean diet in Lithuanian young adults.

**Methods.** Nationally representative cross-sectional study included 3031 young adults aged 18-36 years, with the mean age 23.72±4.81 years-old. Adherence to Mediterranean diet was evaluated using Mediterranean Diet Adherence Screener (MEDAS) (Martínez-González et al., 2012). Self-reported moderate to vigorous physical activity (MVPA) and inactivity were measured.

**Results** indicated that 7.2% of young adults fully comply to Mediterranean diet patterns, 58.4% partly comply and 34.4% do not comply at all to healthy eating patterns, that represents Mediterranean diet. Results of multiple linear regression indicated that sufficiently physically active had better adherence to Mediterranean diet than not sufficiently physically active ( $\beta=.154$ ;  $p < .001$ ).

**Conclusion.** Main health behaviors – nutrition and physical activity – are interrelated and go along. The higher is physical activity the higher is the adherence to healthy eating patterns in young population of non-Mediterranean country. Inactivity reduces the probability to better adhere to healthy eating patterns.

**Key words:** *Mediterranean Diet, Physical Activity*

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## ASSOCIATIONS OF SLEEP QUALITY WITH CARDIOVASCULAR DISEASE RISK FACTORS IN ADOLESCENTS

Petra Jurić, Maroje Sorić

University of Zagreb Faculty of Kinesiology, Croatia

**Purpose:** The aim of this observational study was to determine whether objectively assessed sleep quality is associated with overweight, high blood pressure and low physical activity level in 15-16-year-old children.

**Methods:** This investigation is a part of the CRO-PALS, a 4 year longitudinal cohort study among adolescents in Zagreb (Croatia). The sample for this investigation consists of 128 adolescents (mean age=15.6 years, SD=0.4) with complete data on sleep efficiency (SE), BMI, blood pressure (RR) and physical activity (PA) level. To objectively measure sleep and PA, participants wore the SenseWear Pro3 Armband™ monitor (SWA; software v. 8.1; BodyMedia Inc., PA, USA) for whole 5 consecutive days. Sleep quality was operationalized through sleep efficiency (SE) and was considered low if average SE<75% (Ohayon et al., 2017). High blood pressure was determined according to cut-offs from the Fourth report on high RR in children and adolescents (Falkner, et. al., 2004), overweight (including obesity) was categorized according to IOTF criteria (Cole et al., 2012) and adequate PA level was judged according to WHO global recommendations. Associations of low SE with overweight, high RR and low PA level were tested by logistic regression analysis using MedCalc statistical software. The model was adjusted for age, gender and smoking. Data are presented as odds ratios (95%CI).

**Results:** Average SE was classified as low in 32/128 participants (25%). Low SE was not associated with obesity (OR=1.01; 95% CI= 0.15-6.95), high RR (OR=1.49; 95%CI=0.41-5.39) or low PA (OR=1.73; 95%CI=0.45-6.64).

**Conclusion:** We found that reduced average SE over 5 days of objective monitoring was not associated with obesity, high RR and low PA when adjusted for age, gender and smoking. Longer period of monitoring may be needed to show adverse health effects of inadequate sleep in adolescence.

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**Key words:** Exercise, sleep, blood pressure, overweight

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## FORECASTING INJURY AMONG ATHLETIC AND NON-ATHLETIC YOUTH: USAGE OF THE ARTIFICIAL INTELLIGENCE METHODS

Josip Karuc<sup>1</sup>, Marko Šarlija<sup>2</sup>, Marjeta Mišigoj-Duraković<sup>1</sup>, Goran Marković<sup>1</sup>, Vedran Hadžić<sup>3</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia

<sup>3</sup>University of Ljubljana Faculty of Sport, Slovenia

**Introduction:** This study aimed to predict injuries in one year with application of machine learning (ML) methodology using various risk factors in a representative sample of adolescents.

**Methods:** This research is a part of the CRO-PALS study conducted in a representative sample of urban youth in Zagreb (Croatia). Analyses for this study are based on 558 adolescents from the CRO-PALS cohort (age:16-17 years). Risk factors that were measured at baseline included: sex, age, body mass index, body fat percentage, moderate-to-vigorous physical activity (MVPA), training hours per week (only for athletic participants), socioeconomic status (SES) and functional movement operationalized through a total score of the Functional Movement Screen test. The details on study protocols were described elsewhere (Štefan et al., 2018). Data on injury occurrence were collected with a computerized self-reported questionnaire one year after the baseline measurements. ML analyses, as a form of interfacial intelligence, were conducted separately for athletic (n=193) and non-athletic (n=365) group of children. The model with the highest value of the area under the ROC curve (AUC) was selected as an estimate of the best predictive accuracy. In addition, values of sensitivity, specificity, and OR (95% CI) are provided.

**Results:** Among athletic and non-athletic participants injury incidence during a 1-yr period was 25.4% and 11.2%, respectively. Within athletic and non-athletic participants, k-nearest neighbors (kNN) showed the highest value of AUC (0.64 and 0.61), and was thus chosen as the model with the highest predictive accuracy. Within athletic youth, kNN-150 showed sensitivity of 0.52, specificity of 0.76, and OR (CI 95%) of 3.42 (1.73-6.76). Among non-athletic participants, kNN-100 exhibited sensitivity of 0.83, specificity of 0.45, and OR (CI 95%) of 3.93(1.69-9.14).

**Conclusion:** The results of this study suggest that with given predictors: sex, age, BMI, body fat percentage, MVPA, training hours per week, SES, and functional movement, kNN exhibited the best accuracy over other models. However, in the context of prediction accuracy, kNN method exhibited poor predictive accuracy for injury incidence among both athletic and non-athletic participants. Future studies should try to include more predictors in ML models to improve the accuracy of injury prediction among adolescents.

**Key words:** *puberty, AI, movement patterns, musculoskeletal conditions, musculoskeletal injury, sport trauma, adolescence*

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## PREVALENCE OF OBESITY AMONG STUDENTS AT UNIVERSITY OF SARAJEVO

Erol Kovačević<sup>1</sup>, Denis Čaušević<sup>2</sup>, Izet Bajramović<sup>2</sup>, Josipa Nakić<sup>3</sup>, Elvir Kazazović<sup>2</sup>, Ensar Abazović<sup>2</sup>

<sup>1</sup>Faculty of Sport and Physical Education, University of Sarajevo; Institute of Sport, Faculty of Sport and Physical Education, University of Sarajevo

<sup>2</sup>Faculty of Sport and Physical Education, University of Sarajevo

<sup>3</sup>University of Zagreb Faculty of Kinesiology

### Abstract

This research aimed to determine the epidemiological indicators of the prevalence of obesity in students at the University of Sarajevo. For this purpose, 2145 students were tested, of which men ( $n = 967$ ; age =  $23.47 \pm 3.35$ ) and women ( $n = 1178$ ; age =  $22.66 \pm 2.39$ ). Standardized anthropometric tests were used: body height, body weight, BMI, waist circumference, hip circumference, and waist to hip ratio. The results obtained indicate that the average body height of men is  $181.77 \pm 7.41$ ; body mass =  $80.41 \pm 12.24$ ; BMI =  $24.31 \pm 3.26$ ; waist circumference =  $85.85 \pm 14.06$ ; hip circumference =  $102.92 \pm 11.06$ ; waist to hip ratio =  $0.83 \pm 0.10$ . The same indicators for women are: body height =  $166.74 \pm 6.73$ ; body mass =  $62.31 \pm 9.80$ ; BMI =  $22.41 \pm 3.29$ ; waist circumference =  $73.41 \pm 8.44$ ; hip circumference =  $97.67 \pm 11.31$ ; waist to hip ratio =  $0.76 \pm 0.13$ . According to standard categorization based on BMI recommended by WHO (The World Health Organization), overweight or obesity have 654 or 30.48% of students, of which 416 or 19.39% are men, and 238 or 11.09% are women. The results obtained confirm that the population of students at the University of Sarajevo has averaged overweight and obesity values recorded in previous studies at the European Union and developed country level.

**Key words:** Obesity, prevalence, body mass index, students, University of Sarajevo

### Introduction

The World Health Organization (WHO) has described both obesity and overweight as an abnormal accumulation of excessive body fat, which may be harmful to health (Poirier et al., 2011). It can also be defined as the accumulation and storage of excess body fat while being overweight is defined as a pre-obese condition that implies increased BMI (according to reference tables) (Ogden and Flegal, 2010). Given the significant health implications as well as the rapid growth of obesity worldwide, this issue is receiving increasing attention. However, there are still different approaches to collecting, processing, and interpreting results, which may be an additional problem. In this regard, De Onis et al. (2010) stated that out of a total of 144 World Health Organization (WHO) countries, 33 have only one reported, while 38 have two or more measurement points for childhood obesity. Some, which have multiple measurement points, as cited by de Onis et al. (2010), have different methodological approaches to measurements, and that is why it was recommended to create a unique methodology so that, based on the data collected, it is possible to unquestionably follow the trend of development and results of individual activities, both locally and in the total population. In most countries that keep records on this subject, the number of obese persons has increased three to five times during this period (Bray, 2007; Bray, 2011; Bray, 2008). Thus, for example, in the 1970s, 14.5% (approximately 25 million) of the United States population was obese (Fryar et al., 2015), while, according to recent information (Ogden et al., 2014), this percentage increased to 34.9% (approx. 80 million). Lobstein (2010) states that since the 1960s, the number of obese people has quadrupled in some countries. At the level of Bosnia and Herzegovina, there is no exact epidemiological data on the number of overweight and obese persons, and it is quite clear that the prevalence of a sub-sample or population. A particular problem is the small number of studies in BiH that have addressed this issue. At this point, the scientifically verified and published data available (Kovacevic et al., 2018; Colakhodzic et al., 2017; Abazovic et al., 2016; Abazovic et al., 2017; Mesihovic-Dinarevic et al., 2011) refer to the population of children and adolescents. The overall morphological status and composition of the body is frequently determined and represented by three specific indicators: body mass index, a sum of five subcutaneous fat points and waist circumference (Duggan, Mercier, & Canadian Society for Exercise, 2007)

## Methods

The sample of respondents in this study consisted of 2145 students (men  $n = 967$ ; women  $n = 1178$ ), ages 20 to 28, who voluntarily agreed to participate in a survey conducted in the fall of 2018 at the University of Sarajevo. Students from 15 different faculties at the University of Sarajevo participated in the research. All subjects were measured: body height, body weight, BMI, waist circumference, hip circumference, and waist-to-hip ratio. The tests were determined according to a standardized procedure recommended by the International Biological Program (Mišigoj-Duraković, 2008). BMI is calculated by the formula:

$$BMI = \frac{Weight (kg)}{BHeight (m)^2}$$

The usual range of BMI, for adults, has a value between 18.5 kg / m<sup>2</sup> and 24.9 kg / m<sup>2</sup> (National Institutes of Health, 2000; WHO, 1998; Health Canada, 2003; Cornier et al., 2011). A more detailed classification of nutritional status based on BMI values for people over 20 is presented in Table # 1.

Category	BMI (kg/m <sup>2</sup> )	
	Principal cut-off points	Additional cut-off points
<b>Severely underweight</b>	<16.00	
<b>Underweight</b>	16.00 – 18.50	16.00 – 16.99
		17.00 – 18.49
<b>Normal</b>	18.50 – 24.99	18.50 – 22.99
		23.00 – 24.99
<b>Overweight</b>	25.00 – 29.99	25.00 – 27.49
		27.50 – 29.99
<b>Obese</b>	≥ 30.00	
<b>Obese Class I</b>	30.00 – 34.99	30.00 – 32.49
		32.50 – 34.99
<b>Obese Class II</b>	35.00 – 39.99	35.00 – 37.49
		37.50 – 39.99
<b>Obese Class III</b>	≥ 40.00	

The waist-to-hip ratio is calculated by the formula:

$$WHR = \frac{waist\ circumference}{hip\ circumference}$$

The waist-to-hip rate is a measure that represents the next step in measuring the distribution of body fat because it gives a somewhat more detailed insight into which part of the body is found in a higher proportion of fat. In general, a waist-to-hip ratio above 0.95 in men and 0.85 in women is considered an indicator of central obesity.

## Results

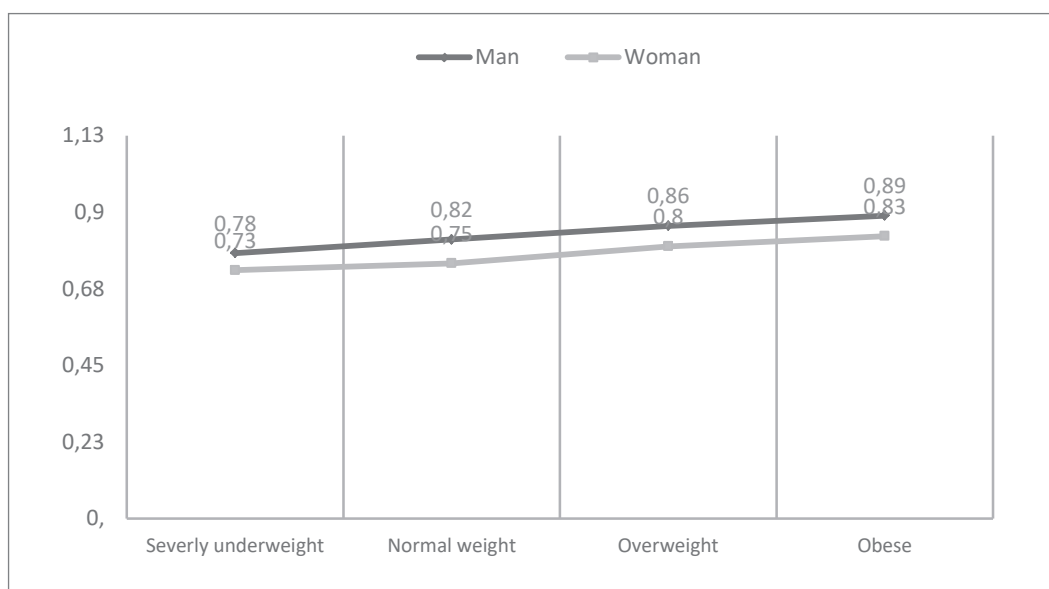
Based on the insight into the basic descriptive indicators (Table 2), it is possible to observe the average values of all analyzed variables. The results obtained indicate that the average body height of men is  $= 181.77 \pm 7.41$ ; body mass  $= 80.41 \pm 12.24$ ; BMI  $= 24.31 \pm 3.26$ ; Waist circumference  $= 85.85 \pm 14.06$ ; Hip circumference  $= 102.92 \pm 11.06$ ; Waist to hip ratio  $= 0.83 \pm 0.10$ . The same indicators for women are: body height  $= 166.74 \pm 6.73$ ; body mass  $= 62.31 \pm 9.80$ ; BMI  $= 22.41 \pm 3.29$ ; Waist circumference  $= 73.41 \pm 8.44$ ; Hip circumference  $= 97.67 \pm 11.31$ ; Waist to hip ratio  $= 0.76 \pm 0.13$ . According to standard categorization based on BMI recommended by WHO, overweight or obesity has 654 or 30.48% of students of which 416 or 19.39% are men, and 238 or 11.09% are women. When it comes to the male population of the complete sample,  $n = 967$ , 43%, or 416 are overweight or obese to women,  $n = 1178$ , 20.19%, or 238 are overweight or obese. When it comes to waist-to-hip ratio, the range ranges from 0.78 males to malnutrition to 0.89 males; while in women, this range from 0.73 - malnourished to 0.83 - is obese. When it comes to these relationships, it can be concluded that they are within normal limits and that obese individuals are at the risk of cardiovascular disease (Abazović et al., 2017)

Table 2. Descriptive indicators

	Man n = 967	Woman n = 1178
Age	23.47 ± 3.35	22.66 ± 2.39
Height	181.77 ± 7.41	166.74 ± 6.73
Body mass	80.41 ± 12.24	62.31 ± 9.80
BMI	24.31 ± 3.26	22.41 ± 3.29
Waist circumference	85.85 ± 14.06	73.41 ± 8.44
Hip circumference	102.92 ± 11.06	97.67 ± 11.31
WHR	0.83 ± 0.10	0.76 ± 0.13

Table 3. BMI classification

	n	%	Man BMI	n	%	Woman BMI
Severely underweight	26	2.68	17.37 ± 1.02	104	8.82	17.60 ± 0.66
Normal weight	543	56.15	22.46 ± 1.58	836	70.96	21.58 ± 1.68
Overweight	375	38.77	26.65 ± 1.28	208	17.65	26.69 ± 1.36
Obese	41	4.23	32.87 ± 2.54	30	2.54	32.60 ± 2.08



Graph 1. Waist-to-hip ratio

## Discussion

The main objective of this survey was to establish epidemiological indicators of the prevalence of obesity in a student at the University of Sarajevo. The results show that 654 or 30.48% of students are overweight or obese. Given that, at this time, the authors are not aware of studies of a similar nature in this population, the results are compared to younger age groups. According to a survey conducted in Canton Sarajevo (KS), a sample of 33,200 elementary school students (95% of the population) found that only 50.7% of children had normal body weight in line with WHO benchmarks. 39.6% out of the total number of students surveyed had an increased value of BMI, of which 21.1% are overweight, and 18.5% are obese (Abazovic et al. 2016). The results of an earlier study (Hasanbegović et al., 2010) (2 329 students from 9 elementary schools in the KS area) indicate that a smaller number of overweight and obese children (22.5%) were observed. Comparative analysis has led to a particularly worrying finding that in just seven years, there has been a significant increase in the number of overweight children or obese primary school children. Another study seriously identified the prevalence of overweight and obesity in primary school children in the City of Mostar, involving a total of 1 940 students. In particular, 36.4% of children were overweight and obese, of which 19% were overweight, and 17.4% were obese (Čolakhodžić et al., 2017). Among all studies that included children older than primary school age, the most important is the study (Abazović et al., 2017), in which of the total number of high school students in KS covered by the

survey, (1 700) or 22.2% was overweight and only 5.9% were obese. When it comes to the rest of Europe, the percentage of obese people is very worrying, 25.1%, which is significantly higher than African countries (up 14.7%), Pacific countries (up 14.6%), and SE Asia at the moment. (up 19%) (Krzysztożek et al., 2019). When it comes to the waist/hips ratio, it is evident that the results obtained do not indicate higher values than those recommended by WHO (Table 2; Chart 1). Results may indicate that the subjects in this study do not tend to central obesity. However, these parameters should be viewed in conjunction with BMI parameters, thus providing a real insight into the obesity of the subjects. The risk factors for the onset of obesity have been well documented in numerous studies (Berkey et al., 2003; Moreno and Rodríguez, 2007; Maffei et al., 2000; Ludwig et al., 2001; Bowman et al., 2004; Hancox et al., 2004; Vasconcellos et al., 2014). Obesity is a very complex multifactorial disease that develops under the influence of genetic and metabolic factors, the environment, social and cultural environment, and poor living habits. The causes of obesity can be multiple. Increased intake of high-calorie foods, rich in fat and refined sugars, with reduced physical activity, creates excess energy, which is stored in the body in the form of fat (Medanić and Pucarín-Cvetković, 2012). Research shows a significant genetic influence on the development of obesity (Maes et al., 1997). Based on the results of “family” studies, ie, studies on twins, Watson et al. (2010) and Lajunen et al. (2009) concluded that genetic factors also influence the so-called “obesity sensitivity.” A recent meta-analysis, involving a total of 117 scientific studies, (Elks et al., 2012) stated that a genetic factor explains between 24% and 90% of inter-individual variation in BMI. Namely, when it comes to studies with twins, the median inheritance index was 75%, that is, if one twin is obese, it can be argued with 75% that the other twin is also obese. Increased risk for morbidity is present in men with a waist circumference greater than 102 cm and in women with a waist circumference greater than 88 cm (López-Jiménez and Cortés-Bergoderi 2011).

Metabolic syndrome is a metabolic disorder most commonly mentioned in the context of its association with the increased prevalence of obesity. Research indicates that the prevalence in people between the ages of 20 and 29 is 6.7% (Ford et al., 2002). Medanić and Pucarín-Cvetković 2012 state that the clinical manifestations of metabolic syndrome are: insulin resistance syndrome, obesity, hyperlipidemia, type 2 diabetes, hypertension, and coagulation disorder and it is diagnosed by the presence of three or more clinical manifestations. Metabolic syndrome, as well as obesity, has been shown to increase the risk of heart attack and stroke. Heart and stroke are three times more common in men and twice as high in women with metabolic syndrome (Vorko-Jović and Heim 2010). Of these diseases, diabetes mellitus is a chronic metabolic disease that has a very high worldwide prevalence. Obesity is one of the risk factors for developing type 2 diabetes mellitus, and this type is the most common form of diabetes. It has about 90% of all patients (Aganović et al., 2008). It is most commonly caused by insulin resistance. Obesity is directly related to many other diseases. Obesity is a chronic metabolic disorder associated with an increase in the morbidity and mortality index of cardiovascular disease (Gomes et al., 2010). More than two-thirds of patients with chronic cardiovascular disease are overweight or obese (López-Jiménez and Cortés-Bergoderi, 2011). The prevalence of hypertension has been shown to increase with increasing BMI. In men with BMI > 30, it increases to 24% and in women with BMI > 30 to 38% (Poirier et al., 2006). The results of various epidemiological studies indicate an association between obesity and different types of cancer. There is evidence that 5% of all cancers can be associated with obesity, 3% in men and 6% in women, and that the majority of cases are associated with colorectal cancer, endometrial cancer, and breast cancer (Bergström et al. 2001). It has also been found that 14-20% of all cancer deaths are associated with obesity (Calle, 2003). Obesity is considered one of the causative factors for several benign and malignant gastrointestinal disorders such as fatty liver, non-alcoholic steatohepatitis, gastroesophageal reflux disease, gallbladder diseases, and cancers (John et al., 2006). Numerous studies have suggested an association between obesity and chronic respiratory diseases (Poulain et al., 2006). There are also diseases of the locomotor system that may be associated with obesity, most commonly mentioned are knee and hip osteoarthritis, and degenerative changes in the lumbar spine (Medanić and Pucarín-Cvetković, 2012).

## Conclusion

The obtained parameters indicate overweight or obesity in 654 or 30.48% of students, of which 416 or 19.39% are male, and 238 or 11.09% are female students of the University of Sarajevo. Given that numerous studies have highlighted that higher obesity has significant health effects, this study identifies obesity as a substantial risk factor for obesity prevention.

The following references are most commonly mentioned in the literature to date:

1. Skipping breakfast (Berkey et al., 2013; Kovács et al., 2010),
2. Increased food intake (Moreno and Rodríguez, 2007; Bellisle et al., 1988),
3. Increased food intake in the late evening (Maffei et al., 2000; Bellisle et al., 1988),
4. Increased consumption of carbonated beverages (Ludwig et al., 2001; James et al. 2004),
5. Intake of fast food (Bowman et al., 2004; French et al., 2001),
6. Prolonged television viewing (Robinson, 1999; Hancox et al., 2004)
7. Decreased level of physical activity (Tremblay and Willms, 2003; Reilly et al., 2005; Patrick et al., 2004; Vasconcellos et al., 2014).



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## DOES CARDIORESPIRATORY FITNESS ATTENUATE CARDIOMETABOLIC RISK IN OBESE ADOLESCENTS?

Lavinia La Grasta Sabolić<sup>1</sup>, Maja Cigrovski Berković<sup>2</sup>, Marija Požgaj Šepić<sup>1</sup>, Gordana Stipančić<sup>1</sup>

<sup>1</sup>Department of Pediatrics, Sestre milosrdnice University Hospital Center, Zagreb, Croatia

<sup>2</sup>Department of Sport and Exercise Medicine, University of Zagreb Faculty of Kinesiology, Croatia; <sup>2</sup>Department of Internal Medicine, Clinical Hospital Dubrava, Zagreb, Croatia

**Introduction:** The clustering of cardiometabolic risk factors is strongly associated with obesity. Results regarding the influence of cardiorespiratory fitness (CRF) on cardiometabolic risk (CMR) in obese youth are still inconsistent. It is unclear whether the beneficial effect of fitness on health exists in obese adolescents. Previous literature suggests that such an effect may be attenuated or even abolished in severe obesity.

**Methods:** Cross-sectional data from forty five obese, pubertal white adolescents (mean age 14.6 years, female 28/45, mean BMI 35.6 kg/m<sup>2</sup>) were analysed. Among them 13 had severe (mean BMI 41.8 kg/m<sup>2</sup>), 20 moderate (mean BMI 34 kg/m<sup>2</sup>) and 12 mild obesity (BMI 31.5 kg/m<sup>2</sup>). CMR score was calculated as the sum of sex- and age-specific z-scores for waist circumference, fasting plasma glucose, triglycerides, HDL cholesterol and systolic blood pressure. CRF was estimated using the submaximal protocol and expressed in ml/kg/min.

**Results:** Using Spearman's rho correlation analysis a significant correlation was observed between CRF z-scores and CMR scores (correlation coefficient -0.43, P < 0.05). Lower CRF z-scores predicted higher CMR scores ( $\beta$  coefficient -0.482, P < 0.001). Adolescents with mild obesity had similar CMR scores as moderately obese adolescents (P = 0.94), while severely obese had significantly higher CMR scores (P = 0.020). In the group of adolescents with severe obesity, CRF was moderately and negatively correlated with CMR score (r = -0.53, P < 0.05).

**Conclusions:** As cardiometabolic risk is elevated in obese adolescents, efficacious obesity treatment programs are needed. CRF may play an important role in lowering the risk of cardiometabolic diseases in obese youth, including those with severe obesity.

**Key words:** cardiorespiratory fitness, cardiometabolic risk, obese adolescents

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## EFFECT OF CAFFEINE INGESTION ON BADMINTON PERFORMANCE

Feng Liang, Zhou Zhihui, Cao Jianmin, Wang Xiaoting, Qi Bing, Leng Bo, Dai Jin

*Bei Jing sports university*

**Introduction:** It is recognised that a combination of excellence in technical, tactical, anthropometrical, physical and mental skills is needed for elite sports performance. Improvement in exercise performance following caffeine ingestion has been attributed to adenosine receptor antagonism, which is proposed to result in reduced sensations of effort and pain, increased alertness, improved neural firing rates and enhanced motor unit recruitment and frequency of activation. Therefore, the purpose of this study is to investigate the effect of ingesting caffeine tablet on measures that are central to success in badminton.

**Methods:** Seventeen male and elite badminton players performed a badminton anticipatory skills, including key underlying mechanisms, such as gaze behaviour, badminton smash-accuracy test and a shuttle run agility test (SRAT). Participants then consumed 300mg caffeine tablet or a similar tasting placebo tablet with identical shape and size. After 50-min all measures were repeated again.

**Results:** Shuttle run agility was improved after the ingestion of caffeine compared with PLA. Badminton anticipatory skills was improved and showed a positive change in the efficiency of their visual search behaviour after the ingestion of caffeine compared with PLA. But there was no significant difference on smash accuracy between caffeine and PLA.

## PLATELET - RICH PLASMA (PRP) INJECTIONS TO ACCELERATE RECOVERY IN A PROFESSIONAL ATHLETE: A CASE REPORT

**Bruno Lovreković, Luka Davidović, Daniel Peškiri, Milan Milošević**

*Poliklinika Ribnjak, Croatia*

### Background

Among various types of knee pathologies, MCL injuries are the most common ones, especially in physically active population. Mechanism of injury is the valgus movement of the knee which leads to strain or even rupture of MCL. Treatment usually includes conservative approach in terms of physical therapy and, rarely, operative treatment.

We present you with a case of 32-year-old professional MMA fighter and Judoka olympic winner, who visited our clinic three weeks after he suffered traumatic valgus force on his right knee and has not been treated since.

This case report offers another option of conservative treatment of MCL injury – PRP (platelet-rich plasma).

### Materials and methods

PRP is an autologous derivative made out of the patient's blood that contains factors which stimulate growth and healing of various kind of tissues, especially ligaments, tendons and muscle fibers. Therefore, we firmly believe that PRP provides great method in the treatment of sports injuries.

The patient was treated with a series of four ultrasound guided PRP injections with one week in between each.

At each arrival, two tubes of blood were drawn and placed in a centrifuge device. After the process of centrifugation, 4mL of platelet – rich plasma was injected into the area around the lesion. Patient was not referred to physical therapy in parallel.

### Results

Ultrasound examination showed a partial lesion of the MCL without effusion. Combination of clinical and ultrasound examination revealed grade 2 MCL injury.

Patient's check-up examination, performed one week after the last PRP injection was given, showed clinical improvement of knee condition, while ultrasound examination showed fully healed and regenerated MCL.

The Return to Play time was cut down from expected 42 to 28 days.

### Conclusion

The results of our study have shown that the use of Platelet – Rich Plasma can be beneficial for MCL injuries and expediting Return to Play in a professional athletes.

*Key words: Platelet-rich plasma, injury, return-to-play*

## DOPING ATTITUDES AND DOPING KNOWLEDGE OF COMPETITIVE CROATIAN ROWERS

**Dora Marić<sup>1</sup>, Šime Veršić<sup>2</sup>, Antonela Sinković<sup>3</sup>**

<sup>1</sup>*University of Palermo, PhD Program in Health Promotion and Cognitive Sciences*

<sup>2</sup>*University of Split, Faculty of Kinesiology*

<sup>3</sup>*University of Zagreb, Faculty of Kinesiology*

### Abstract

The aim of our study was to evaluate doping attitudes (DA), and certain correlates of DA in competitive rowing athletes. Study included 53 competitive male rowing athletes from Croatia (age: 20.47±4.17 years). The data was collected by previously validated questionnaires. Apart from descriptive statistics, logistic regression was calculated for categorical criterion – doping likelihood with positive DA set as referent value. Majority of rowers (64.15%) stated that doping is primarily a problem of “fair play”. Self-education is reported as a primary source of information about doping and nutrition in 56.60% of rowers. Altogether 56.60% of rowers specifically declared negative DA. Logistic regression results show no significant correlation. Because of the relatively high percentage of rowers with positive DA, and the fact that majority of studied athletes declared fair-play as the most important problem of doping, there is a clear necessity of anti-doping education in this sport.

*Key words: rowing, doping, knowledge*

### Introduction

The use of doping is not a new sporting phenomenon, it is health-threatening behavior that corrupts the essence of sport, which is considered to be a display of fair play, health, and dedication. (Ljungqvist, 2014; Sajber et al., 2013). Consequentially the ongoing war against doping was declared with the establishment of the World Anti-Doping Agency (WADA) in November of 1999. However, even though WADA, with its accompanying laboratories, has been consistently working on the development of reliable diagnostic tools and protocols for doping detection, anti-doping rule violation reports do not provide consistent evidence of the decrease of Adverse Analytical Finding (WADA, 2016, 2018). That being said, it is apparent that efficient anti-doping strategies are required.

More preventive approach targeted on the identification of the factors (protective/predictive) associated with doping and/or potential doping behavior (PDB), would allow better understanding of factors influencing doping behavior and identification of specific athletes at risk of doping. Studies done so far are indicating that factors associated with doping behavior in one group of athletes are commonly insignificantly or inversely associated with doping behavior in other groups, depending on gender, socio-cultural environment, and type of sport (Rodek et al., 2013). This implies the necessity for sport-specific investigation of factors influencing doping behavior, which would provide more efficient development and implementation of the Anti-doping campaigns.

Rowing is an Olympic sport most commonly described as a strength-endurance sport (Steinacker, 1993). Olympic events in rowing are conducted over a 2,000 m course. Depending of the number of rowers in the boat and upon competition classification (i.e. lightweight and heavyweight, woman or man, rowing or sculling) events last from 320 to 460 seconds (Ingham et al., 2002). It is estimated that a typical rowing race takes 70–80% aerobic and 20–30% anaerobic energy demands (Mäestu et al., 2005). Abuse of doping substances and methods is no stranger to the rowing community, in 2007 during Rowing World Cup eight athletes with coaches were ban from competition for two years (Jan et al., 2011). However, even though there is evidence of the usage of prohibited substances and methods in rowing, there is evident lack of information about sport-specific factors influencing doping behavior. To our knowledge, there are no studies investigating factors associated with doping and/or PDB in rowing. Accordingly, the aim of our study was to evaluate doping attitudes (DA), and certain correlates of DA in competitive rowing athletes from Croatia.



## Methods

**Subjects:** Study included 53 competitive male rowing athletes, from Croatia (age: 20.47±4.17 years).

**Variables:** The data was collected by previously validated questionnaires: (i) Questionnaire of Substance Use (QSU) (ii) Knowledge of Doping (KD) and knowledge of sports nutrition (KSN) (D. Sajber et al., 2013; D. Sekulic et al., 2016). The QSU includes questions about sociodemographic background, sport-related factors, and doping factors. The KD and KSN questionnaires consisted of 10 questions each. Each question/statement was in a “false (F) or true (T)” format; the athletes scored one point if the answer was correct. The final score ranged from 0 to 10. The correct answers were based on WADA standards. The detailed description of questionnaires used can be found in previously published papers (Sajber et al., 2013; Sekulic et al., 2016).

**Statistics:** Normality of distribution was assessed by Kolmogorov Smirnov test, the means, and standard deviations were reported for age and knowledge on doping and nutrition, while frequencies and percentages were reported for other variables. Logistic regression was calculated for categorical criterion – DA, with positive DA being set as referent value.

## Results

The statistics for KD and KSN are presented in Table 1. Frequencies data derived by questionnaire on substance use (Table 2) are showing, that almost 80% of athletes have experience in rowing longer than 5 years. The 16.98% of athletes won a medal on the international level at the senior level. When it comes to doping the majority of rowers (64.15%) stated that doping is primarily a problem of “fair play”, 26.42% indicated doping is primarily health-threatening behavior, and only 1.85% believes that doping should be allowed. Self-education is reported as a primary source of information about doping and nutrition in 56.60% of rowers. Most of the athletes (81.13%) were never tested on doping. The 11.32% of rowers were of the opinion that doping is not used in their sport. The 3.77% declared that doping should be permitted, 33.96% agreed that doping offenders should be excluded from the competitions for a couple of seasons, while 35.85% declared that the first time should be milder than lifetime suspension. Altogether 56.60% of rowers specifically declared negative DA.

Logistic regression results (Table 3) show no significant correlation between predictors and DA derived by questionnaire on substance use.

Table 1. Descriptive statistics for age, knowledge on doping (KD) and knowledge on nutrition (KN)

Variable	Valid N	Mean	Min	Max	SD
Age	53	20.47	0	8	2.17
KD	53	2.29	0	10	2.63
KSN	53	5.92	0	34	4.17

LEGEND: Mean – mean value, Min – minimum result, Max – maximum result, SD – standard deviation

Table 2. Responses on variables derived by questionnaire on substance use (F – frequency; % - percentage)

	N	%
<b>EXPERIENCE IN ROWING</b>		
1-2 years	1	1.89
3-5 years	12	22.64
6-10 years	26	49.06
11-15 years	8	15.09
>15 years	6	11.32
<b>HIGHEST RANK OF COMPETITION AS A SENIOR</b>		
Compete on national level	6	11.32
Medal won on national level	11	20.75
Compete on regional level	2	3.77
Medal won on regional level	5	9.43
Compete on international level	11	20.75
Medal won on regional level	9	16.98
I did not compete on senior level	9	16.98
<b>THE MAIN PROBLEM OF DOPING IN SPORTS</b>		
It is mainly health-threatening behaviour	14	26.42
It is against fair play	34	64.15

I'm not sure it should be banned	4	7.55
Doping should be allowed	1	1.89
<b>PRIMARY SOURCE OF INFORMATION ON SPORT NUTRITION AND DOPING</b>		
I have no knowledge about it	8	15.09
Coach and doctor	6	11.32
Formal education	9	16.98
Self-education (internet, books, magazines)	30	56.60
<b>DOPING TESTING</b>		
Never tested on doping	43	81.13
1-2 times	9	16.98
2-5 times	1	1.89
>5 times	0	0
<b>DOPING IN SPORT</b>		
I don't think doping is used in sport	6	11.32
Don't know/Not sure	23	43.40
Used, but rarely	17	32.08
Frequently used	4	7.55
Regularly used	3	5.66
<b>OPINION ABOUT PENALTIES FOR DOPING OFFENDERS</b>		
Lifelong suspension	11	20.75
First time milder punishment, than lifelong suspension	19	35.85
Suspension for couple of seasons	18	33.96
Financial punishment	3	5.66
Doping should be allowed	2	3.77
<b>DOPING LIKELIHOOD</b>		
I will use doping if it will help me	1	1.89
I will use it if it will help me with no negative health cons	11	20.75
Not sure	11	20.75
I will not use doping	30	56.60
Missing		

Table 3. Logistic regression results for categorical criterion – doping likelihood; positive DA being set as referent value

Variables	Athletes
	OR (95%CI)
Age	1.08 (0.97-1.07)
Rowing experience	0.66 (0.36-1.22)
Sport result senior	1.04 (0.86-1.24)
Doping testing cont	0.46 (0.47-5.36)
Doping in sport cont	1.36 (0.77-2.40)
Penalties for doping offenders cont	1.35 (0.77-2.36)
Knowledge on doping	1.29(0.99-1.69)

## Discussion

Doping is a poorly explored topic when it comes to rowing, even though WADA statistics suggest it is not doping-free sport (Jan et al., 2011). This fact is supported by some extent with the opinion about doping presence in rowing in our study, where only 11.32% of athletes declared that doping is not used in rowing. Accordingly, understanding doping attitudes of rowing athletes is important in order to proceed with the anti-doping campaign and more precise investigation. There are few important findings of this study. First, results are highlighting low knowledge of doping which is accompanied by self-education as a primary source of information on this topic, secondly doping is considered mainly fair play problem by the majority of rowers, and third doping likelihood in rowing is similar to sports with higher doping prevalence.

Descriptive statistics indicates low knowledge of doping, in comparison to other sports (Sekulic et al., 2016). This is an alarming fact especially because the majority of athletes reported self-education as a primary source of information about doping and nutrition. Although this is not the first time that athletes declared “self-education” as the main source of information about doping and sports nutrition, (Rodek et al., 2012) this issue deserves special attention. Namely, modern society provides a wide variety of verified and unverified sources of information. Knowing that self-education about doping and nutrition can be particularly dangerous since dissemination and later implementation of faulty adopted information can lead to potential health hazardous consequences. To be more precise, lack of proper knowledge of doping substances can lead to the increased possibility of the hazardous health effect of inadequate usage of what is to begin with health-threatening methods and substances (Petróczi & Naughton, 2007).

Athletes perspective on doping has changed from the past 6 to 8 years. Studies examining swimming, sailing and table tennis athletes from that period were perceiving health-hazardous consequences as main concern of doping consumption (Kondric et al., 2011; Kurimay et al, 2017; Rodek et al., 2012; Sajber et al., 2013). However, according to our findings majority of rowers (64.15%) consider doping as primarily “fair play problem”, while 26.42% declared doping as mainly health-threatening behavior, which is supporting more recent studies conducted on team sport, sailing and swimming athletes (Devic et al., 2018; Sajber et al., 2019; Sekulic et al., 2016; Rodek et al., 2012). Therefore, our findings on the majority of rowing athletes who perceive doping as mainly fair-play issue, and not health-threatening behavior is not surprising. For a moment, it is hard to assume what is a probable cause of such alteration in attitudes. However, it could be that athletes examined are highly competitive and consequentially perceive doping mainly as a “fair play issue”.

Another important and concerning finding is the fact that negative DA in here studied rowers is relatively low (56%). For example, recent studies on swimming evidenced 71.76% swimmers with a self-declared negative tendency toward doping (Sajber et al., 2019), while swimming is among top 10% of most doping contaminated sports according to WADA statistics (WADA, 2016). Rowing is considered to be highly objective sport, just as swimming, since competitive results are reliably measured by relay times. Therefore, athletes are able to estimate for themselves their athletics capacity irrespective of factors that are known to affect athletic achievement in some other sports (i.e., the quality of the opponent in martial arts, and the athletic capacity of teammates in team sports). With that being said, it is possible that rowers may recognize their relative physical “inferiority” as a matter that could be efficiently overcome by the use of doping. However, this problem is seeking for more thorough investigation for a better understanding.

## Conclusion

Rowing is poorly explored in terms of doping and factors influencing doping behavior. Here presented results evidenced the necessity for further more comprehensive and detailed exploration of this subject, given that results have shown a lower, and similar negative doping tendencies in comparison to more doping contaminated sports. What’s more, dissemination and later implementation of incorrect information about doping and nutrition are building an unhealthy misinformed environment in the rowing community and can potentially lead to the future of improperly educated athletes unaverred of harm they are doing to themselves. That being said, it is crucial to develop educational / anti-doping strategies to avoid these problems in the future.

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## ASSOCIATIONS BETWEEN PHYSICAL ACTIVITY AND SLEEP IN ACTIVE ADULTS: A SUBJECT-SPECIFIC ANALYSIS

Antonio Martinko, Filip Koradžija, Maroje Sorić

University of Zagreb Faculty of Kinesiology, Croatia

**Introduction/Purpose:** The main purpose of this study was to examine whether the duration of moderate-to-vigorous physical activity during the day (MVPA) is associated with sleep quantity and quality the following night [i.e. total sleep time (TST), sleep efficiency (SE)].

**Methods:** Fitbit Charge 3 was used to assess MVPA and sleep related data among 35 recreationally active adults by combining triaxial accelerometry, heart rate and heart rate variability signals. Two linear regression models were constructed where every subject represented a single unit of analysis. The models included MVPA as an independent variable and TST or SE the following night as dependent variables. Both models included the following confounders: 1) dependent and independent variables at the preceding lag, to control for possible autocorrelations, 2) the progressive number of days as a means of controlling for the effect of elapsed time on the associations, 3) weekday/weekend, 4) age, 5) sex, 6) self-reported BMI. Missing data values were imputed as mean values of respective variables and subjects were clustered into 2 groups based on average TST (<7hrs vs. >7 hrs)

**Results:** A median number of 14 pairs of days and nights from each of the 35 subjects were analysed (60% females, age = 43.83±8.42 years, BMI = 24.76±2.83 kg/m<sup>2</sup>). Significant associations between MVPA and TST were found in only three subjects (two positive and one negative association), while MVPA and SE were associated in only one subject (positively). There was an absence of a significant relationship among the other 32 subjects (91% of subjects), without a clear general trend for the effect of MVPA on sleep. More precisely, for TST point estimates pointed to the positive effect of MVPA on TST in 14/23 participants with average TST longer than 7h, while negative point estimates were seen in 10/12 participants who slept <7h on average. For SE, point estimates pointed to negative and positive effect equally frequently in both groups.

**Conclusions:** This study found that among these recreationally active and healthy subjects, physical activity did not affect subsequent sleep quantity or quality. Still, a relatively short study period and predominantly optimal sleep quality limit our conclusions.

**Key words:** *sleep, physical activity, adults, regression*

## THE PREVALENCE OF WORK-RELATED MUSCULOSKELETAL DISORDERS AMONG URBAN BUS DRIVERS IN ZAGREB

**Martina Mavrin Jeličić**

*Faculty of Transport and Traffic Sciences, University of Zagreb, Croatia*

### Abstract

Work-related musculoskeletal disorders may affect the quality of work among workers in many occupations, and low back pain has been identified as one of the most costly disorders among the worldwide working population (Lis, A.M. et al. 2007). Many studies conducted around the world have found that urban bus drivers have a high prevalence rate of musculoskeletal pain, especially in the lower back. The City of Zagreb has about 400 ZET buses which represent one of the means to transport a large number of residents. The aim of this study was to investigate the prevalence and incidence of work-related musculoskeletal disorders among professional male bus drivers operating urban buses in Zagreb and to create guidelines for an interventional kinesiology program to increase the health of the musculoskeletal system in drivers. Methods: a total of 116 bus drivers participated in the study that consisted of a musculoskeletal pain questionnaire survey. The results show that 93.1% of the subjects reported musculoskeletal pain. In conclusion, the results of this study showed a very high rate of prevalence of musculoskeletal disorders, which warrants further investigation and implementation of kinesiological interventions.

**Key words:** *bus drivers, musculoskeletal disorders, low back pain*

### Introduction

The driving force of our society is the working population and the degree of its health is of inestimable importance. Numerous studies indicate a high prevalence of work-related musculoskeletal disorders, especially lower back pain, in various occupations, which may contribute to large economic losses to individuals as well as to the community (Bureau of Labour Statistics, 2003). The results of a large number of studies emphasize that bus drivers are at high risk for developing musculoskeletal pain due to prolonged sitting in a relatively small space and the impact of vehicle vibrations (Anderson, 1992). According to data of Bureau of Labour Statistics (2016) bus drivers belong to the group of employees with high sitting rate, they spend as much as 82,4% time sitting and 17,6% standing or walking. Studies conducted in the USA, Asia and Europe report that bus drivers have a high prevalence of work-related musculoskeletal disorders (Magnusson et al., 1996), while data for urban bus drivers in Croatia are still unknown.

Hakim et al. (2017) found bus drivers to be at an increased risk of musculoskeletal disorders, primarily related to lower back pain, due to several factors associated with physical and occupational circumstances. In this study urban bus drivers have shown high levels of back pain, which was associated with driving longer than 8 hours per day, uncomfortable seats, and incorrect steering wheel positions and stiffness of the steering wheels. Data from the European Foundation for the Improvement of Living and Working Conditions, based on data from 15 European countries (Croatia not included), showed that 25% of bus drivers reported work-related neck/shoulder pain, and 15% reported work-related arm pain. (De Kraker et al. 2005). Furthermore, study done on bus drivers in Denmark found that prevalence rate of lower back pain was as high as 57% among bus drivers (Netterstrom, 1989). The aim of this study was to investigate the prevalence and incidence of work-related musculoskeletal disorders among professional bus drivers in Zagreb.

### Methods

This study is based on a primary data collection from professional male bus drivers operating in the City of Zagreb. Age between 40 and 55 years and a minimum of 15 years of working experience were used as eligibility criteria. The sample included 116 respondents. Musculoskeletal conditions of respondents were evaluated by using the standardized and validated questionnaire – the Örebro Musculoskeletal Pain Questionnaire (ÖMPQ) (Linton et al., 2003). The ÖMPQ data were analyzed by using descriptive indicators. The descriptive statistics for categorical variables included frequency analysis, while the distributions of quantitative variables were described by using the arithmetic means, standard deviations, medians and quartiles. The normality of distribution was tested with the Shapiro-Wilk test, which showed that the quantitative variables of interest were not normally distributed ( $p < 0.001$ ). Therefore, non-parametric tests were used for data analysis. The relationship between categorical variables was analyzed by the means of chi-square test or Fisher exact test for small samples. When one of the variables was quantitative in nature, the Kruskal- Wallis test or Mann-



Whitney U test was used for comparison. P-value less than 0.05 was considered as the evidence of statistical significance. Statistical analysis was performed in the SAS System (SAS Institute Inc., North Carolina, USA).

## Results

Respondents were between 40 to 55 years of age, with the median age of 44 (Table 1). They had 23 years of working experience on average, and had a typical working week of 43 hours.

Table 1. Socio-demographic characteristics of respondents

Variable	n	%	Mean	SD	Med	Q1	Q3	Min	Max
Age (years)	116		46.1	5.9	44.0	40.0	52.0	40.0	55.0
Total working experience (years)	116		23.1	6.7	22.0	16.0	29.5	15.0	35.0
Typical working week (hours)	116		43.2	7.8	42.0	40.0	45.0	6.0	72.0

Note: Mean = Arithmetic mean; SD = Standard deviation; Med = Median; Q1 = 1st quartile; Q3 = 3rd quartile; Min = Minimum; Max = Maximum.

Every tenth bus driver was on a sick leave during the last month (prior to the survey), with the duration of a sick leave between 7 and 345 days (Table 2). The reasons for taking a sick leave were stress, prostate, spine, lower back pain, hernia and flu. Overwhelming majority of respondents (93%) felt musculoskeletal pain. Lower back was the main source of musculoskeletal pain (reported by 72% of respondents), followed by neck (22%), shoulders (16%), leg (16%), upper back (15%) and arm (10%). Other reported sources of pain were hip (n = 6) and knee (n = 2). Almost every third bus driver (31%) felt current pain for a week or less and every second (50%) for more than two months. A considerable share of drivers (37%) felt pain for a period longer than a year. During the last 12 months, 46% of bus drivers were on a sick leave. The most frequent duration of a sick leave was between 8 and 14 days (18%).

Table 2. The condition of musculoskeletal system of respondents

Variable	n	%	Mean	SD	Med	Q1	Q3	Min	Max
Were on a sick leave during the last month	12	10.3							
Duration of a sick leave (days)	8		100.4	151.6	21.0	8.0	196.5	7.0	345.0
Pain area									
Neck	26	22.4							
Shoulders	19	16.4							
Upper back	17	14.7							
Lower back	84	72.4							
Leg	18	15.5							
Arm	11	9.5							
Other	8	6.9							
Number of missed work days in the last 12 months									
0 days (1)	63	54.3							
1-2 days (2)	2	1.7							
3-7 days (3)	8	6.9							
8-14 days (4)	21	18.1							
15-30 days (5)	13	11.2							
1 month (6)	3	2.6							
2 months (7)	.	.							
3-6 months (8)	2	1.7							
6-12 months (9)	2	1.7							
Over 1 year (10)	2	1.7							
Duration of the current pain problem									
0-1 week (1)	36	31.0							
1-2 weeks (2)	4	3.5							
3-4 weeks (3)	15	12.9							
4-5 weeks (4)	.	.							
6-8 weeks (5)	3	2.6							
9-11 weeks (6)	.	.							
3-6 months (7)	4	3.5							
6-9 months (8)	5	4.3							
9-12 months (9)	6	5.2							
Over 1 year (10)	43	37.1							

Note: Mean = Arithmetic mean; SD = Standard deviation; Med = Median; Q1 = 1st quartile; Q3 = 3rd quartile; Min = Minimum; Max = Maximum; Coded values shown in parentheses.

In a subset of bus drivers who felt musculoskeletal pain (93%), the majority had lower back problems (78%). Lower back problems were usually not in a mix with other pain problems (Group 1;  $n = 50$ ), but nevertheless a considerable share of bus drivers besides the lower back pain also felt pain in the other body area (Group 2;  $n = 34$ ), and some had pain in the other body area, but not in the lower back (Group 3;  $n = 24$ ).

The members of Groups 1 were generally younger (median age of 41 years) than the members of Group 2 (median age of 46.5 years) and Group 3 (median age of 48.5 years) (Table 3;  $p = 0.008$ ). Group 2 generally had a longer working age (median of 27 years) compared to Group 1 (median of 18 years) (Mann-Whitney U test;  $p = 0.004$ ), and also generally missed more work days in the last 12 months (median of 8 to 14 days) than Group 1 (median of 0 days) (Mann-Whitney U test;  $p = 0.008$ ).

Table 3. Relationship between the lower back pain and age, total working experience, duration of working week, number of missed work days and duration of the current pain problem

Variable	Group 1			Group 2			Group 3			p-value
	Lower back pain only			Lower back pain and pain in the other body area			Pain, but not in the lower back			
	Med	Q1	Q3	Med	Q1	Q3	Med	Q1	Q3	
Age	41.0	40.0	50.0	46.5	42.0	54.0	48.5	42.0	52.5	0.008
Total working experience (years)	18.0	15.0	25.0	27.0	20.0	30.0	25.5	17.5	30.0	0.005
Typical working week (hours)	45.0	40.0	48.0	43.5	40.0	45.0	41.0	40.0	45.0	0.327
Number of missed work days in the last 12 months <sup>b</sup>	1.0	1.0	3.0	4.0	1.0	5.0	1.5	1.0	4.0	0.008
Duration of the current pain problem <sup>b</sup>	9.0	1.0	10.0	8.5	2.0	10.0	4.0	1.0	8.5	0.168

Note: Med = Median; Q1 = 1<sup>st</sup> quartile; Q3 = 3<sup>rd</sup> quartile.

<sup>a</sup> P-value of Kruskal-Wallis test.

<sup>b</sup> Coded values.

Group 2 had a higher share of drivers (29%) who were on a sick leave during the last month (prior to the survey) compared to Group 1 (4%) and Group 3 (no respondents who were on a sick leave during the last month) (Table 4;  $p < 0.001$ ).

Table 4. Relationship between the lower back pain and taking a sick leave during the last month

Variable	Group 1		Group 2		Group 3		p-value <sup>a</sup>
	Lower back pain only		Lower back pain and pain in the other body area		Pain, but not in the lower back		
	n	%	n	%	n	%	
Sick leave during the last month							
Were on a sick leave	2	4.0	10	29.4	0	0.0	< 0.001
Were not on a sick leave	48	96.0	24	70.6	24	100.0	

<sup>a</sup> P-value of chi-square test or Fisher exact test.

## Discussion

This study investigated the prevalence of musculoskeletal disorders. The results of this study show that 93.1% of respondents reported having musculoskeletal pain, which can be considered a high prevalence rate compared to studies done in Europe so far. Data from the European Foundation for the Improvement of Living and Working Conditions, based on data from 15 European countries showed that 25% of bus drivers reported work-related neck/shoulder pain, and 15% reported work-related arm pain. (De Kraker et al. 2005). The data obtained indicate that most of the bus drivers have lower back pain, while pain in the neck, shoulder, legs, upper back, arms, hips, and knees are present at a slightly lower rate. The prevalence of lower back pain compared to other parts of the body is similar to the results of other studies, where the highest rate of lower back pain was reported by bus drivers. (Magnusson et al., 1996).

This study examined the individual characteristics of the subjects and the results showed that drivers who have only back pain (group 1) are generally younger than those who have pain also in other parts of the body (group 2). This data may suggest that older drivers are more likely to develop pain both in the lower back as well as in the surrounding areas. A combination of pain in different segments of the body, where lower back pain is always present, could be referred pain from the spine or localized due to mechanical stress in that segment of the body associated with sustained sitting postures and repetitive movements in bus-driving (Grace et al. 2007).

Also, the results show that drivers with pain both in the lower back and in other areas of the body generally had somewhat longer overall work experience than drivers who had lower back pain only. It can be assumed that long-term exposure to risk factors of driving may be associated with a wider dispersion of body pain in drivers. Other studies that have investigated these problems have also reported an increased risk due to age and years of driving, with reports of increased odds ratio of back and neck pain in drivers who drive more than 20 hours per week regularly (Krause et al. 1997).

The use of sick leave for the last month and the days of sick leave in the last 12 months are significantly higher for those who have pain both in the lower back and in another area of the body than for those who do not have lower back pain at all. These results indicate that drivers with greater dispersal of body pain also have a higher rate of sick leave use. Waddell (2005) also reported that musculoskeletal disorders are one of the most common causes of sick leave, long-term inability to work and early retirement.

This study has limitations. History of pain development was not investigated therefore no information was available whether it started before or during employment. Also, this study examined only a sample of bus drivers and it is unknown whether this represents the true characteristics of all drivers as a whole.

## Results of the survey and guidelines of interventional measures

1. Undoubtedly, this occupation has its difficulties in the ergonomic aspects of the workplace itself, namely inactivity while driving, poor posture, prolonged sitting time, whole body vibrations, repetitive and static positions of arms and legs and the spine. All of these factors that characterize a particular workplace can cause long-term musculoskeletal disorders in bus drivers (Mirmohammadi et al. 2012). Based on the evidence obtained in this paper that the presence of pain in the musculoskeletal system is very high (93.1%), and the most recurring area of pain is in the lower back and neck, we will present possible guidelines for an interventional kinesiology program.

- a) kinesitherapy program - exercising in the workplace that can help eliminate the most common problems of the musculoskeletal system in the neck and lower back area.
- b) education of the drivers - about exercises that relieve the area affected by pain, and strength exercises that strengthen muscles in order to release tension in that area.

If we want to encourage changes that will lead to improved health in professional bus drivers, it is necessary to raise their awareness about possible negative health risk factors. Awareness leads to understanding, and understanding the problem to the necessary motivation, the primary means of engaging in physical activity programs at work, in transportation, at home, and during leisure time.

## Conclusion

The results of this study showed a high prevalence rate of musculoskeletal pain especially in the lower back and neck, followed by the shoulders, knees, and hip that may be work-related among urban bus drivers in Zagreb. As many previous studies emphasize that physical activity is one of the possible factors for the prevention of diseases of the musculoskeletal system, the importance of developing interventional kinesiology programs and promoting physical activity among bus drivers in the Republic of Croatia becomes evident and aims to improve health in the workplace.

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## NUTRITION HABITS AND DIET REGIME OF KAZAKHSTAN STUDENTS ENROLLED IN PHYSICAL EDUCATION AND SPORTS PROGRAM

Kazys Milašius<sup>1</sup>, Yeldana Yerzhanova<sup>2</sup>, Zhanna Sabyrbek<sup>2</sup>, Galiya Madiyeva<sup>2</sup>,  
Ermek Dilmakhanbetov<sup>2</sup>, Zhanna Kalmatayeva<sup>2</sup>

<sup>1</sup>*Vytautas Magnus University, Lithuania*

<sup>2</sup>*Al-Farabi Kazakh national university, Kazakhstan*

The aim of the research was to assess the habits and the actual nutrition of Kazakhstan students enrolled in the program of physical education and sports. 199 students (42 female and 157 male) from 1st to 4th year of study participated in the research. A questionnaire interrogation was used to clarify nutrition habits and factors determining the students' food choice. Aiming to analyse the results of the study, traditional methods of mathematical statistics were used.  $\chi^2$  (chi-square) criterion was applied for the analysis of categorical data reliability.

The results of the study showed that the majority of the surveyed students did not always stick to the healthy diet. 57.1% of female and 62.4% of male students enrolled in the program of physical education and sports have their meals 3 to 4 times per day, but 38.1% of female students and 25.5% of male students eat only 1 to 2 times per day. Similar data were obtained on the response to the students' snacking – 50.0% of female and 44.6% of male students had their snacks 1 to 2 times per day; respectively, 40.4% and 40.8% of them had snacks 3 to 4 times per day, while 4.8% female and 2.5% male respondents reported not having snacks throughout the day at all.

Breakfast is not a usual habit for the students of physical education and sports, as the research have demonstrated. Only 69.0% of female respondents reported doing so regularly, whereas 9.5% of the students do not have breakfast at all, and 21.5% of them – sometimes. Male students tend to have a regular breakfast more often. Female students rarely use catering services, while 28.0% of men use these services every day, and 42.0% of them – 2 to 3 times a week.

Conclusions. According to the results of our research, the main factors of influence on students' healthy lifestyle are health, the kind of sport they're practicing, and body composition, while trending nutrition supplements, nutrition habits, family and friends are the factors of lower impact. Questionnaire interrogation results highlighted the fact that students do not always observe their daily nutrition mode.

**Key words:** *physical education, students, athletes, diet, mode, eating and food habits*

### Introduction

Health dependence on nutrition is greater than on any other factor, thus forming healthy eating habits appears to be an important task (Bills & Manore, 2006; Burke, 2007; Jeukendrup & Gleeson, 2010). Numerous authors point out very close relationship between nutrition and health, since good nutrition ensures good functioning of all body parts and systems (Zimberg et al. 2008; Likus et al., 2013). Recent scientific publications focus on nutritional status of various social groups. Authors often come to the conclusion that eating habits are deteriorating, people choose fast food products of lower biological value. Sport experts are well aware of the rule that to promote health, one should first of all regularly take healthy and balanced food (Czaja et al., 2008; Nazni & Vimala, 2010) so athletes must strictly abide to their eating habits and diet (Ubeda et al., 2010). Research results of Polish scientists Z. Szygula et al. (2009) on triathlon athletes' eating habits showed these athletes mainly consuming bakery products, muesli, yoghurt, kefir, enzyme cheeses, fresh vegetable salad and fresh fruit during the day. Less often, they eat rye bread, pasta, potatoes, cottage cheese, pork, beef and sugar. Spanish scientists E. Iglesias - Gutierrez et al., (2008) evaluated the eating habits of football and basketball players and found out that their most often consumed meal is meat, chicken products, eggs, rice, pasta, bread, confectionery, sweets, fruit and juice. Less commonly, these athletes eat vegetables (82%) and fish (64%). Ubeda et al (2010), while studying eating habits of Spanish athletes, found out that the most frequently consumed products are pasta, meat, breakfast cereals among wrestling sports athletes, but bean products, fish, and fresh vegetables are less consumed. Many authors state that students-athletes due to their great occupation cannot always keep diet and eat at the same time. While analysing the publications of foreign authors, it can be noted that wrong diet is a problem for students in many countries. A. Lakshin & N. Kozhevnikova (2008), having evaluated the diet of Moscow students, noticed that only 72% of respondents ate 3 to 4 times per day, while 72.2% of the daily calories were received during dinner. M. Musingo & L. Wang (2009), who studied the dietary habits of students in the US state of Florida, found out that respondents ate an average meal only 2.04

times per day. Z. Satalic et al. (2007) [11] state that Croatian university students eat on average 3 times per day, and female students - 2.8 times; these authors also found that male students eat 1.4 times on average, and women – 1.7 times per day. Similar results are presented by French scientists Mooneuse et al. (1997), who believe that the majority of students (66.8% of men and 71.2% of women) consume their meal 3 times per day. Most of the surveyed students indicated that they did not snack or snack once per day regardless of the amount of the main meal. Polish scientists W. Likus et al. (2013), who investigated the nutrition of students at Gdansk Medical University, found that only 9% of the surveyed students eat regularly 3 times per day, while it became clear that 79% of them eat between main meals.

In Kazakhstan, the diet and eating habits of athletes have not been sufficiently studied, the main criteria determining the diet and eating habits have not been identified, and the importance of acquired knowledge on the formation of eating habits of students and athletes of various sports has not been assessed yet. Therefore, it is relevant to explore the habits and actual nutrition of physically active individuals and athletes-students of physical education and sports study program, as they are a specific group of society whose physical condition, functionality and health is determined by rational and balanced diet (Yerzhanova et al., 2018<sup>a, b</sup>). The relevance of this issue has determined the purpose of this study.

**The aim of the work** is to assess the habits, regime and the actual nutrition of Kazakhstan students enrolled in the program of physical education and sports.

## Methods

In this study of nutrition habits and diet, 199 students of Al-Farabi Kazakh National University and Abay Kazakh National Pedagogical University physical education and sports (1st to 4th years of study) were investigated. The research employed 42 female students with average means being: age  $19.1 \pm 1.3$  years, height -  $166.1 \pm 7.5$  cm, body weight  $57.5 \pm 8.8$  kg, body mass index (BMI) -  $20.8 \pm 2.3$ , and 157 male participants, average means being as follows: age -  $20.2 \pm 2.3$  years, height -  $177.3 \pm 8.6$  cm, body weight -  $68.8 \pm 10.6$  kg, BMI -  $21.8 \pm 2.4$ .

To analyse the results of the study, standard methods of mathematical statistics were used, calculating the arithmetic mean data (X) and standard deviations (S). To analyse the reliability of categorical data, the  $\chi^2$  (chi-square) criterion was applied. The difference  $p < 0.05$  was considered as reliable. A questionnaire, prepared by Steptoe et al. (1995), was applied to clarify eating habits and factors determining the choice of food for students, directly interviewing each respondent. The questionnaire included the questions about sociodemographic data (gender and age), indicators of body development (height, body weight, BMI), the level of physical activity during the week, as well as questions about diet and eating habits. Research permission was issued by Ethics committee of the Al-Farabi Kazakh National University with participants' voluntary consent to participate in the research. Confidentiality of the research data was observed.

## Results

Analysing the percentage distribution of respondents' answers on compliance with the diet, it should be noted that surveyed physical education and sports students do not always follow the diet: 47.6% of female and 39.4% of male respondents provided "Yes and No" answers concerning compliance with the diet. Relatively large number of students - 26.2% of female and 21.7% of male students reported not keeping to the diet (Table 1).

Table 1. Percentage distribution of respondents in response to the question about keeping diet

№	Dietary criteria	Female (n=42)		Male (n=157)	
1	Agree	23.8		34.4	
2	Yes and No	47.6	$\chi^2 = 17.238; df=3, p=0,001$	39.4	$\chi^2 = 45.930; df=3 p=0.000$
3	Disagree	26.2		21.7	
4	Don't know	2.4		4.5	

It was found that the majority of female students eat 3 to 5 times per day (61.9% and 74.5%, respectively,  $p = 0.000$ ). However, 38.1% of female students and 25.5% of male students eat only 1 to 2 times per day (Figure 1). Evaluating the multiplicity of food depending on gender, it should be noted that male students eat more often than their female fellows.

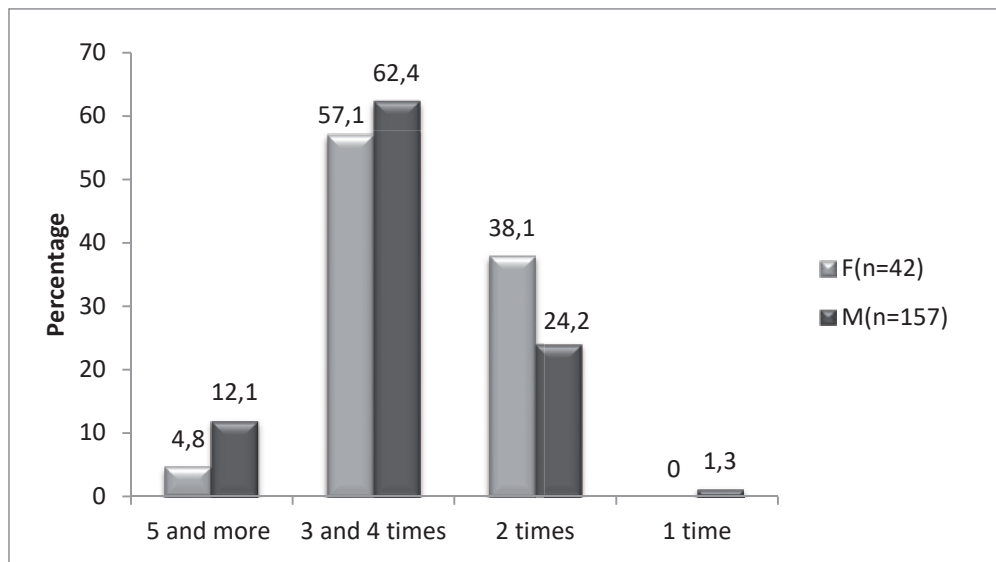


Figure 1. The percentage of respondents in answering the question "How many times do you eat?" (F -  $\chi^2 = 17.714$ ,  $df = 2$ ,  $p = 0.000$ ; M -  $\chi^2 = 133.777$ ,  $df = 3$ ,  $p = 0.000$ )

Analysis of the answers to the question "How many times do you have a snack per day?" revealed that the majority of respondents eat it 1 to 4 times. The survey results showed no significant difference in the number of snacks between female and male respondents (Table 2), the largest number of surveyed students (50.0% of female and 44.6% of male) eat 1 to 2 times between main meals. A relatively large number of students (40.4% of female and 40.8% of male) eat 3 to 4 times.

Table 2. Percentage distribution of respondents in response to the question "How many times per day do you have a snack?"

No	Criteria	Female (n=42)		Male (n=157)	
1	5-6 times	4.8		12.1	
2	3-4 times	40.4		40.8	
3	1-2 times	50.0	$\chi^2 = 28.286$ ; $df=3$ , $p=0.000$	44.6	$\chi^2 = 86.803$ ; $df=3$ , $p=0.000$
4	Don't snack	4.8		2.5	

Most of the students surveyed provided positive answer to the question "Do you have breakfast?". 69% of female students and 81.5% of male students have a regular breakfast ( $p = 0.000$ ) (Table 3). It should be noted that a large percentage of female students do not eat breakfast compared to male ones, and a large number of female ones (21.5%) do not eat breakfast regularly.

Table 3. Percentage distribution of respondents in response to the question "Do you eat breakfast?"

No	Criteria	Female (n=42)		Male (n=157)	
1	Yes	69.0	$\chi^2 = 25.000$ ; $df=2$ , $p=0.000$	81.5	$\chi^2 = 167.554$ ; $df=3$ , $p=0.000$
2	No	9.5		3.2	
3	Sometimes	21.5		15.3	

Our study has shown diversity of the diet of our investigated students-athletes. Some of them use catering services, others cook themselves or eat at home (Table 4).

Table 4. Percentage distribution of respondents in response to the question "How often do you use catering services?"

No	Criteria	Female (n=42)		Male (n=157)	
1	Daily	14.3		28.0	
2	2 to 3times a week	21.4		42.0	$\chi^2=32.987$ , $df=3$ , $p=0.000$
3	Once a week	31.0		18.5	
4	Once a month	33.3	$\chi^2=3.905$ , $df=3$ , $p=0.272$	11.5	



## Discussion

Despite the large amount of scientific information worldwide dealing with nutrition habits issues, the questions on students-athletes eating and diet are still little investigated in Kazakhstan. An appropriate nutritional diet determines the body's adaptation to physical exertion and helps to achieve the highest sports results (Zimberg et al, 2008; Burke et al., 2011; Boguszewski et al., 2013). Due to great occupation, lack of time and possessed eating habits, students-athletes do not always follow balanced nutrition guidelines (Kouloutbani et al., 2012).

Eating 3 times per day is not rational for athletes since the necessary concentration of glucose in the blood is not maintained, and a large amount of food is consumed during the meal. Many authors, investigating the diet issues, believe that athletes should eat 4 to 5 times at the same time (Hinton et al., 2004; Dunn et al., 2007). According to our research, only 4.8% of female and 12.1% of male athletes eat 4 to 5 times per day; 57.1% of female and 62.4% of male students have their meals 3 to 4 times per day, and 25.5% of male and 38.1% of female ones eat only 2 or 1 times per day.

Many authors who have studied eating habits of athletes believe that the optimal amount of snacking should be 3 to 4 times between main meals. Our studies have shown that 40.4% of female students and 40.8% of male students enrolled in physical education and sports study program eat 3 to 4 times per day, 50.0% of female and 44.6% of male athletes eat 1 to 2 times per day, and 4.8% of female and 2.5% of male ones do not eat at all. According to the authors L. Rossi et al. (2009), S. Quintana et al. (2010), regular breakfast is of great importance for physically active people. Unfortunately, only 69.0% of surveyed female students and 81.5% of male ones have regular breakfast.

Our studies have shown that the eating habits of Kazakhstan athletes are similar to those of athletes from other countries. According to the study, it became clear that our respondents consume little cereal products, whereas athletes in other countries consume cereal products in accordance with the requirements of a balanced diet (King et al., 2010; Noda et al., 2009; Beis et al., 2011). One of the nutritional deficiencies of the examined Kazakhstan athletes, as well as of the athletes from other countries, is insufficient consumption of fresh vegetables and fruits. We could find only some research (Szygula et al., 2009) with established consumption of fresh vegetables and fruits in correspondence to recommendations. Our results showing the frequent consumption of flour products coincide with the results of the study on nutrition of Spanish (Iglesias-Gutierrez et al., (2008) and Portuguese athletes (Martins & Rocha 2010).

The choice of products consumed by Kazakhstani athletes for breakfast, lunch and dinner is varied. Students who live at home or in dormitories have a more varied food choice.

Our research results show that the most of the students surveyed do not always follow the balanced diet. The diet of Kazakhstan students is not optimal, not sufficient number of the studied athletes eat 4 or more times per day. Most students of the physical education and sports program eat 3 to 4 times per day, but 38.1% of female students and 25.5% of male students eat only 1 to 2 times per day. Similar data were obtained when examining students' snacking - 50.0% and 44.6% snack 1 to 2 times, 4.8% and 2.5% of women and men do not have snacks. Students of physical education and sports do not always have breakfast. Only 69.0% of female students do it regularly, whereas 9.5% do not have breakfast, and 21.5% of them sometimes have breakfast. Male students have breakfast more regularly. Female students rarely use catering services, while 28.0% of men use these services every day, and 42.0% of them – 2 to 3 times per week.

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## RELATIVE ENERGY DEFICIENCY IN SPORTS AND STRESS FRACTURES

**Milan Milošević**

*Polyclinic Ribnjak Zagreb, Croatia*

**Introduction:** Relative energy deficiency in sports can have a detrimental effect on athletes health. It is a syndrome that affects physiological function and athletic performance. Stress fracture is an overuse injury and can be the result of increased intensity on weakened bone. Female Athlete Triad is a condition among women that consists of disordered eating habits, irregular menstruation, and premature bone loss what can lead to bone injury.

**Methods:** A systematic, computerised literature search of Medline, PubMed and SPORTDiscus databases (from January 2014) using keywords related to stress fracture, relative energy deficiency in sport (RED-S) and low energy availability.

**Results:** Low energy availability increase markers of bone resorption and decrease markers of bone formation in physically active individuals. Evidence suggests that physically active individuals who have low EA present with lower bone mass and strength as well with increased risk for stress fracture injuries.

**Conclusion:** Prevention of stress injuries in physically active individuals is crucial due to recovery time that can be prolonged.

Stress fractures account for up to 10% of all orthopedic injuries.

Risk factors have to be underlined while physiological balance in relative energy deficiency is mandatory in order to obtain good clinical outcome.

**Key words:** *Stress fracture, Relative energy deficiency in sport (RED-S); Athletic triad, Low energy availability, Adolescent*

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## OCCUPATIONAL KINESIOLOGY: PREVALENCE OF MUSCULOSKELETAL DISORDERS AND MANUAL HANDLING IN PRINTING INDUSTRY

Josipa Nakić<sup>1</sup>, Asim Bradić<sup>1</sup>, Erol Kovačević<sup>2</sup>, Ensar Abazović<sup>2</sup>

<sup>1</sup>Faculty of Kinesiology University of Zagreb, Croatia

<sup>2</sup>Faculty of Sport and Physical Education, University of Sarajevo, Bosnia and Herzegovina

### Abstract

The aim of this paper is to determine the prevalence of musculoskeletal disorders in physical workers employed in the graphic industry, as well as to determine whether the observed distributions of the correctness of manual handling differs from the theoretical ones. The results of the survey based on Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms (Kuorinka et al., 1987) that was conducted on a sample of 121 physical workers employed in the graphic industry showed that in the last 12 months workers mostly had problems with lower back (64.46%), neck (49.59%), shoulders (44.62%), and knees (42.14%). Chi-square test showed no statistically significant difference in those who have pains related to those who do not have, given whether they perform spinal flexion or not. 76.03% of the physical workers perform spinal flexion during manual handling. During manual handling, younger workers usually perform the tasks with spinal flexion, while older workers keep a neutral spina. The results of this research have shown that physical workers employed in the graphic industry are not trained to work safely when it comes to manual handling and that education is necessary. The ideal staff that has been educated for this are kinesiologists.

**Key words:** Occupational kinesiology, physical workers, spinal flexion, neutral spina, musculoskeletal disorder

### Introduction

European Agency for Safety and Health at Work campaigns that address the importance of musculoskeletal disorder prevention in the labour sector include: 2000 Turn your Back on Work Related Musculoskeletal Disorders, 2007 Lighten the Load, and 2020-2022 Prevention Of Work-Related Musculoskeletal Disorders. In 2020, the European Agency for Safety and Health at Work published a synthesis of a report by ten countries on the prevalence of MKP (Jesus, 2020). Some of the main conclusions of this report are that musculoskeletal disorders are one of the most common work-related health problems. According to EU-OSHA results from 2019 (de Kok et al., 2019b) 60% (2015 y.) and 62% (2010 y.) of employees in Croatia reported at least one or more musculoskeletal disorders in the last twelve months.

Back in 1995, the results of a study (Marras et al., 1995) showed that the frequency of lifting of loads, torque of force, and movements and speed of movement of the lumbar part of the spine in the frontal, sagittal and transversal planes are a good predictor of medium and high risk for the occurrence of low back pain associated with work. Vladimir Mihajlovic Zaciorski stated in 1975 that the neutral position of the *spine* is of great importance when lifting weights from the floor. The author also emphasizes that if the back is bent that there is a high risk of injury of i.v. discs. According to EU OSHA (Schneider et al., 2010) heavy physical work, manual handling, and poor posture (flexion, torsion, static positions) represent some of the most important risk factors in developing low back pain. Das and Sengupta (Das & Sengupta, 2000) state that Punnet, Fine and Keyserling back in 1987 found that torsion and torsion with flexion represented a statistically significant risk factor for lower back pain. It can be noted that some authors, along with the quantity of work, also focus on the quality.

Based on all of the above, regarding the risk factors of the occurrence of musculoskeletal disorders, occupational kinesiology extracts biomechanical factors related to quantity and quality of work and claims that physical workers do not have problems with musculoskeletal disorders because they handle loads in their workplace. Occupational kinesiology claims that workers have problems with musculoskeletal disorders because they use incorrect techniques during manual handling. When it is established that the workers handle the loads properly, only then the quantity of work can be a possible factor of the occurrence and progression of the musculoskeletal disorders in workers.

According to the Regulations on Safety at Work in Manual Load Transfer (no. 42/05), the employer must familiarize workers with the characteristics of the loads and other factors that affect safe operation and enable them to perform manual transferring of cargo in a safe way, avoiding back injuries. On this basis, it could be assumed that 100% of the employed persons handle the loads properly. However, if it is assumed that the subject of measurement is equally distributed in the population, then it is assumed that 50% of workers work with the correct or at least average good manual handling

technique, and 50% of workers work with improper manual handling techniques. So, we hypothesized that 50% of all physical workers were trained to work safely when it comes to manual cargo transfer and that there is no statistically significant difference between observed and theoretical (50:50) cargo handling techniques. The aim of this paper is also to determine the prevalence of musculoskeletal disorders in physical workers employed in graphic and publishing industry.

## Methods

### Participants

The sample of respondents is suitable and consists of 121 physical workers (84 M, 37 W) employed in the graphic and publishing activities. The average age is 41.80 y (+/- 10.66y), average work experience is 17.55 y (+/- 10.71 y), average body height is 1.75 m (+/- 0.08 m) and the average body mass is 81.18 kg (+/- 14.74 kg).

### Procedure

At trainings on proper and safe ways of handling cargo, respondents completed survey questionnaires. The basis of the questionnaires are questions from Standardized Nordic Questionnaires for the analysis of musculoskeletal symptoms. Each survey questionnaire had a large number on the first page that later served to identify workers. Before starting the education, each employee demonstrated his usual lifting technique. Workers were told to put the paper down three times and lift it off the floor the way they usually do, all captured on camera. Video clips were later reviewed. The only criteria for the correctness of the cargo handling technique were lumbar flexion. If when lifting and lowering the paper to the floor there was spinal flexion, the technique was recorded as irregular. If the back remained straight and without motion then the technique of handling loads was recorded as correct i.e., neutral spin.

### Data analysis

The data was processed by the Statistics 13.5.0.17. program package. Descriptive statistics methods were applied. Independent t-test by groups was used to determine the statistical significance of differences between groups of workers. Chi-square test was used to determine the significance of observed frequency deviations from theoretical ones.

## Results

The results of the survey conducted on a sample of 121 physical workers (Figure 1) employed in the graphic industry showed that in the last 12 months workers mostly had problems with lower back (64.46%), then neck (49.59%), shoulders (44.62%), and knees (42.14%). 26.45% of workers had problems with lower back, neck, and shoulders during the last 7 days.

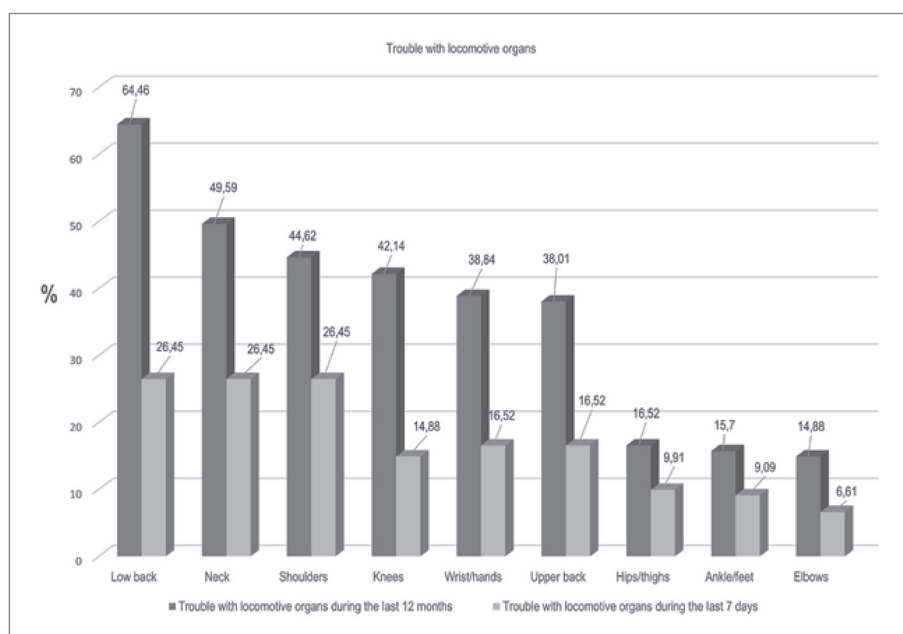


Figure 1. Trouble with locomotive organs during the past 12 months and during the past 7 days.



The results in Table 1 show that 23.97% of workers (N 29/121) with the average age of 46.46 years had neutral spin during manual handling; that 76.03% of workers (N 92/121) with the average age of 40.30 years performed spinal flexion during manual handling; that in the last 12 months, 64.46% (N 78/121) of workers with the average age of 43.08 years had lower back problems; that out of the total number of workers with flexion, 60.80% of workers have back pain (N 56/92); that 7 workers (5.78%) with the average age of 40 years do not feel lower back pain and they practice manual handling with neutral spin; that 22 workers (18.18%) with the average age of 48 years practice manual handling with neutral spin; that 36 workers (29.75%) with the average age of 39.36 years perform spinal flexion and do not have back pain; and that 56 workers (46.28%) with the average age of 40.95 years perform flexion and have back pain.

Table 1. Chi-square results, number and percent of workers with and without back pain regardless to lifting techniques with spinal flexion and neutral spina.

(Chi-square 2,16, p level 0,14, Phi-square 0,02)										
		Back pain			No back pain			Σ	Σ	Σ
Spinal flexion	N 56	46,28%	40,95 years	N 36	29,75%	39,36 years	N 92	76,03%	40,30 years	
Neutral spina	N 22	18,18%	48,00 years	N 7	5,78%	40,00 years	N 29	23,97%	46,46 years	
Σ	78	64,46%	43,08 years	N 43	35,53%	39,49 years	121	100%	41,80 years	

The results of chi-square test suggest that the difference in frequencies (Table 1) is not statistically significant. It means that workers who work with flexion do not have statistically significantly more back problems than those who work with neutral spina. The probability that there is a difference in the population is 86% vs. 14% that there is no difference. So, differences are more likely to occur than not, but because of the sample size and size of the difference here it is not statistically proven.

60% of workers (N 56/92) working with spinal flexion have back pain. 76% of workers (N 22/29) working with neutral spin have back pain. Independent t-test results ( $p=0.008$ ), by groups (flexion vs. years of life) showed that there is a statistically significant difference, i.e., that the correct technique of handling loads is more often used by older workers (76.03%, N 92, AS age 40.33 years), and that improper manual handling technique is more often used by younger workers (23.97%, N 29, AS age 46.06 years).

The results of chi-square test (Table 2) showed that there is a statistically significant difference between observed and theoretical cargo handling techniques, which workers would have assuming that the subject of measurement is equally distributed in the group, i.e., assuming that the regularity of cargo handling techniques is equally distributed in the population.

Table 2. Observed vs. Expected Frequencies, Chi-Square

Observed vs. Expected Frequencies, Chi-Square = 32,80165, df = 1 p = ,000000				
Case	observed fo	expected fe	O-E	(O-E)**2 /E
Neutral spina	29,0000	60,5000	-31,5000	16,40083
Spinal flexion	92,0000	60,5000	31,5000	16,40083
Sum	121,0000	121,0000	0,0000	32,80165

Based on the Chi square test, it can be concluded that the measured feature is not equally distributed in the population because of a significantly larger number of workers who use improper cargo handling technique.

## Discussion

The results of the study showed that physical workers employed in graphic and publishing activities during the past 12 months have mostly experienced problems with lower back, then neck, shoulders, and knees. The results of the study are expected, and this research confirmed that lower back problems are one of the biggest problems from musculoskeletal disorders with physical workers.

The results of the Chi-square test and p-level showed that the difference in observed and theoretical frequencies of those who have pains related to those who do not, given whether they perform flexion or not, is not statistically significant or that workers working with flexion do not have significantly more back problems than those who work with neutral spina. Based on these results, it could be assumed that the technique of handling loads is not important and has no impact on



lower back problems. However, this is not the case. The probability that there is a difference in the population is 86% vs. 14% that there is no difference. The technique of handling loads plays an important role in predicting and/or preventing back problems in physical workers, and this has been proven by numerous authors (Zaciorski Mihajlovic, 1975, Anderson et al., 1987; William S. Marras et al., 1995)(William S. Marras et al., 1995)(William S. Marras et al., 1995)(William S. Marras et al., 1995); Karwowski & Marras, 1999; Das & Sengupta, 2000 according to Punnet, Fine and Keyserling, 1987; Allread, Marras, & Burr, 2000; W. S. Marras, Allread, Burr, & Fathallah, 2000; McGill, 2001; McGill, 2002; Bogadi-Šare in 2002; McGill, 2004; Jang et al., 2007; Schneider et al., 2010; Alessa and Ning, 2018 (Schneider et al., 2010)(Schneider et al., 2010)(Schneider et al., 2010)(Alessa & Ning, 2018)(Alessa & Ning, 2018)(Alessa & Ning, 2018); Grazio, 2012; McGill & Carroll, 2018).

The correct load handling technique is one of the basic preventive measures when it comes to lower back pain. Primary prevention refers to the application of proper load handling techniques before problems with lower back pain occur, and secondary prevention refers to the application of proper load handling techniques in situations where lower back pain already exists. The results of this study showed that manual handling with flexion is more often done by younger workers (AS 40 years), and manual handling with neutral spina by older workers (AS 48 years). In this case it looks like older workers, who have more back problems, more often apply proper load handling techniques probably because they cannot do their job when they work with spinal flexion.

During trainings on proper and safe ways of handling cargo, several workers answered the informal question “How come you work so properly?” in the context of “I cannot do it any other way, my back hurts”. Namely, Younger workers can afford to work incorrectly, while older workers cannot because their back hurts and they cannot do it any other way. In support of this interpretation are the results of the t-test (flexion vs. years of life) which clearly show that there is a statistically significant difference i.e., older workers are more likely to use the correct load handling technique and younger workers are more likely to use improper cargo handling technique.

The hypothesis which states that the neutral and flexed spina during manual handling will be equally distributed in the population was rejected because 76.03% of workers handle loads using flexion spina, and only 23.97% of workers have a neutral spina when handling loads. The results of this study showed that physical workers employed in the graphics industry are not trained to work safely when it comes to manual handling of loads.

The main conclusion of this study is that physical workers employed in graphic and publishing activities are not trained to work safely from the body posture point of view. Given that the system throughout Croatia is the same, it can be assumed that other physical workers are not adequately trained for manual handling, but this is something that further research needs to prove. It concludes that physical workers will continue to have problems with their lower backs until the need to change the system of education of physical workers on proper, safe, and economical load handling techniques is recognized. Occupational kinesiology should have its place in the system of workers' health protection.

## Conclusion

The results of the study showed that in the last 12 months physical workers mostly had problems with lower back, then neck, shoulders, and knees. 76.03% of physical workers with the average age of 40.30 years perform spinal flexion during manual handling. The results of the Chi-square test did not show a statistically significant difference in the representation of those who have pains related to those who do not, given whether they are performing flexion or not. Handling loads is more often done improperly with spinal flexion by younger workers, and properly with neutral spina by older workers. The reason for this is probably because some older workers who have low back pain cannot work with flexion due to the flexion hurting their backs. This is a thesis that needs to be confirmed by further research. The results of this research have shown that physical workers employed in the graphic industry are not trained to work safely in the part related to hand-conveying cargo and that education is necessary. Occupational kinesiology should have its place in the system of workers' health protection.

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## PHYSICAL FITNESS AND INJURIES IN CLASSICAL BALLET ENSEMBLE: A RETROSPECTIVE STUDY

Marija Rakovac<sup>1</sup>, Dubravka Sajković<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>University Clinic of Traumatology, Zagreb, Croatia

### Introduction/Purpose

Classical ballet places a high physical demand on dancers throughout the season and dancers are prone to injuries. Physical fitness was put forward among factors influencing injury occurrence (Koutedakis & Jamurtas, 2004). A difference in the daily workload according to dancers' ranking in ensemble was also observed, suggesting a possible difference in fitness level and injury occurrence between soloists and corps de ballet (Twitchett et al., 2010). The purpose of this study was to test the differences in components of physical fitness between: a) dancers who were injured during the previous year and those who were not, b) soloists and corps de ballet.

### Methods

The participants were classical ballet dancers of the Croatian National Theatre in Zagreb (n=40; 26 females – age (mean±SD) 32.2±7.9 yrs, height 166.1±4.3 cm, weight 52.6±5.4 kg; 14 males – 29.7±7.4 yrs, 177.9±4.8 cm, 69.5±7.0 kg). Data on injuries (Liederbach et al., 2012) sustained during the previous year were collected via questionnaire. Muscular fitness was measured by curl-up repetition test, back extension height test, plank. Body composition was calculated using the Jackson-Pollock 7-site-skinfold equation. Sit-and-reach and range of hip internal/external rotation and ankle dorsal/plantar flexion were measured to determine flexibility. An independent-samples t-test was used to compare physical fitness components for injured and non-injured dancers and for soloists and corps de ballet. A Chi-square test for independence was used to explore the association between position in the ensemble and injury occurrence.

### Results

There were no significant differences in any of the measured components of physical fitness between injured and non-injured dancers ( $p > .05$  for all). Soloists performed significantly better only on plank ((mean±SD) 46.8±17.6 sec in initial proper alignment) than corps de ballet (36.0±14.9 sec);  $t(38) = -2.1$ ,  $p = .04$ . There was no significant association between position in the ensemble and injury occurrence ( $X^2 = .00$ ,  $p = 1.00$ ).

### Conclusions

The dancers injured in the previous year did not differ from the non-injured ones in the measured components of physical fitness. However, the study is retrospective, a recall bias cannot be excluded and physical fitness can differ depending on the demands of a particular theatre season. The topic should be further investigated in prospective studies.

**Key words:** *dance, muscular fitness, flexibility, injury*

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## THE INFLUENCE OF THE TESTING PROTOCOL FOR THE MAXIMAL RATE OF OXYGEN UPTAKE. CAN WE TEST THE MAXIMAL VALUES?

Ivan Struhár, Vojtěch Grün, Tomáš Vencúrik

*Faculty of Sports Studies*

### Abstract

This study aimed to investigate the applicability of three different types of testing protocols on the value of maximal oxygen uptake. The study also wants to shine new light on debates through an examination of maximal oxygen uptake through using the self-paced testing protocol. The data was collected from twenty-one physically active male participants (age  $26.18 \pm 2.53$  years; body mass  $75.81 \pm 4.22$  kg; body height  $1.80 \pm 0.04$  m). Significant differences (Maximum rate of oxygen uptake, Maximum Minute Ventilation, Peak Power) were found for the self-paced protocol (according to the exact *rate of perceived exertion- Borg Scale*) by comparing with the traditional concept of testing (increasing of body weight every minute until to volitional failure; increasing 1W/kg of body weight every minute until to volitional failure). This study has shown that self-paced protocol results in higher the maximum rate of oxygen uptake values than traditional protocol.

**Key words:** *aerobic capacity, exercise, ratings of perceived exertion, oxygen consumption*

### Introduction

The maximum rate of oxygen uptake ( $VO_{2max}$ ) is a valuable measure in exercise physiology but also can be used to individuals with several pathologic conditions (Bassett & Howley, 2000; Montes et al., 2018; Sousa et al., 2015). One of the most significant current discussions are testing protocols and mechanisms of  $VO_{2max}$  regulation. For this reason, the occurrence of the plateau at the end of the test is one of the crucial components of test validity. It is often described as the  $\Delta VO_2 \leq 1.5 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  over the final two consecutive periods of the test (Gordon et al., 2015). It means if the researcher increased the testing load at the end of the test, the participant could accept it but without the mentioned increase of oxygen consumption. On the other hand, blood lactate concentration, the maximal heart rate, and respiratory exchange ratio are secondary criteria of validity (Mier et al., 2012; Poole et al., 2008; Schaun, 2017).

Another problem is the proper assumption of testing time. If the test lasts too long, it is almost impossible to prove the validity of testing. Our experience from laboratory exercise physiology is working with that the  $VO_{2max}$  test should not last much more than 10 minutes, and during each stage should be seen the steady-state of  $VO_2$ . Another practical advice which is also necessary to think about is the load increasing between stages. Recently, researchers have shown an increased interest in this component of testing (Hamlin et al., 2012; Lim et al., 2016; Pierce et al., 1999)

This study seeks to obtain data that will help to understand the role of testing design in the concept of  $VO_{2max}$  testing.

### Methods

#### Subjects

Twenty-one physically active male participants (age  $26.18 \pm 2.53$  years; body mass  $75.81 \pm 4.22$  kg; body height  $1.80 \pm 0.04$  m) volunteered to participate in the study. The informed consent form was obtained from each participant before the start of all measurements. The study was approved by the Research Ethics Committee of Masaryk University. All participants had no experience with the testing methods used in the study. One week before the study, all participants completed a familiarization meeting with all procedures which were used during the study. All participants were free from all types of cardiovascular, metabolic, and orthopedic diseases that can limit their work capacity at least six months before the study. Participants were all recreationally active (running- training load of less than  $25 \text{ km}\cdot\text{week}^{-1}$  and cycling- training load of less than  $40 \text{ km}\cdot\text{week}^{-1}$ ) and were familiar with the experimental testing methods used in the study.

## Study design

The participants visited the laboratory three times, separated by at least 7-days. Each participant returned to the laboratory during the same time of day ( $\pm 1$  hour). The participants were instructed 48 hours before the experimental test not to attend any intense physical activity and to take anti-inflammatory medication. Participants were advised to maintain the same daily routine and physical activity training program. The researcher also instructed the participants to be fully hydrated and having a meal at least 2.5 hours before the test.

The testing protocol started with a randomly chosen testing protocol. Afterward, the researcher analyzed a capillary blood sample for determining the lactate activity. Subsequently, the bicycle ergometer was set up according to the anthropometric characteristic of each participant. Then, the chosen testing of the maximum rate of oxygen uptake ( $VO_{2max}$ ) started according to the prescribed protocol. Finally, lactate activity was measured three minutes after the selected protocol.

## Measures

### A. Determining the maximum rate of oxygen uptake ( $VO_{2max}$ )

A gas system (MetaMax® 3B; Cortex) was used for analyzing the ventilation and expired gases. The calibration of the gas analyzing system was done before every testing day, according to the manufacturer's instruction.

#### 1. Self-paced $VO_{2max}$ test ( $VO_{2max}$ test $5 \times 2 \text{ min}$ )

The testing protocol consisted from warm-up phase (0 W, 3 min, pedal cadence was set up at 75 RPM), test phase (initial workload of 0.5/kg of body weight for 1 min followed by 5 x 2 min stages, where each stage was adjusted according to exact *rate of perceived exertion* (RPE). Stages (5 x 2min) were kept at the exact RPE- stage 1 (1-3 min, RPE 11), stage 2 (3-5 min, RPE 13), stage 3 (5-7 min, RPE 15), stage 4 (7-9 min, RPE 17), stage 5 (9-11 min, RPE >18), and cool-down phase (0 W, 5 min, pedal cadence was set up at 65-70 RPM).

#### 2. Incremental test until volitional exhaustion ( $VO_{2max}$ test $1 \text{ min}$ )

The testing protocol consisted from warm-up phase (0 W, 3 min, pedal cadence was set up at 75 RPM), test phase (initial workload of 1W/kg of body weight for 1 min followed by increasing of body weight every minute until to volitional failure or the cadence dropped below 65 RPM), and cool-down phase (0 W, 5 min, pedal cadence was set up at 65-70 RPM).

#### 3. Incremental test until volitional exhaustion ( $VO_{2max}$ test $1 \text{ W/kg, 1 min}$ )

The testing protocol consisted from warm-up phase (0 W, 3 min, pedal cadence was set up at 75 RPM), test phase (initial workload of 1W/kg of body weight for 1 min followed by increasing 1/kg of body weight every minute until to volitional failure or the cadence dropped below 65 RPM), and cool-down phase (0 W, 5 min, pedal cadence was set up at 65-70 RPM).

### B. Determining the performance parameters

All three tests were conducted on the bicycle ergometer (Lode Excalibur sport). For the study, peak power and power to weight ratio (PWR) were recorded during the three experimental protocols.

### C. Heart rate assessment

Heart rate was continuously monitored during all three protocols using the *Polar H10 heart rate* sensor chest strap.

### D. Analysis of Lactate (LA) activity

The finger-prick blood sample was obtained with a *portable lactate analyzer* (Lactate Plus (manufactured by Nova Biomedical). The analysis of lactate was recorded before the test, 2 minutes post.

## Statistical analyses

Data are expressed as the mean value  $\pm$  standard deviation. The statistical significance was set at  $< 0.05$ , and all analyses completed using Statistica 12.0 program.

## Results

All data are expressed in Table 1 and Table 2.

Table 1. Physiological and power variables during the three different testing protocols

Variables	The testing protocol			
	$VO_{2max}$ test $5 \times 2min$	$VO_{2max}$ test $,1 min$	$VO_{2max}$ test $1W/kg,1 min$	<b>p-value</b> $VO_{2max}$ test $5 \times 2min$ vs. $VO_{2max}$ test $,1 min$ vs. $VO_{2max}$ test $1W/kg,1 min$
Maximum rate of oxygen uptake ( $ml \cdot kg^{-1} \cdot min^{-1}$ )	57.12 ± 5.52	51.36 ± 2.51	52.72 ± 7.06	<b>0.0455*</b>
Maximum Minute Ventilation ( $L \cdot min^{-1}$ )	163.41 ± 8.78	153.22 ± 8.41	154.97 ± 4.56	<b>0.0311*</b>
Respiratory exchange ratio	1.31 ± 0.05	1.21 ± 0.03	1.26 ± 0.04	NS
Maximal heart rate ( $beats \cdot min^{-1}$ )	185.21 ± 2.07	182.56 ± 2.20	181.37 ± 3.74	NS
Anaerobic Threshold (expressed by heart rate) ( $beats \cdot min^{-1}$ )	152.34 ± 3.22	147.19 ± 4.81	146.94 ± 2.94	NS
Test time (min:sec)	10.00	9.27 ± 0.25	5.5 ± 1.81	<b>0.0494*</b>
Peak power (W)	425.29 ± 19.39	360.24 ± 28.97	391.64 ± 74.79	<b>0.0374*</b>

\* $p < 0.05$ ;

NS: not statistically significant

The results obtained from the analysis showed statistical significance between the values of the maximum rate of oxygen uptake (0.0455). The highest value was recorded for the  $VO_{2max}$  test  $5 \times 2min$  ( $57.12 \pm 5.52 ml \cdot kg^{-1} \cdot min^{-1}$ ). From this data, we can see that  $VO_{2max}$  test  $,1 min$  resulted in the lowest value of the maximum rate of oxygen uptake ( $51.36 \pm 2.51 ml \cdot kg^{-1} \cdot min^{-1}$ ). A two-way ANOVA revealed the statistical significance between the values of Peak power (0.0374). The highest value was observed for  $VO_{2max}$  test  $5 \times 2min$  ( $425.29 \pm 19.39 W$ ), which is approximately 16 % higher comparing with  $VO_{2max}$  test  $,1 min$ . There were no significant differences between the level of Anaerobic Threshold (determining the change from the linear heart rate-work relationship during testing).

Table 2. Lactate concentration between pre and post-test

Variables	The testing protocol						<b>p-value</b> (post-tests) $VO_{2max}$ test $5 \times 2min$ vs. $VO_{2max}$ test $,1 min$ vs. $VO_{2max}$ test $1W/kg,1 min$
	$VO_{2max}$ test $5 \times 2min$		$VO_{2max}$ test $,1 min$		$VO_{2max}$ test $1W/kg,1 min$		
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	
Lactate concentration ( $mmol L^{-1}$ )	1.72 ± 0.12	7.1 ± 0.23	1.87 ± 0.32	5.9 ± 0.74	1.45 ± 0.44	6.1 ± 0.52	NS

\* $p < 0.05$ 

NS: not statistically significant

Table 2 compares the results obtained from the lactate activity. There were no significant differences between the testing protocols. On the other hand, it is necessary to mention the highest value of LA activity was observed for the  $VO_{2max}$  test  $5 \times 2min$ .

## Discussion

This study set out with the aim of assessing the importance of testing the protocol of determining  $VO_{2max}$  values. The study compares three different types of testing protocols to find out the value of  $VO_{2max}$ . We compared two classical testing models where the load is progressively increased by 1W/kg of body weight per 1 min or of body weight per 1 min with a self-paced test. A load of the self-paced test was continuously monitored and adjusted according to the exact RPE. It means that the researcher repeatedly asked questions about subjective feelings during the test. The test was divided into five stages. Each stage was represented by exact values of RPE (11,13,15,17, >18).

Very little was found in the literature on the question of regulation of  $VO_{2max}$ . The first theory assumes that  $VO_{2max}$  is limited by the capacity of the human heart to be able to provide oxygen to the working muscles (Ekblom, 2009). On the other hand, the second theory supposes that there is a physiological capacity of the cardiovascular system against fatal failure. This model is often described through the motor unit, which is recruited during exercise (Noakes & Marino, 2009). This means that the number of recruited motor units is regulated by the human brain. This mechanism protects the human body against irreversible damage.



It has been found that self-paced protocol produced higher values of  $\text{VO}_{2\text{max}}$ . The most exciting finding was that the highest value was recorded for the  $\text{VO}_{2\text{max}}$  test  $_{5 \times 2 \text{min}}$  ( $57.12 \pm 5.52 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ) and the lowest for the  $\text{VO}_{2\text{max}}$  test  $_{1 \text{min}}$  ( $51.36 \pm 2.51 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ). The findings of the current study are consistent with the study of Mauger's (Mauger et al., 2013), who provided the evidence that self-paced protocol produces higher values for maximal oxygen uptake. Our findings are in agreement with Lander's study (Lander et al., 2009) findings, which showed that Self-paced exercise is less physically challenging than enforced constant pace exercise. The similar findings were found for Maximum Minute Ventilation ( $\text{VO}_{2\text{max}}$  test  $_{5 \times 2 \text{min}}$   $163.41 \pm 8.78 \text{ L} \cdot \text{min}^{-1}$ ;  $\text{VO}_{2\text{max}}$  test  $_{1 \text{min}}$   $153.22 \pm 8.41 \text{ L} \cdot \text{min}^{-1}$ ;  $\text{VO}_{2\text{max}}$  test  $_{1 \text{W/kg}, 1 \text{min}}$   $154.97 \pm 4.56 \text{ L} \cdot \text{min}^{-1}$ ). A possible explanation for this might be that the self-paced protocol was in the closed-loop (10 minutes). It means that the participants had the chance to set up the pace at the beginning and also know that the test will last ten minutes. The other protocols are not in the closed-loop format. The researcher does not know the time of the test, and it entirely depends on an athlete's ability to sustain the load during the test. The authors of this article also believed that not just the closed-loop format could explain the higher values of  $\text{VO}_{2\text{max}}$  test  $_{5 \times 2 \text{min}}$  protocol. A possible explanation can be that self-paced design may reduce the recruitment of fast-glycolytic muscle fibers. It can be supposed to increase the recruitment of more oxygen dependent muscle fibers. Similarly, Mauger and Sculthorpe (Mauger & Sculthorpe, 2010) assert that the mentioned fact can decrease the anaerobic component of the test.

## Conclusions

This study has shown that self-paced protocol results in higher  $\text{VO}_{2\text{max}}$  values than traditional protocol. From the outcome of our investigation, it is possible to conclude that the protocol influences not just the maximal values. Testing the maximum rate of oxygen uptake is one the cornerstone of exercise testing. This test is generally accepted for its widespread use as a strong predictor of endurance performance but also cardiovascular health. It is important to mention also using this test for setting up the training zones. Future research should, therefore, concentrate on the investigation of the influence of testing protocol on prescribed physical activity.

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## TENSIOMYOGRAPHY DETECTS EARLY ATROPHY BEFORE CHANGES IN MUSCLE ARCHITECTURE

Boštjan Šimunič<sup>1</sup>, Stefano Lazzer<sup>2</sup>, Carlo Reggiani<sup>1</sup>, Enrico Rejc<sup>3</sup>, Rado Pišot<sup>1</sup>, Marco Narici<sup>4</sup>, Hans Degens<sup>5</sup>

<sup>1</sup>Science and Research Centre Koper, Institute for Kinesiology Research, Koper

<sup>2</sup>Department of Medicine, University of Udine, Udine

<sup>3</sup>Kentucky Spinal Cord Injury Research Center, University of Louisville, Louisville, KY

<sup>4</sup>Department of Biomedical Sciences, University of Padova, Padova

<sup>5</sup>School of Healthcare Science, Manchester Metropolitan University

**Purpose:** In young and older people skeletal muscle mass is reduced after as little as seven days of disuse. The declines in muscle mass after such short periods are of high clinical relevance, particularly in older people who show higher atrophy rate, and a slower, or even a complete lack of muscle mass recovery after disuse (Pišot et al., 2016).

**Methods:** Ten healthy men (24.3 (2.6) years) underwent 35 days of 6 degrees head-down tilt bed rest followed by 30 days of supervised recovery. During bed rest, a neutral energy balance was maintained, with three weekly passive physiotherapy sessions to minimise muscle soreness and joint stiffness. All measurements were performed in a hospital at days 1-10 (BR1-BR10), day 16 (BR16), 28 (BR28) and 35 (BR35) of bed rest, and day 1 (R+1), 3 (R+3) and 30 (R+30) after reambulation. Vastus medialis obliquus (VMO), vastus medialis longus (VML) and biceps femoris (BF) thickness (d) and pennation angle ( $\Theta$ ) were assessed by ultrasonography, while twitch muscle belly displacement (Dm) and contraction time (Tc) were assessed with tensiomyography (Šimunič et al., 2011).

**Results:** After bed rest, d and  $\Theta$  decreased by 13–17% in all muscles ( $P < .001$ ) and had recovered at R+30. Dm was increased by 42.3–84.4% ( $P < .001$ ) at BR35 and preceded the decrease in d by 7, 5 and 3 days in VMO, VML and BF, respectively. Tc increased only in BF (32.1%;  $P < .001$ ) and was not recovered at R+30.

**Conclusions:** Tensiomyography can detect early bed-rest-induced changes in muscle with higher sensitivity before overt architectural changes and atrophy can be detected. It remains to be seen whether such early changes are a result of the fluid shift away from muscle during head-down bed rest and/or reflects structural bed-rest induced changes (Šimunič et al., 2019).

**Key words:** *tensiomyography, contraction time, skeletal muscle, rehabilitation, ageing*

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## ALCOHOL AND SMOKING HABITS IN COMBAT SPORTS ATHLETES

Renato Šunjerga, Hrvoje Karninčić

University of Split, Faculty of Kinesiology, Croatia

### Abstract

Regarding alcohol and tobacco consumption, combat sports are classified into the group of sports considered as hazardous in all aspects and they generate severe physical and psychological stress. Recent studies reveal the problem of consumption of these substances in sports involving rough contact (rugby, hockey, Australian football, handball) and combat sports team with rough contacts. The question is what alcohol and tobacco consumption habits athletes participating in combat sports have. The research included 144 fighters from different combat sports (wrestling, judo, jujitsu, boxing, kickboxing and taekwondo).

We used surveys to study the consumption habits of alcohol and tobacco products. The differences among groups in age, sex, experience and the type of combat sport have been tested by Man-Whitney U test. The research revealed that fighters have a bigger problem with alcohol consumption and a smaller problem with tobacco consumption. The most hazardous fighter profile involves less experienced older male fighters. Female fighters are characterized by drinking less than men, but are much closer to men considering tobacco consumption. Fighters, trainers and all other participants in these sports must be aware of these trends. We have to take all the necessary measures to change this trend in addition to working on prevention in particularly hazardous groups.

**Key words:** *combat sports, substance abuse, alcohol, tobacco*

### Introduction

Although it was previously considered that sport is a protective factor as far as alcohol consumption is considered, numerous researches have disputed this claim (de Villiers et al., 2012; Du Preez et al., 2017; Gouttebauge, Aoki, Lambert, Stewart & Kerkhoffs, 2017). Some studies classify this sport as a hazardous factor regarding alcohol consumption (Dietze, Fitzgerald & Jenkinson, 2008). Hypotheses linked to this theory claim that athletes drink more due to stress or to increase the level of happiness hormone (Lisha and Sussman, 2010). As the consumption increases at the age when athletes reach senior level, we may assume that due to stronger competition, the number of won matches decreases leading to the decrease in happiness hormone. Alcohol and tobacco consumption should not be studied separately (Battjes, 1988), there are groups of athletes who have a problem with tobacco consumption as well (Rolandsson & Hugoson, 2003). The researches indicate that problems with alcohol and tobacco in athletes are linked to the macho identity (Gouttebauge, Kerkhoffs & Lambert, 2016) and they are more substantial in sports with rough contacts between players (Karninčić, Cavala & Rogulj, 2018). Alcohol consumption risks are higher in sport games and power sports than in endurance sports (Wichstrøm and Wichstrøm, 2009). Generally, combat sports are considered to be the oldest sports (Blanchard, 1995; Poliakoff, 1987). Combat sports team with rough contacts, they are stressful and are linked to macho identity and they are classified as power sports (Costarelli & Stamou, 2009; Knapik et al., 2001). Anything considered hazardous from the aspect of alcohol and tobacco consumption can be found in athletes in combat sports. The researches conducted on rugby, hockey, Australian football and handball reveal problems in alcohol consumption and these sports in particular have many links with combat sports (Dietze et al., 2008; Du Preez et al., 2017; Karninčić et al., 2018). It would be interesting to study fighters' habits from the aspect of alcohol and tobacco consumption. If there is a problem with alcohol and tobacco among the fighters, in order to act preventively, one should reveal which combat sports generate a higher risk in alcohol and tobacco consumption and which fighter profile is most hazardous. The aim of this study is to establish the differences in alcohol and tobacco consumption among fighters from different combat sports and to form the fighters' profile which would be considered as hazardous regarding the consumption of given substances.

### Methods

The sample of respondents included 144 fighters, aged 23,68±4,66 on average where 22,2% of them were women. All the fighters have been competing in their sports for 8,59±5,33 years. Detailed description of the sample is displayed in table 1. The fighters come from different combat sports: wrestling, judo, jujitsu, boxing, kickboxing and taekwondo. The sample has been classified in two groups according to sex, age (older ≥ 25 years old), experience (more experienced

≥ 10 years), type of the combat sport (grapplers: wrestling, judo, jujitsu; strikers: boxing, kickboxing and taekwondo) which makes the total of 8 subsamples.

The sample of variables involved the World Health Organization (WHO) survey – AUDIT, to assess the alcohol consumption habits while to assess tobacco consumption habits, a respondent circled one of the five suggested claims from *I have never smoked* (1) to *I smoke more than 20 cigarettes a day* (5). AUDIT is a reliable measuring instrument (Bell & Britton, 2015; Lundin, Hallgren, Balliu & Forsell, 2015) consisting of 10 particles, the answers to the questions are on the Likert scale from 0 to 4. Based on their survey results, the respondents have been classified into four groups: low risk, hazardous drinkers, harmful drinkers and probable dependence.

To confirm the reliability of the survey, we calculated Cronbach's alpha and inter item correlation. The variables have been processed by descriptive statistics and we calculated frequencies and percentages for all the claims (tobacco) as well as for all the subgroups in the survey referring to alcohol (low risk, hazardous drinkers, harmful drinkers, probable dependence). We calculated the percentage of fighters smoking on daily basis (more than 10 cigarettes a day). Descriptive statistics (arithmetic means and standard deviation) was calculated for the total score of both surveys as well as for variables describing the sample. The differences among groups have been tested by Mann-Whitney U test.

## Results

The survey satisfies reliability criteria in all subsamples: Cronbach's alpha from 0,72 to 0,88, inter item correlation from 0,24 to 45 (DeVellis, 2016).

Table 1. Displays descriptive statistic parameters, arithmetic mean and standard deviation for all the variables separately in each subsample as well as the differences among groups (Mann-Whitney U test – MWU)

	Age		Experience		Number of training		Tobacco		AUDIT	
	mean±SD	MWU (p)	mean±SD	MWU (p)	mean±SD	MWU (p)	mean±SD	MWU (p)	mean±SD	MWU (p)
All groups	23.68±4.66		8.59±5.33		6.83±3.64		1.99±1.28		16.15±5.24	
Young	21.23±2.29	>0.01	7.79±3.99	0.12	6.81±3.40	0.64	1.84±1.20	0.05	15.62±4.97	0.06
Old	29.25±3.79		10.41±7.28		6.86±4.16		2.32±1.41		17.34±5.69	
Male	24.00±5.07	0.36	8.37±5.40	0.32	7.01±3.67	0.23	2.04±1.35	0.49	16.68±5.54	0.02
Female	22.56±2.51		9.38±5.10		6.19±3.51		1.78±1.01		14.28±3.49	
Grappling	22.66±4.42	0.02	8.63±5.43	1.00	6.82±3.34	1.00	1.77±1.11	0.18	15.61±5.01	0.28
Striking	24.33±4.71		8.57±5.30		6.83±3.83		2.13±1.37		16.49±5.38	
More exp.	23.87±5.21	0.99	14.22±4.14	>0.01	7.96±3.76	>0.01	1.76±1.26	0.06	14.69±3.77	0.02
Less exp.	23.56±4.31		5.11±1.92		6.12±3.40		2.12±1.29		17.04±5.81	

More exp - more experience, Less exp. - less experience

Table 2. Displays descriptive statistical parameters (f-frequency, %-percentage) in four categories of AUDIT survey for all the respondents together and separately for all the subsamples.

	Low risk		Hazardous drinkers		Harmful drinkers		Probable dependence	
	f	%	f	%	f	%	f	%
All groups (n=144)	0,00	0,00	74,00	51,39	43,00	29,86	27,00	18,75
Young (n=100)	0,00	0,00	18,00	40,91	15,00	34,09	11,00	25,00
Old (n=44)	0,00	0,00	56,00	56,00	16,00	16,00	28,00	28,00
Male (n=112)	0,00	0,00	34,00	30,36	54,00	48,21	24,00	21,43
Female (n=31)	0,00	0,00	20,00	64,52	9,00	29,03	3,00	9,68
Grappling (n=66)	0,00	0,00	31,00	46,97	19,00	28,79	6,00	9,09
Striking (n=88)	0,00	0,00	43,00	48,86	24,00	27,27	21,00	23,86
More exp. (n=55)	0,00	0,00	17,00	30,91	33,00	60,00	5,00	9,09
Less exp. (n=89)	0,00	0,00	42,00	46,07	26,00	29,21	22,00	24,72

More exp.-more experience; Less exp.-less experience; f- frequency; %-percentage

Table 3 displays there are no fighters who do not consume alcohol or who consume smaller quantities (low risk group). In the total sample there are most fighters who drink moderately (hazardous drinkers) 51,35% and as the quantity of consumed alcohol increases, the number of respondents decreases (harmful drinkers 28,86% and probable dependence 18,75%).

Table 3. presents descriptive statistical parameters (*f*-frequency, %-percentage).

	Never smoked		Quit smoking		Smoking from time to time		Smoking more than 10		Smoking more than 20		Percentage of daily smokers
	f	%	f	%	f	%	f	%	f	%	
All groups (n=144)	78,00	54,17	20,00	13,89	27,00	18,75	8,00	5,55	11,00	7,64	<b>13,19</b>
Young (n=100)	61,00	61,00	9,00	9,00	20,00	20,00	5,00	5,00	5,00	5,00	<b>10,00</b>
Old (n=44)	17,00	36,64	11,00	25,00	7,00	15,91	3,00	6,82	6,00	13,64	<b>20,46</b>
Male (n=112)	59,00	52,68	18,00	16,07	17,00	15,18	7,00	6,25	11,00	9,82	<b>16,07</b>
Female (n=32)	19,00	59,38	2,00	6,25	10,00	31,25	1,00	3,13	0,00	0,00	<b>3,13</b>
Grappling (n=66)	34,00	60,71	7,00	12,50	11,00	19,64	2,00	3,57	2,00	3,57	<b>7,14</b>
Striking (n=88)	44,00	50,00	13,00	14,77	16,00	18,18	6,00	6,82	9,00	10,23	<b>17,05</b>
More exp. (n=55)	37,00	67,27	4,00	7,27	8,00	14,55	2,00	3,64	4,00	7,27	<b>10,91</b>
Less exp. (n=89)	41,00	46,07	16,00	17,08	19,00	21,35	6,00	6,74	7,00	7,87	<b>14,61</b>

More exp.-more experience; Less exp.-less experience; f- frequency; %-percentage

Table 4 reveals that there is significant age difference between younger and older fighters ( $Z = -9,54$ ,  $p > 0,01$ ) in tobacco consumption ( $Z = -2,00$ ,  $p = 0,05$ ) and borderline significant difference in alcohol consumption ( $Z = -1,87$ ,  $p = 0,06$ ). Men significantly differ from women only in alcohol consumption ( $Z = 2,26$ ,  $p = 0,02$ ). Statistically significant differences between more and less experienced fighters were obtained by the number of weekly training sessions ( $Z = -3,01$ ,  $p > 0,01$ ) and alcohol consumption ( $Z = 1,89$ ,  $p = 0,06$ ) in addition to borderline significant differences in tobacco consumption ( $Z = 1,89$ ,  $p = 0,06$ ).

## Discussion

The fact that all respondents consume alcohol is disturbing, followed by an even more alarming fact that they take large quantities and with no respondents in low risk category. For the next category, hazardous drinkers, literature suggests prevention, intervention and constant observation (Kingsland, Wiggers, Vashum, Hodder & Wolfenden, 2016). The only positive data is the fact that the respondents' percentage decreases as the quantity of alcohol increases (hazardous 51,39%, harmful 29,86% and dependence 18,75%). A similar study on handball players revealed even a more serious problem with no one in the first category (low risk) as in this research, but they were equally distributed in three other categories (Karnincic et al. 2018). All the fighters consume alcohol as well as all the handball players, but fighters have a minor issue with quantities unlike handball players or rugby players (Gardner et al. 2017; Karnincic et al., 2018). Somatic and cognitive stressors present in combat sports are common, but adding deliberate destruction of the opponent (strikes, levers and chokeholds) which probably induces considerable stress. Interestingly, older fighters drink more than the young ones (almost significantly  $p = 0,06$ ). Literature suggests that interest in alcohol increases from the age of 18 and decreases after the age of 25. Younger respondents in this paper are within age limits of the hazardous group (aged 18 to 25) while the older ones are at an age when interest for alcohol should be decreasing. Not only this is not the case, but older fighters drink more, with almost statistical significance ( $p = 0,06$ ). This finding matches Kotarska's finding (2019) who established that fighters who drink more are those who take part in other sports as well in addition to fighters who train, but do not actively compete any longer (Kotarska, Nowak, Szark-Eckardt & Nowak, 2019). Interestingly, older, but less experienced fighters drink more. We may assume that these are athletes who joined sport later and who are in a position to fight against people more experienced than themselves, which imposes an additional stressor. According to this study, female fighters drink less than men (but they still drink), however, the fact that they do not smoke significantly less than men, which was to be expected, is quite surprising (Hull et al. 2016). Furthermore, following global trends where women near men in alcohol and tobacco consumption (Bloomfield, Gmel, Neve and Mustonen, 2001), this finding is expected. Considering tobacco consumption, the fact that only 54,17% of fighters have never smoked and 13,19% smoke on daily basis, is quite disturbing.



## Conclusion

None of the fighters belong to the alcohol consumption low risk group. The study has revealed that the most hazardous fighters are the older, but less experienced ones. Hazardous groups are similar as far as alcohol and tobacco are considered, but women catch up men in tobacco consumption while they consume alcohol to a much smaller extent. Based on everything discussed above, combat sports and most other sports considered hazardous upon this issue should undergo an intervention, while fighters, trainers and others involved in these sports should be made aware of this problem in order to start changing trends.

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## HYDRATION STATUS OF SEMI-PROFESSIONAL MALE AND FEMALE SLOVENIAN HANDBALL PLAYERS

**Kaja Teraž**

*Science and Research Centre Koper, Slovenia*

### Abstract

The hydration status of an athlete can have a significant impact on his or her performance. Therefore, it is important that an athlete and his/her support group must be familiar with the latest hydration strategies. The aim of the study was to assess the hydration status of two Slovenian handball teams. Hydration status was assessed by body mass change and urine specific gravity. In this study 26, athletes (17 male handball players and 9 female handball players) participated. There was statistical body mass change after the training for both genders (for female  $t=-3.717$ ,  $p=0.006$  and for male  $t=-2.273$ ,  $p=0.038$ ). Most of the male players (82.4%) were hypohydrated in the morning, whereas only 37.5% of female players were. Some of them (mostly male players) had problems replacing the loss of fluids during the day.

**Key words:** *hydration status, weight loss, urine specific gravity, handball*

### Introduction

The hydration status of an athlete can be as important as her physical or tactical preparation. Dehydration is the process of losing body water, whereas hypohydration is a deficit of body water caused by acute or chronic dehydration (McDermott et al., 2017). Hyperhydration is a state of excessive total body water (a normally functioning body excretes the excess fluids through sweat, urine, respiration, feces, or vomiting). Both hyperhydration and hypohydration can negatively affect athletic performance and can be potentially fatal (Benton et al., 2015). For an athlete it is important that she does not lose too much fluid during physical activity; signs of excess fluid loss include poor physical and cognitive performance. It is already established that only a modest level of hypohydration is allowed (less than 2% of body mass) in sport. Maintaining hydration status within the range of +1 to -1% of body weight change (Casa et al., 2019) allows the body to optimally function, with normal thermoregulation, maintaining cardiovascular functions, and peak cognitive performance (Casa et al., 2000; McDermott et al., 2017).

For athletes and their support staff, it is important to be familiar with hydration assessment methods. Calculating body mass change, assessment of the first-morning urine, urine osmolality, urine colour, and personal cues (McDermott et al., 2017; Shirreffs, 2003) are simple techniques used to assess hydration status. Calculating body mass change before and after training has been used to quantify body water losses or gains due to sweating and/or drinking (Shirreffs, 2003). Test of urine specific gravity compares the concentration of urine with distilled water (McDermott et al., 2017). The specific gravity of the sample depends on the osmolality of urine, the concentration of urea, glucose, and protein (Oppliger & Bartok, 2002). Assessment techniques are few; one of them is using a refractometer which can provide a result within the range of 1.010 and 1.030 (American College of Sports Medicine, 2007; Casa et al., 2000). Urine can be categorized by specific gravity as hydration status in three categories: euhydrated status is when urine's specific gravity is less than 1.020; hypohydration status is when urine's specific gravity is in a range from 1.020 to 1.029; and, significantly, hypohydration status is when urine's specific gravity is equal or more than 1.030 (Volpe et al., 2009).

### Methods

The survey was conducted in Koper, Slovenia, among two semi-professional, national handball clubs (a male team [Rokometno društvo Koper 2013], and a female team [Žensko rokometno društvo Koper]), which included 26 players, of which 17 were male and 9 female.

The anthropometric properties of the handball players were measured at the Science and Research Centre - Kinesiology Centre in Koper. Body composition was measured with a Tanita MC-980 bioimpedance scale (Tanita Corporation Co., USA) and body height with a standardized meter. Anthropometric values are described in Table 1.

Table 1. Anthropometric values of participants

	Male (n=17)	Female (n=9)mass
	mean $\pm$ SD	mean $\pm$ SD 0.7 $\pm$ 0.5%
Age (years)	22.0 $\pm$ 4.3	21.9 $\pm$ 2.7
BH (cm)	186.9 $\pm$ 0.1	174.1 $\pm$ 7.2
BM (kg)	89.6 $\pm$ 7.3	71.5 $\pm$ 7.4
FFM (kg)	74.6 $\pm$ 5.4	52.5 $\pm$ 3.1
BMI (kg/m <sup>2</sup> )	25.7 $\pm$ 2.1	23.7 $\pm$ 3.0
FM (%)	16.6 $\pm$ 3.2	26.2 $\pm$ 4.8

Upon receipt of ethical committee approval, the subjects recorded fluid intake during training, and collected urine samples in the morning, before training and after training. One female participant did not give her urine sample because she had menstruation. During training male participants drank the isotonic beverage Multipower IsoDrink, while female participants only drank water. Data were collected for both male and female handball players from March 29 to April 4, 2016.

Hydration data were statistically processed in Microsoft Office Excel 2013 and IBM SPSS Statistics for Windows, version 22.0 software (IBM Corp, Armonk, New York, USA, 2013). Basic statistical methods (i.e., descriptive statistics) were used to present the group characteristics. To determine the differences between groups, it was used a one-sample t-test. A p-value of less than 0.05 was considered statistically significant.

## Results

The results that are presented in table 2 show that both male and female participants had statistically different body mass before and after trainings (for female  $t=-3.717$ ,  $p=0.006$  and for male  $t=-2.273$ ,  $p=0.038$ ).

Table 2. Body mass before and after training

	Body mass before training (kg)	Body mass after training (kg)	Mean % of changed body mass
Female	<b>72.14 <math>\pm</math> 7.47</b>	<b>72.61 <math>\pm</math> 7.48*</b>	-0.7 $\pm$ 0.5%
Male	<b>89.52 <math>\pm</math> 7.19</b>	<b>89.76 <math>\pm</math> 7.14*</b>	-0.3 $\pm$ 0.5%

\*statistically significant difference ( $p<0.05$ )

After analysing samples of urine collected in the morning, before and after training, the data showed the percentage of players who were in state of good hydration, minimal dehydration, significant dehydration and serious dehydration (Table 3).

Table 3. Hydration status of male and female participants

Condition	Urine specific gravity	Male			Female		
		M	BT	AT	M	BT	AT
Euhydrated	<1.020	11.8%	37.6%	12.5%	62.5%	100%	62.5%
Hypohydrated	1.021-1.029	82.4%	62.5%	87.5%	37.5%	0%	37.5%
Significantly hypohydrated	>1.030	5.9%	0%	0%	0%	0%	0%

\*M: morning urine, BT: before training, AT: after training

Most of the male players were hypohydrated (82.4 %) in the morning, a slightly smaller percentage (62.5 %) of players were hypohydrated before training, and after training the percentage of hypohydrated players increased (87.5 %). For female players the results were quite different; only 37.5 % of female players were hypohydrated in the morning, all of them were euhydrated the training, and after training only a few of them (37.5 %) were hypohydrated.

## Discussion

The hydration status of an athlete is an important enough factor that it requires monitoring. After conducting an analysis of our study, we came to the conclusion that although there was a significant difference in body mass before and after training (for both genders), the percentage of changed body mass after the training was not higher than 2%. That indicates that despite a certain amount of lost water during training, handball players either replaced it by drinking during the training or did not lose too much water at all. As we stated, more than 2% of body mass can compromise exercise performance (Kerksick et al., 2018), so it is very important to prepare hydration strategies during and after the training. The International Society of Sport Nutrition recommends that after exercise athletes should consume three cups of fluid for every 500g lost during training to restore primary hydration of the body (Kerksick et al., 2018).

Furthermore, we were interested in the specific gravity of urine in the morning, before the training and after the training.

Before training, 37.6% of male participants were euhydrated and 62.5% were hypohydrated. None of the male participants were significantly hypohydrated. That information suggests that male participants need to be educated about proper hydration techniques or about the effect that hydration status has on an athlete's body and performance. On the other hand, all female participants came to training euhydrated.

After the training, the number of hypohydrated male participants had increased to 87.5%; only 12.5% of male participants were euhydrated. Once again, none of them were significantly hypohydrated. We can assume that all male participants had consumed a sufficient amount of fluid during training (we can conclude that from the percentage of changed body mass after training, which was not greater than 2%); therefore, the hydration status concluded from urine samples after the training is associated with hydration status before training. Although the hydration strategies during training are effective, male participants should consume more fluid during the day. One way to promote optimal pre-training hydration is to ingest 500 mL of water or selected sport drink the night before, an additional 500 mL during the next morning and finally 400 to 600 mL half an hour before training (Kerksick et al., 2018). 62.5% of female participants were euhydrated after the training and 37.5% of them were hypohydrated. We can conclude that female participants did not have problems replacing loss of fluids.

After conducted our study, 11.8% of male participants and 62.5% of female participants were euhydrated in the morning. First-morning urine samples can be an indicator of day to day water balance (Cheuvront et al., 2015), which indicates that most male participants failed to replace lost fluids from the previous day.

## Conclusion

After analysing the hydration status of our participants, we concluded that female handball players who participated in our study had better hydration status than male handball players. All participants had sufficient fluid intake during training, but some of them had problems with rehydration during the day. There can be many different reasons for that. In any case, it is useful for an athlete to use appropriate hydration techniques to adequately replace fluid loss. This can be ensured through the proper education of athletes and support staff.

The biggest limitation of the study is that the sample of a study was too small to conclude the results for the specific sport, this is handball.

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## DECREASE IN SALIVARY LYSOZYME MAY NOT BE PARALLELED BY A DECREASE IN SALIVARY IMMUNOGLOBULIN A (SIGA) AFTER PROLONGED INTENSE SPORTS LOAD IN ADOLESCENT MALE GYMNASTS. A PILOT STUDY

Petr Váňa<sup>1</sup>, Jana Juříková<sup>1</sup>, Martina Bernaciková<sup>1</sup>, Alena Žáková<sup>2</sup>, Marie Budíková<sup>3</sup>, Radim Polasek<sup>4</sup>, Jakub Mazur<sup>1</sup>, Petr Hedbávný<sup>5</sup>

<sup>1</sup>Masaryk University, Faculty of Sport Studies, Department of Kinesiology, Czech Republic

<sup>2</sup>Masaryk University, Faculty of Science, Department of Experimental Biology, Czech Republic

<sup>3</sup>Masaryk University, Faculty of Science, Department of Mathematics and Statistics, Czech Republic

<sup>4</sup>University of Ostrava, Faculty of Education, Department of Information and Communication Technologies, Czech Republic

<sup>5</sup>Masaryk University, Faculty of Sports Studies, Department of Gymnastics and Combatives, Czech Republic

### Abstract

Salivary lysozyme (SLys), an antimicrobial protein of nonimmunoglobulin nature, and salivary immunoglobulin A (sIgA), the principal antibody in saliva, cooperates in ensuring of oral tissue and airways health. Besides their antibacterial activity SLys and sIgA have been proven as parameters changing in response to stressful stimuli of different origin (e. g., physical or mental strain), therefore might be useful for assessing optimal sports load/recovery ratio. There is only one study investigating SLys (and numerous studies regarding sIgA) after long-term intense exercise in adolescent athletes, however no study has been conducted to deal with relationship (correlation) between SLys and sIgA in relation to the individual periods of adolescent athletes' annual training cycle (I-just after the pre-seasonal rest, II-immediately after the training period and III-just after the competition period). Therefore -based on previous research- in this pilot study in adolescent male gymnasts of national/international level (n=11, age: 15.0±1.6), we aimed to prove/disprove following hypotheses: 1) SLys and sIgA values could correlate positively as examined for individual periods of the annual training cycle. 2) more strenuous long-term physical exercise could be connected to higher decrease in SLys and sIgA. Obtained results have shown that SLys levels were found to have no significant relationship with sIgA for any of individual periods of the annual training cycle. SLys levels at period II (just after the training period) are significantly lower ( $p < 0.05$ ) compared to both period I and period III, whilst sIgA levels does not differ significantly among the individual periods of the annual training cycle.

**Key words:** lysozyme, immunoglobulin A (sIgA), saliva, gymnasts, exercise, load

### Introduction

Saliva may serve as an interesting source for variety of biomarkers with respect to its noninvasive and simple sampling. Immunoglobulin IgA (IgA) is the principal immunoglobulin at human mucous surfaces, including oral cavity and airways. In contrast to serum IgA, so called secretory IgA, i. e. dimeric form of IgA linked via the J-chain to the secretory component (epithelial glycoprotein increasing resistance of IgA to proteolytic enzymes), is predominantly present on mucous membranes and therefore also in saliva. Salivary IgA (sIgA), consisting mainly of secretory IgA, acts as the first line defence from environmental factors such as viruses, bacteria, allergens and toxins. Lysozyme or muramidase (EC 3.2.1.17) is a low-weight enzyme with antibacterial activity (especially against Gram-positive bacteria) present not only in saliva but also in other secretions and body fluids, including polymorphonuclear or mononuclear leukocytes. Lysozyme is one of the two most abundant antimicrobial proteins (AMP) in saliva and it exerts its antibacterial action in cooperation with antibodies (such as predominant sIgA) and other salivary AMP of nonimmunoglobulin nature (such as lactoferrin,  $\alpha$ -amylase and others) (Hill et Porter, 1974; Garofalo and Goldman, 1999; Katsafadou et al., 2019). With respect to the fact that salivary IgA and lysozyme have been proven as parameters changing in response to stressful stimuli of different origin (e.g. physical or mental strain) (Chojnowska et al., 2021), they might help with revealing the persons who are at risk of heightened stress levels. It can be useful for assessing optimal training (competition) load/recovery ratio to optimize training regimen, avoid development of states of pathological fatigue or predict risk of upper respiratory tract infections (URTI) before and during competition, which can be crucial to competitive success (Nieman 2000, Neville et al., 2008; Fahlman et Engels, 2005; Francis et al., 2005). To our knowledge, barring our study on adolescent male



gymnasts (Váňa et al., 2020) no studies have been conducted to study the relationship between SLys levels and long-term intense physical activity in children or adolescent athletes. On the other hand, numerous studies have addressed the relationship between sIgA and prolonged intense physical activity in both adult and adolescent (or children's) athletes (Gleeson et al., 1995; Mortatti et al., 2012; D'Ercole et al., 2016). Mentioned studies in youth regarding both SLys (Váňa et al., 2020) and sIgA (Mortatti et al., 2012; D'Ercole et al., 2016) suggest relationship between low sIgA or SLys levels and prolonged intense physical activity. Similarly to SLys (Váňa et al., 2020) sIgA has been reported to decrease after prolonged intense exercise in young athletes in contrast to its increase after long-term mild physical activity (Cieslak et al., 2003). Swimmers, football and ice-hockey players were the most frequent participants in these studies analysing sIgA in children or adolescents (Mortatti et al., 2012; D'Ercole et al., 2016; Gleeson et al., 1999), however one study reported no significant changes of sIgA levels in elite young female gymnasts over 5-months training period (Filaire et al., 2004) As we previously reported the decrease in SLys levels (Váňa et al., 2020) in adolescent male gymnasts just after the training period, in the present work with adolescent male gymnasts as the participants again, we aim to compare both SLys and sIgA levels among all 3 individual periods kover annual training cycle (i.e. immediately after period I - the preseasonal rest, period II - trainings and III - competitions) and to reveal possible relationships (correlations) between sIgA and SLys levels for individual periods. We hypothesized that depending on the type of exercise and its intensity (volume was the same in all periods, while frequency were the same in periods II, III and lower in period I - see table 2 below) resulting in different training/competition load we could obtain following results: 1) SLys and sIgA values could correlate positively, 2) more strenuous long-term physical exercise would be connected to higher decrease in SLys and sIgA.

Our aim regarding the current study was to investigate the relationship between SLys and sIgA in gymnasts while considering the level of the training.

## Methods

The participants in this study were competitive adolescent gymnasts of national and international level.

Table 1. Participant characteristics. (Measurement of both  $VO_2$ max and  $W_{max}$  was done using the bicycle ergometer test) (Source: Study of authors)

Type of athletes	N	Age (years)	Body mass (kg)	Height (cm)	$VO_2$ max (ml/min/kg)	$W_{max}$ /kg (W/kg)
Gymnasts (mean $\pm$ SD)	11	15.0 $\pm$ 1.6	51.7 $\pm$ 8.6	160.0 $\pm$ 9.8	53.9 $\pm$ 4.0	4.3 $\pm$ 0.3

All participants enrolled in the study had their sample of saliva taken:

- 1) after pre-seasonal rest, just before the beginning of the preparatory training period (termed as period I).
- 2) immediately after the end of the preparatory training period (termed as period II)
- 3) immediately after the end of the competition period (termed as period III)

Characteristics of sports load of the participants of the study are in table 2. The volume is expressed as a quality units per a week (unit/week) and given period (I, II, III - see above). The frequency is a number of hours per training/competition unit and per a week (unit/week). The intensity of the training/competition units was determined using Borg's scale (Borg, 1982).

Table 2. Characteristics of sports load of the participants of the study (Source: Study of authors)

Sport	Volume Number of hours per: unit /week			Frequency Number of units per: week/period		
	Period I	Period II	Period III	Period I	Period II	Period III
Gymnasts	2.5/20.0	2.5/22.5	2.5/22.5	8/32	9/108	9/108

The subjects and their parents were provided both, written document describing the study and a verbal explanation. Consequently, all participants (including their guardians) provided written informed consent before volunteering for the study, and anybody who wished to withdraw could do so at any time. This study was approved by the Masaryk University's research ethics committee.

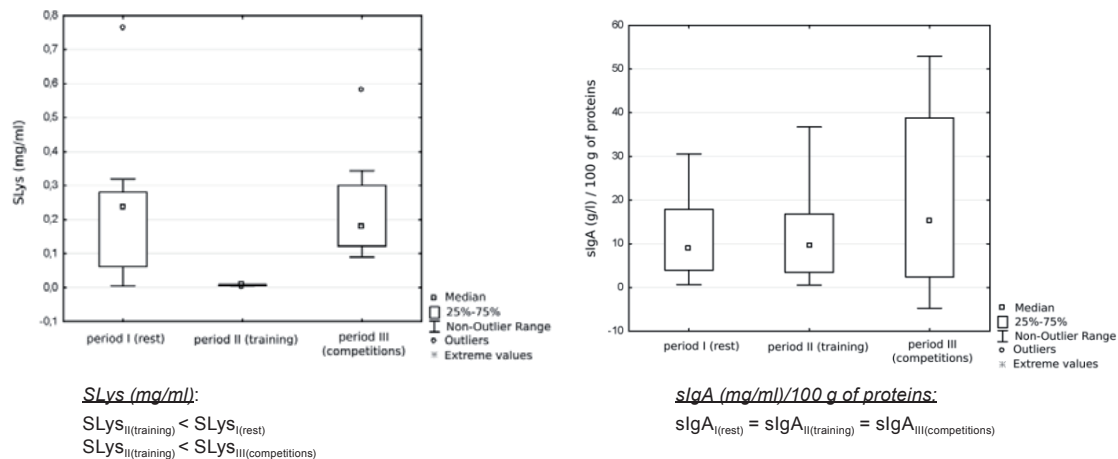
## Saliva sampling and processing

To avoid variation of salivary lysozyme (SLys) levels during the day, whole unstimulated saliva samples were collected between 7 and 8 a.m. on the day of sampling after the subjects (with rinsing participant's mouth out 15 minutes before saliva collection) had not been eating or drinking for 2 hours. Participants were in the seated position, leaning forward

with their head tilted and were passively dribbling saliva into Eppendorf microtubes until microtubes became full. Finally, samples of saliva were centrifuged (1500 g for 10 min at room temperature) and supernatant stored at -20 °C until analysed for lysozyme and salivary IgA. Both SLys and salivary IgA concentration was analysed as technical duplicates of the saliva samples (without any pretreatment), namely using enzyme-linked immunosorbent assay (ELISA) for IgA assesment and the lysoplate method for determination of SLys. The lysoplate method is based on a diffusion of the sample into the agarose gel containing *Micrococcus luteus* (incubation in the wet-chamber at 4 °C). The diameter of the clearance zone measured after 24-hours is proportional to the logarithm of the concentration (Tenovuo, 1989). Lysozyme (Sigma-Aldrich, USA) was used for preparation of calibration solutions.

## Statistical analysis

After removing extreme values, all obtained data (concentrations of SLys and IgA/100 g of proteins) were checked for both the normality of the distribution using the Shapiro-Wilk test and the homogeneity of variance of the data (visually, using box plots). As a normal distribution of data was excluded (it was non-normal at least in one period of each type of sport) one-way non-parametric ANOVA (Mood's median test or Kruskal-Wallis test depending on different/similar variability of the data in compared groups) was used to test the null hypothesis ( $H_0$ ) that the medians of the compared groups (period I, II or III) equals. If the test rejected the null hypothesis, the post-hoc multiple comparison method was used. This method identifies pairs of groups that differ. Relationships between sIgA/100 g of proteins and SLys levels of the participants were examined for all individual periods of the annual training cycle (I, II, III) via Spearman's rank rho ( $\rho$ ) order correlation coefficient. Values of  $p < 0.05$  were considered significant in all analyses. Data are expressed as the mean (with standard deviation - SD) if normally distributed or the median (with interquartile range - IQR) if non-normally distributed. All calculations were done with help of statistical software STATISTICA Cz 12 (StatSoft, Inc. 2013).



## Results

Relationship between SLys and sIgA of proteins during sport periods with different physical load is in figure 1.

Figure 1. SLys (mg/ml) and sIgA (mg/ml)/100 g of proteins in adolescent male gymnasts during sports periods with different sports (physical) load (see section „Experimental design“ and table 2) (Source: Study of authors)

SLys levels at period II (just after the end of preparatory training period) are significantly ( $p < 0.05$ ) lower compared to both period I (just after the pre-seasonal rest) and period III (after the end of the competition period). As sIgA (mg/ml)/100 g of proteins concerns, the null hypothesis ( $H_0$ ), that the medians of the compared groups (period I, II or III) equals, can not be rejected ( $p < 0.05$ ).

Relationship between sIgA and SLys levels of the participants in different sport periods are in table 3.

Table 3. Relationships between sIgA/100 g of proteins and SLys levels (mg/ml) of the participants (adolescent male gymnasts) for given sports periods (I, II, III) (Source: Study of authors)

A pair of variables (sIgA, SLys)	Spearman's correlations of adolescent male gymnasts' sIgA and SLys levels		
	Number of valid	Spearman's R	p-value
Period I (rest)	11	0,410024	0,210403
Period II (training)	11	-0,227062	0,528127

Period III (competition)	11	-0,209091	0,537221
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SLys levels were found to have no significant relationship with sIgA/100 g of proteins for any of sports periods (I, II, III).

## Discussion

Earlier in our study (Váňa et al., 2020), we confirmed the decrease in SLys levels in a small group of adolescent male gymnasts immediately after the training period (compared to period of pre-seasonal rest). Based on our both, previous and present data in adolescent male gymnasts of national/international level, the sports load is supposed to be the highest just after the preparatory training period (period II, table 2). Therefore we might assume more probable and more pronounced physiologic response in SLys levels compared to its levels after pre-seasonal rest or competition period

However, in the present pilot study, we aimed to compare SLys and sIgA response in adolescent male gymnasts among the individual periods of the annual training cycle and reveal possible relationships (correlations) between sIgA and SLys levels for all periods.

The results we have achieved in this study (Figure 1), i.e. significant decrease of SLys in period II (immediately after trainings) in comparison to period I (rest) and III (competitions) indicate that assessment of SLys in adolescent male gymnasts undertaking prolonged intense exercise might be sensitive sufficiently to detect marked decrease in SLys levels (as it was in period II), but slight decrease of SLys is undetectable (period III). This result is in accordance with our mentioned study (Váňa et al., 2020), while according to our knowledge **there are not any other** works in adolescent gymnasts investigating the relationship between SLys levels and long-term intense physical activity. The decline in SLys after long-term period of intense physical activity has been also confirmed by works in adult elite athletes such as rowers (West et al., 2010) or rugby players (Cunniffe et al., 2011).

As lysozyme exerts its antibacterial action in cooperation with antibodies and other AMPs of nonimmunoglobulin nature, we hypothesized that supposed decline in SLys levels might be paralleled by decrease in sIgA. However, in spite of many works (except for one study in elite adolescent female gymnasts (Filaire et al., 2004). on both youth and adults that have confirmed decrease in salivary IgA after long-term intense sports activity (Mortatti et al., 2012; D'Ercole et al., 2016; Gleeson et al., 1999), in our work sIgA levels neither differ among individual sports periods (figure 1) nor significant correlation was found between sIgA and SLys levels for any from these periods (table 3). In respect to the fact that number of the participants in the present pilot study is very small and at least a few other studies have proved the decrease in sIgA in adolescent athletes undergoing prolonged training/competition load (Mortatti et al., 2012; D'Ercole et al., 2016), our results may not be final. Moreover, many variables (Gleeson et al., 2004) influencing sIgA and SLys levels, including saliva flow rate (Kugler et al., 1996), were not under sufficient control.

## Conclusion

To our knowledge, the present pilot study was the first one to study the relationship between sIgA and SLys levels in adolescent gymnasts (and in adolescent athletes in general) undergoing training or competition activities of the annual training cycle. In this study, measurement of SLys indicates its potential as possible biomarker of enormous prolonged sports load again (Váňa et al., 2020). However, relationship (correlation) between sIgA and SLys levels in the participants regarding the individual periods of the annual training cycle has not been proved. It may have connection with limits of this pilot study such as the small number of the subjects, their non-random allocation and also the fact that we wasn't able to meet criteria suggested by Gleeson and co-workers for researchers and clinicians interested in exploring relationships between exercise and mucosal immunity (Gleeson et al., 2004). Therefore, larger studies with monitoring the deciding variables more carefully are warranted.

## Acknowledgement

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## PARTIAL ACL TEARS IN YOUNG AND ACTIVE PATIENTS: IS A CONSERVATIVE TREATMENT WAY TO GO?

Goran Vrgoč<sup>1</sup>, Jean-Marie Fayard<sup>2</sup>, Bertrand Sonnerly-Cottet<sup>2</sup>, Padhraig O'Loughlin<sup>3</sup>,  
Geoffroy Dubois de Mont Marin<sup>2</sup>, Benjamin Freychet<sup>2</sup>, Thais D. Vieira<sup>2</sup>, Mathieu Thauinat<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Centre Orthopedique Santy, Hopital Prive Jean Mermoz, France

<sup>3</sup>Mater Private Hospital, Ireland

**Background:** Isolated ACL tears account for nearly half of all knee ligament injuries and primarily affect young and active patients. Partial ACL tears are difficult to diagnose and there is currently no consensus on treatment protocols.

**Methods:** Forty-one patients, all less than 30 years of age and active in sports, were diagnosed with a partial ACL tear with no associated meniscal or chondral lesions. All were assigned a conservative treatment programme. Lachman test, Rolimeter® and magnetic resonance imaging (MRI) were utilised for diagnosis. Tegner and IKDC scores were assessed pre-and post-injury, and ACL-RSI at last follow-up.

**Results:** The partial ligamentous injury progressed to a complete ACL tear in 16 (39%) patients. In the remaining 25 patients, mean Tegner/IKDC scores were respectively 7.0/96.0 pre-injury, and 5.9/85.7, at last follow-up. The mean ACL-RSI was 69.3. Tegner and IKDC scores were significantly lower post-injury. Only 18 (44%) patients returned to their pre-injury level of sports activities. Patients under 20 years and practising pivot-contact sports had a statistically significant risk for progression to a complete ACL tear OR 0.19, p=0.037 and OR 6.29, p=0.026). Meniscal lesions were found in 50% of patients with a complete ACL tear.

**Conclusion:** Young patients ( $\leq 20$  years) practising pivot contact sport after partial ACL tear are at significant risk for progression to complete ACL tear, despite conservative treatment. Surgical treatment may be warranted in young patients who desire to return to pivot contact sports at the same level as prior to partial ACL rupture.

**Key words:** anterior cruciate ligament, partial tear, pivoting sport, conservative treatment, meniscal injury

## EFFECTS OF AEROBIC EXERCISE ON BEHAVIORAL PERFORMANCE OF APP/PS1/TAU TRANSGENIC MICE

Laikang Yu<sup>1</sup>, Li Zhao<sup>2</sup>

<sup>1</sup>*Department of Strength and Conditioning Training, Beijing Sport University, China*

<sup>2</sup>*Department of Exercise Physiology, Beijing Sport University, China*

### Purpose

Large numbers of epidemiological data have confirmed that physical exercise can alleviate the progression of AD and other dementias, or prevent or delay the occurrence of disease if possible. Animal behavioral performance can indirectly mimic dementia symptoms in AD patients. In this study, we were to explore the changes of behavioral performance in the early pathology (6 months) of APP/PS1/tau transgenic (AD model) mice, and the possible mechanism of aerobic exercise improving behavioral performance.

### Methods

AD model mice (2 months old) were randomly divided into exercise groups and sedentary groups (AS, AE), and C57BL/6J mice as cohort control (CS, CE). The exercise groups participated in aerobic exercise for 16 weeks. Step-down fear conditioning test and 8-arm maze test were used to detect the changes of behavioral performance, and brain patch clamp was used to detect the changes of LTP and LTD in hippocampal area CA1.

### Results

In step-down fear conditioning test, the error frequency of AS was increased compared with the CS ( $p < 0.01$ ), the latency ( $p < 0.01$ ) were reduced, also in standard rate. In 8-arm maze test, the working memory error frequency, reference memory error frequency and time consume were increased ( $p < 0.01$ ). In hippocampal area CA1 of AS, the LTP was reduced compared with the CS ( $p < 0.01$ ), while the LTD was increased ( $p < 0.01$ ). Sixteen weeks of aerobic exercise reversed the changes above of AS in the error frequency ( $p < 0.01$ ), the latency ( $p < 0.01$ ), standard rate, the working memory error frequency ( $p < 0.01$ ), reference memory error frequency ( $p < 0.01$ ), time consume ( $p < 0.01$ ), LTP ( $p < 0.01$ ) and LTD ( $p < 0.01$ ). Meanwhile, those signals were also increased in the CE group.

### Conclusion

Aerobic exercise could improve behavioral performance by increasing LTP and weakening LTD in hippocampal area CA1 of the early pathology in AD model mice.

**Key words:** *aerobic exercise, behavioral performance, LTP, LTD, APP/PS1/tau transgenic mice*

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## DETERMINATION OF IGA AND LYSOZYME CONCENTRATIONS IN SALIVA AS A STATE OF MUCOSAL IMMUNITY IN ATHLETIC YOUTH

Alena Žáková<sup>1</sup>, Filip Tokár<sup>2</sup>, Petr Váňa<sup>3</sup>, Martina Bernaciková<sup>3</sup>, Jana Juříková<sup>3</sup>, Radek Ševčík<sup>4</sup>

<sup>1</sup>Department of Animal Physiology and Immunology, Institute of Experimental Biology, Faculty of Science; Department of Biology, Faculty of Education, Masaryk University (MU), Czech Republic

<sup>2</sup>Department of Animal Physiology and Immunology, Institute of Experimental Biology, Faculty of Science, Masaryk University (MU), Czech Republic

<sup>3</sup>Department of Kinesiology, Faculty of Sports Studies, Masaryk University, Czech Republic

<sup>4</sup>Radetum, s.r.o., Research and development department, Czech Republic

**Introduction:** Saliva is part of the defense mechanisms of specific and non-specific immunity. They contain water (99.4%), organic substances (0.6%) (mucin,  $\alpha$ -amylase, lipase, lysozyme, immunoglobulin A, lactoferrin) and inorganic substances ( $\text{HCO}_3^-$  - I-, K<sup>+</sup>, Cl<sup>-</sup>, Ca<sup>2+</sup>, phosphates). The most important antimicrobial proteins in saliva are mucin (20-30% of proteins), immunoglobulins, agglutinin, lysozyme and lactoferrin. Salivary immunoglobulins belong primarily to the IgA subclass (> 85%) and to a lesser extent to the IgG subclass. Together, they make up about 5-15% of total salivary protein. IgA has the ability to neutralize toxins and viruses, agglutinate bacteria, prevents the adhesion of bacteria to the mucous membranes. Lysozyme contained in secretions disrupts the polysaccharide complex in the walls of gram-positive bacteria and is one of the substance mechanisms of non-specific immunity.

**Purpose:** Monitoring of immune parameters of saliva (concentration of IgA, lysozyme and total amount of protein) in high-performance youth under 18 years of age in the disciplines: swimming, gymnastics, badminton

Comparison of set values between athletes and non-sporting controls

Comparison between individual sports during rest and after exercise

**Methods:** ELISA for IgA determination, radial immunodiffusion

**Results:** A difference was observed between controls and the whole group of athletes, where athletes have a statistically significantly higher level of IgA, a lower level of lysozyme. In the group of athletes in period 2, ie after a heavy load, it was found for individual sports:

Swimming: statistically significant increase in IgA, increase in lysozyme, decrease in concentration of protein

Gymnastics: statistically significant decrease in IgA, decrease in lysozyme, increase in c protein

Badminton: statistically significant increase in IgA, decrease in lysozyme, increase in c protein

**Conclusions:** Overall, with a high training and racing load, there was a tendency to worsen heart rate variability, especially in swimmers, less in gymnastics, the least in badminton. The reason is probably the number of training units and the load on the body. Athletes from the swimming group, in contrast to the other two groups, reacted in the parameters of the amount of IgA and the amount of lysozyme in the period after training, and thus after a high load, the opposite trend. It is therefore possible that the amount of these two parameters depends on the type of sport.

**Key words:** IgA, lysozyme concentrations, mucosal immunity, athletic youth

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## SPECIFIC CHANGES IN PHYSICAL ACTIVITY AMONG ADOLESCENTS DURING A FOUR-YEAR PERIOD

**Marija Martina Žanetić, Tatjana Trošt Bobić, Marjeta Mišigoj-Duraković**

*University of Zagreb Faculty of Kinesiology*

### Abstract

Physical activity (PA) confronts a serious drop in adolescence due to maturation and higher school obligations. The reduction of PA intensity may vary during weekdays and weekends as well as among genders. This research is part of *Croatian Physical Activity in Adolescence Longitudinal Study* (CRO – PALS) and it was carried out on a sample of 722 (356 males and 366 females) urban high school students. The aim of this study was to investigate various types of PA among adolescents during week days and weekends according to its intensity in a four-year period collected by SHAPES questionnaire. The data were analyzed by ANOVA for repeated measures and Post hoc - Bonferroni test was done to show differences between every year among male and female students. The results have shown significant decline of PA among both genders, but only for higher intensities PA during weekends. In boys a greater drop has been observed, since the results have shown incline in their PA from the first to second grade of high school. In conclusion, PA decline in adolescence differently affects various intensities of activity, as well as its dynamics between genders. Boys are likely to be more involved in physical activity during both weekdays and weekends, unlike girls who tend to spend more time sedentary and in PA of lower intensities. These findings may be useful for health related behaviour promoting strategies among adolescents, especially those concerning their physical activity.

*Key words: physical activity, intensity, adolescence*

### Introduction

Physical activity (PA), as one of the recommended health-promoting behaviours, confronts a serious drop in adolescence (Jago et al., 2005). The reduction of its intensity, may vary during weekdays and weekends (Jago et al., 2005), as well as among genders although there are not enough longitudinal studies to confirm it (Hallal et al., 2012). The variability of weekly PA amount can be connected with higher school demands in this age that lowers the possibility for adolescents to engage in PA.

Although it is known that significant decline in PA starts with maturation, the prevalence of its drop in adolescence is considerable in comparison to childhood. Some of the studies conducted on large samples, like Health Behaviour in School-aged Children (*HBSC*), brought out data from Europe and North America about 85% of 15-year-olds being physically inactive compared to 77% of 11-year-olds being physically inactive (Jurakić, 2012). This points out the importance of investigating the dynamic of PA drop through the adolescence period. According to *World Health Organization (WHO)*, children and adolescents should have 60 minutes of moderate to vigorous PA daily in order to improve their health status (WHO, 2010). Since WHO recommendations suggest moderate to vigorous PA, besides the largely studied PA amount, intensity of PA should be recorded through investigations. The reduction of PA can bring to higher risk of various numbers of noncommunicable chronic diseases, which include obesity, type II diabetes, hypertension (Guinhouya, 2013), chronic cardiovascular disease, osteoporosis, some types of cancer and all-cause mortality (Melzer, 2004). Taking all in count, adolescence is the crucial time to promote PA as beneficial factor in reducing these risks. Also, conducting researches in order to find out specific reasons of decline in PA intensities along with its amount for this specific age is of great importance.

The aim of this study was to investigate various types of PA among adolescents during week days and weekends according to its intensity in a four-year period. The assumption is that PA intensity and amount reduction differs between week days and weekends and that it depends on age and gender.

### Methods

This research is part of the *Croatian Physical Activity in Adolescence Longitudinal Study* (CRO – PALS) aimed to investigate the health-related habits measurements on a sample of 722 (356 males and 366 females) urban grammar and vocational high school students in the city of Zagreb (Croatia) during a four year period, from 2014. to 2017. At the beginning of the study participants were aged 15,6 +/- 0,4. The data about vigorous (VPA) and moderate (MPA) physical

activity during week days and weekends were collected by means of School Health Action, Planning and Evaluation System (SHAPES) PA questionnaire (Wong et al., 2006) over four years. The collected data were expressed in minutes of physical activity per day (min/day).

All analyses were done in Statistica 13.4.1. software. To analyze the results ANOVA for repeated measures was used and Post hoc - Bonferroni test was done to show differences between each year among male and female students.

## Results

The results presented in Table 1. show changes in various intensities of physical activity in male and female adolescents throughout four years analyzed with repeated measures ANOVA and Bonferroni Post hoc test. Significant differences were found only for VPA and MVPA during weekends.

Table 1. Differences in changes in various intensities of PA between male and female adolescents

Variable	ANOVA rep. measures	F	p	Gender	Post hoc - Bonferroni	Mean + Std.Dev.
VPAwk (min/day)	Sex Year Year*gender	44,68 45,89 2,42	0,00 0,00 0,064	M	1.-2. 1,00	1. 69,55 +/- 45,66 2. 71,90 +/- 50,68 3. 60,29 +/- 44,07 4. 48,69 +/- 39,50
					1.-3. 0,85	
				F	1.-4. 0,00	1. 50,27 +/- 42,88 2. 50,49 +/- 41,09 3. 45,98 +/- 40,99 4. 35,94 +/- 38,32
					2.-3. 1,00	
VPAwnd (min/day)	Sex Year Year*gender	36,47 24,43 4,15	0,00 0,00 0,007	M	1.-2. 0,67	1. 69,87 +/- 62,49 2. 75,54 +/- 63,34 3. 58,04 +/- 56,54 4. 47,93 +/- 50,00
					1.-3. 0,40	
				F	1.-4. 0,00	1. 47,23 +/- 53,22 2. 50,24 +/- 52,84 3. 48,38 +/- 57,45 4. 36,29 +/- 49,16
					2.-3. 1,00	
MPAwk (min/day)	Sex Year Year*gender	0,04 34,46 1,14	0,85 0,00 0,33	M	1.-2. 1,00	1. 63,42 +/- 56,68 2. 67,37 +/- 58,66 3. 52,94 +/- 44,93 4. 43,72 +/- 39,31
					1.-3. 0,04	
				F	1.-4. 0,00	1. 59,33 +/- 48,87 2. 57,66 +/- 49,98 3. 50,22 +/- 43,48 4. 43,41 +/- 38,15
					2.-3. 0,28	
MPAwnd (min/day)	Sex Year Year*gender	0,09 27,08 0,48	0,76 0,00 0,69	M	1.-2. 1,00	1. 64,15 +/- 64,56 2. 68,89 +/- 65,31 3. 53,47 +/- 52,84 4. 44,07 +/- 45,54
					1.-3. 0,06	
				F	1.-4. 0,00	1. 59,62 +/- 52,91 2. 60,63 +/- 57,42 3. 54,24 +/- 54,26 4. 44,43 +/- 44,90
					2.-3. 1,00	

MVPAwk (min/day)	Sex	16,43	0,00	M	1.-2. 1,00	1. 132,98 +/- 85,75 2. 139,29 +/- 89,15 3. 113,23 +/- 71,19 4. 92,41 +/- 64,11
	Year				1.-3. 0,002	
MVPAwk (min/day)	Year*gender	63,99	0,00	F	1.-4. 0,00	1. 109,61 +/- 73,98 2. 108,16 +/- 74,74 3. 96,20 +/- 70,63 4. 79,35 +/- 65,39
		2,43	0,06		2.-3. 0,18 2.-4. 0,00 3.-4. 0,002	
MVPAwnd (min/day)	Sex	11,72	0,00	M	1.-2. 1,00	1. 134,02 +/- 107,47 2. 144,44 +/- 105,80 3. 111,51 +/- 87,97 4. 92,00 +/- 79,07
	Year				1.-3. <b>0,01</b>	
MVPAwnd (min/day)	Year*gender	40,02	0,00	F	1.-4. <b>0,00</b>	1. 106,85 +/- 87,81 2. 110,86 +/- 91,83 3. 102,61 +/- 94,58 4. 80,72 +/- 78,63
		2,73	<b>0,04</b>		2.-3. 1,00 2.-4. <b>0,00</b> 3.-4. <b>0,00</b>	

Legend: M - male, F - female, VPAwk - vigorous physical activity during week, VPAwnd - vigorous physical activity during weekend, MPAwk - moderate physical activity during week, MPAwnd - moderate physical activity during weekend, MVPAwk - moderate to vigorous physical activity during week, MVPAwnd - moderate to vigorous physical activity during weekend

Significant differences in PA changes between male and female adolescents through four years are shown in Figure 1. and Figure 2.

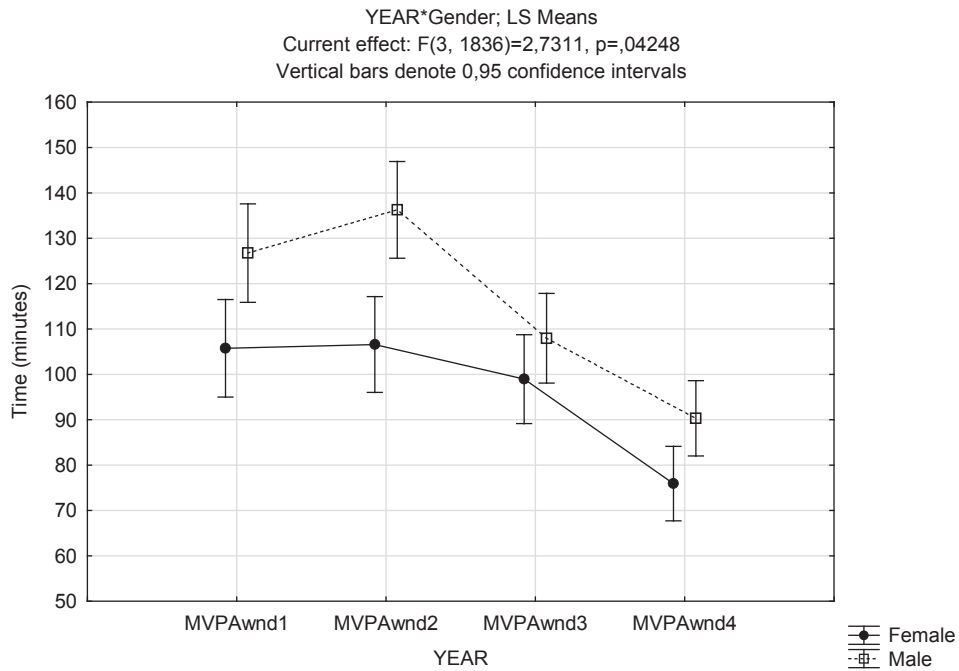


Figure 1. Changes in MVPAwnd in male and female adolescents

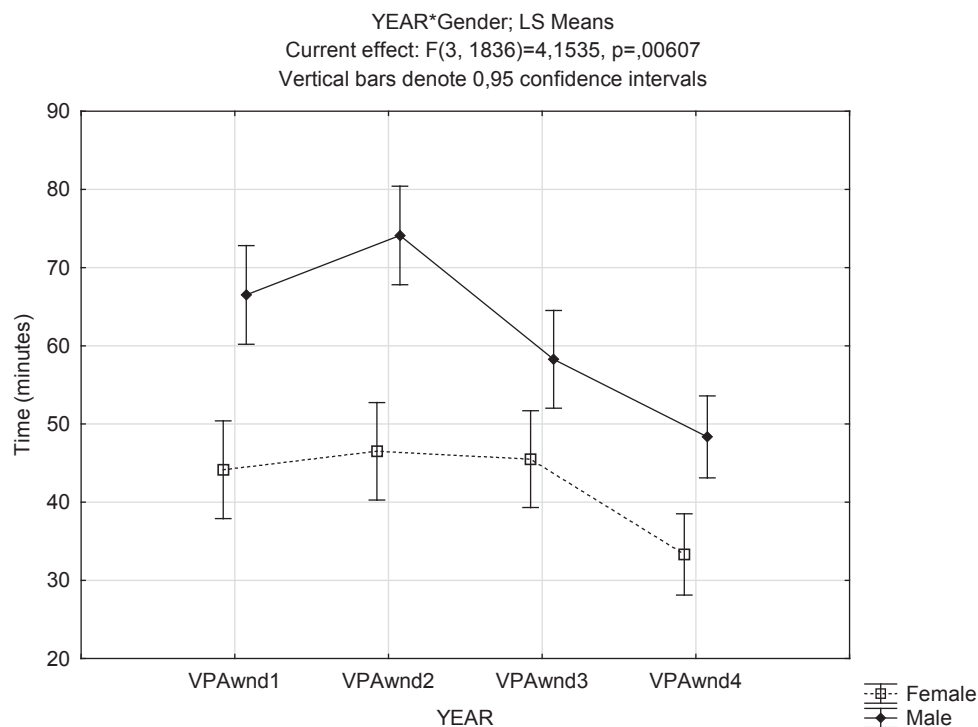


Figure 2. Changes in VPAwnd in male and female adolescents

## Discussion

Our findings based on a 4-year follow-up of 722 male and female urban show significant differences only for MVPA and VPA during weekends. However, greater decline has happened among boys what can be connected with girls having lower levels of physical activity at the beginning. Caspersen et al. (2000) have also found differences between male and female US adolescents in regular vigorous activity through ages; more specifically, from age 14 to 21 among boys and 12 to 20 among girls. Findings in this research could also be connected with the ones from Thompson et al. (2003), done among Canadian adolescents, where they suggest taking maturation age in count when explaining earlier drop in PA among girls in comparison to boys. This research could also explain the greater decline in PA among boys in our research after incline from 1st to 2nd year of high school which girls did not have. Cross-sectional study from Seabra et al. (2008), done on Portuguese adolescents, has shown incline in PA levels from age 10 to 16 among both genders, but after age 16 girls have decreased PA, unlike boys who've had further incline till age 18.

We can assume that higher requirements of school obligations through years have made students spend more time learning during weekends, but not only during week. Since boys've had much higher PA levels than girls, they were forced to reduce it even more significantly. These decline in PA levels can be connected with higher incline of time spent in sedentary behaviours researched by Arundell et al. (2019) who've objectively measured sitting time during week days and weekend days and found out that adolescents are far more inactive during week periods than weekend periods what has mostly to do with time spent in school and learning after school. This research (Arundell, 2019) have also found that girls spend more time in sedentary behaviours which explains why they are less engaged in PA than boys. Because of the great amounts of obligations adolescents must execute during week, weekends enable them much easier engagement in PA. At the beginning of the study students have collected almost the same amount of PA during 2 days of weekend and 5 days of week, which lately resulted in greater drop in PA during weekend since the amount of PA during week was already poor.

One of the limits of this research is subjective PA assesment based on recall of one week, which can be unreliable since 7 days are quite long period to remember exact amount of PA for every day of the week. Furthermore, motivation for participating in this research could also be one of the limits of accuracy of the data; higher motivated participants tend to give much more effort to remember details than lower motivated participants. For further investigations, we suggest combining questionnaires with shorter time of recall, for example 3 days, and usage of objective measurements like accelerometers to get more precise and more reliable results. It would also be useful to parallel collect and analyze data about specific sedentary behaviours as well as PA during the day.

## Conclusion

In conclusion, this research shows that the decline of PA in adolescence may differently affect various intensities of PA, and that vigorous and moderate to vigorous activities are those with greater drop. Also, the dynamic of PA decline differs between boys and girls; more specifically, girls tend to lower the amount of their PA earlier. These findings may be useful in strategies that aims at the promotion of a healthy lifestyle in adolescents, especially for what concerns their physical activity.

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# Physical Conditioning

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## VALIDITY OF THE 30-15 INTERMITTENT FITNESS TEST FOR MEASURING MAXIMAL OXYGEN UPTAKE IN PHYSICALLY ACTIVE INDIVIDUALS

Daniel Bok, Jere Gulin, Dario Škegro

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The goal of the study was to assess criterion-related validity of 30-15IFT in physically active individuals. Eighteen active physical education students (7 females and 11 males, age:  $22.4 \pm 0.9$  years, height:  $175.8 \pm 9.3$  cm, weight:  $73.4 \pm 13.2$  kg) volunteered to participate in the study. The participants performed the 30-15IFT and maximal incremental exercise test in the laboratory on two different occasions separated by at least 72 hours and not more than 7 days. The association between directly measured  $\text{VO}_{2\text{max}}$  and estimated  $\text{VO}_{2\text{max}}$  was analyzed with Pearson correlation coefficient. Bland-Altman plots were used for illustration of intra-individual agreement while one-way analysis of variance (ANOVA) was used to determine the difference between the outcome measures. Regression analysis was used for calculation of the standard error of the estimate. There was a large significant correlation between the measures ( $r = 0.77$ ) with a standard error of the estimate of 3.9 ml/kg/min. The estimated  $\text{VO}_{2\text{max}}$  ( $47.9 \pm 4.1$  ml/kg/min) was significantly lower ( $p < .001$ ) than directly measured one ( $52.4 \pm 6$  ml/kg/min) with large (.6) effect size. The 95% LoA were in range from -12 to 2.9 ml/kg/min with mean difference of  $-4.5 \pm 3.8$  ml/kg/min. The results suggest that 30-15IFT cannot be used as a valid test to assess  $\text{VO}_{2\text{max}}$ , at least in physically active individuals.

**Key words:** aerobic endurance, field test, maximal incremental exercise test

### Introduction

The positive influence of cardiorespiratory fitness (CRF) on parameters of human health is well documented (Garber et al., 2011). As CRF represents is an independent risk factor for all-cause and cardiovascular mortality its development became a high public health priority (ACSM, 2016). The primary physiological measure of CRF is maximal oxygen uptake ( $\text{VO}_{2\text{max}}$ ) which is most accurately determined in the laboratory conditions by performing a maximal incremental exercise test (Bentley, Newell & Bishop, 2007). However, due to the high financial costs, resource unavailability and time-consuming issues, numerous field test emerged as alternatives and are commonly used in practice. Among the most popular ones the 30-15 intermittent fitness test (30-15IFT) was recently developed mainly for the purpose of a more accurate training prescription of high-intensity interval training (Buchheit, 2008, 2010). However, even though it was not developed for that particular purpose the 30-15IFT is still often used for estimation of the  $\text{VO}_{2\text{max}}$ .

To be an adequate substitute for the “gold standard” measure the test needs to present great criterion-related validity (Impellizzeri & Marcora, 2009). The seminal study performed on young intermittent sports players indicated significant large correlation ( $r=0.68$ ) between 30-15IFT end-test speed (vIFT) and  $\text{VO}_{2\text{max}}$  measured on the treadmill in the laboratory (Buchheit, 2008) suggesting that 30-15IFT actually measures some additional capacities besides the  $\text{VO}_{2\text{max}}$  (Buchheit, 2010). However, a formula for calculation of  $\text{VO}_{2\text{max}}$  based on the vIFT was developed and has been used extensively in practice (Buchheit, 2010). Several subsequent studies than reported similar associations between  $\text{VO}_{2\text{max}}$  estimated from vIFT and  $\text{VO}_{2\text{max}}$  measured directly with maximal incremental exercise test in elite rugby league players ( $r=0.76$ ) (Scott et al., 2017), female basketball players ( $r=0.72$ ) (Jeličić et al., 2020) and female soccer players ( $r=0.67$ ) (Čović et al., 2016). In addition, Bland-Altman plots were used for illustration of intra-individual agreement in  $\text{VO}_{2\text{max}}$  between 30-15IFT and incremental exercise test in female basketball and soccer players which indicated significant -2.81 and 5.3 ml/kg/min mean differences, respectively (Jeličić et al., 2020; Čović et al., 2016).

The 30-15IFT is shown to be specific to the high-intensity intermittent running often trained and performed in team sports (Buchheit, 2010). In addition to cardiorespiratory function the test is significantly correlated to several physiological factors such as the anaerobic capacity, inter-effort recovery and change-of-direction abilities (Buchheit, 2008). The degree to which each of these physiological factors contribute to vIFT varies significantly between individuals which is evidenced by an example in which similar vIFT can be reached by individuals with significantly different aerobic capacities (Buchheit, 2008). Also, high degree of differences in contributing physiological factors to vIFT had been observed in different profiles of rugby players (Scott et al., 2017). Namely, the authors found that the level of  $\text{VO}_{2\text{max}}$  contribution varied between players of different positions suggesting that the test could show different levels of criterion-related validity among different

populations. As validity of the 30-15IFT has so far been tested on elite team sports players that might show high degree of homogeneity in aerobic capacity it is important to investigate the validity of the test in a group of individuals with a different training background. Additionally, no study so far assessed standard error of the estimate (SEE) as a measure of validity even though it has been used previously for reporting criterion-related validity of field aerobic fitness tests (Leger & Boucher, 1980; Leger & Lambert, 1982; Martínez-Lagunas & Hartmann, 2014). Therefore, the goal of the study was to assess criterion-related validity of 30-15IFT in physically active individuals.

## Methods

### Subjects

Eighteen physical education students (7 females and 11 males, age:  $22.4 \pm 0.9$  years, height:  $175.8 \pm 9.3$  cm, weight:  $73.4 \pm 13.2$  kg) volunteered to participate in the study. All participants were physically active individuals with training background from different individual and team sports. Five participants were still active national level competitors in their respective sports while the rest of the participants practiced their sport and other physical activities few times a week for the purpose of conducting healthy lifestyle. The subjects were aware that they could withdraw from the study at any point without any consequences. The study protocol was approved by the Ethics Committee of the Faculty of Kinesiology University of Zagreb and conformed to the recommendations of the Declaration of Helsinki.

### Experimental procedure

The participants performed the 30-15IFT and maximal incremental exercise test in the laboratory on two different occasions separated by at least 72 hours and not more than 7 days. Both testing sessions were performed at approximately the same time of the day to avoid any circadian rhythm influence on performance. Participants were familiarized with both tests before the study commencement, and all had recent experiences in maximal aerobic exercise testing as this was part of their study course practical requirement. The same warm-up consisting of 5-minute submaximal jog performed on the treadmill or indoor surface and 2-minute dynamic stretching was practiced on both occasions before the testing. The 30-15IFT was performed indoors on a handball court dimensions gym while maximal incremental exercise test was performed in the faculty's sports performance laboratory.

### Fitness testing

**The 30-15 intermittent fitness test:** The test consists of 30-second incremental shuttle run interspersed with 15-second passive recovery periods. The initial speed was set on 8 km/h for the first 30-second run and increased by 0.5 km/h for each subsequent stage. Participants were required to run back and forth between two lines set 40 m apart at a pace dictated by the prerecorded audio track. This pacing strategy assisted players in adjusting their running speed so that they enter the 3 m zone demarcating the end-court lines or the middle line set in-between at each beep. During the 15-second recovery period the participants walked forward to the next line which might be at the middle or at either side of the court depending on where the previous run stopped. The participants were instructed to complete as many stages as possible. The test stopped when the participant was no longer able to maintain pace or when he or she was unable to reach the 3-m zone around each line for 3 consecutive times. The velocity of the last stage successfully completed was recorded as their vIFT. Maximal oxygen uptake ( $VO_{2max}^{IFT}$ ) was calculated through equation defined by Buchheit (2010). The test has excellent test-retest reliability for vIFT (Grgić, Lazinica & Pedišić, 2020).

**Maximal incremental exercise test:** For the assessment of  $VO_{2max}$  a maximal incremental exercise test was performed on a motor-driven treadmill (h/p Cosmos, Nussdorf-Traunstein, Germany) in laboratory conditions. At the beginning of the test the participants walked for 2 minutes at 3 km/h and the speed was thereafter increased by 0.5 km/h every 30 seconds until volitional exhaustion. The grade of the treadmill was set to 1%. Respiratory gas exchange parameters were continuously recorded breath-by-breath with an automated portable metabolic system (Metamax 3b, Cortex Biophysik, Leipzig, Germany) and averaged across 30-second time epochs. The metabolic system was calibrated according to the manufacturer guideline. The highest  $VO_2$  response recorded during a 30-second time epoch was defined as the  $VO_{2max}$  while a plateau in  $VO_2$  response despite an increase in running speed and/or ratings of perceived exertion  $\geq 8$  in the Borg Category Ratio scale were used as criteria for attainment of the  $VO_{2max}$  (Mezzani et al., 2012).

### Statistical analysis

All data are presented as mean  $\pm$  standard deviation. Normality assumptions were verified using the Kolmogorov–Smirnov test. The association between directly measured  $VO_{2max}$  and  $VO_{2max}$  estimated by using 30-15IFT was analyzed with Pearson correlation coefficient. The magnitude of correlation was considered trivial ( $r < .1$ ), small ( $.1 < r < .3$ ), moderate ( $.3 < r < .5$ ), large ( $.5 < r < .7$ ), very large ( $.7 < r < .9$ ), and almost perfect ( $r > .9$ ) (Hopkins, Marshall, Batterham, & Hanin, 2009). Bland-Altman plots were used for illustration of intra-individual agreement and determining the 95%



limits of agreement (LoA) between estimated and directly measured  $VO_{2max}$  (Atkinson & Nevill, 1998). One-way analysis of variance (ANOVA) was used to determine the difference between outcome measures of the two variables and partial eta squared ( $\eta^2$ ) effect size (ES) was used to describe the magnitude of the difference according to criteria recommended by Hopkins et al. (2009). The partial  $\eta^2$  was considered trivial ( $< .1$ ), small ( $.1 - .3$ ), moderate ( $.3 - .5$ ), large ( $.5 - .7$ ), very large ( $.7 - .9$ ) and extremely large ( $> .9$ ). Regression analysis was used for calculation of the standard error of estimate for the purpose of investigating the accuracy of the proposed equation to estimate real  $VO_{2max}$  values. Statistical significance was accepted at  $p < .05$ . Statistical analyses were performed with Statistica (v 13.2; Dell Inc, Tulsa, OK).

## Results

The estimated  $VO_{2max}$  ( $47.9 \pm 4.1$  ml/kg/min) was significantly lower ( $p < .001$ ) than directly measured one ( $52.4 \pm 6$  ml/kg/min) with large (.6) effect size (Figure 1). The 95% LoA ( $-12$  to  $2.9$  ml/kg/min) and mean difference of  $-4.5 \pm 3.8$  ml/kg/min presented in Bland Altman plot indicate considerable intra-individual discrepancy between the two measures (Figure 2). There was a large significant correlation found between the measures ( $r = 0.77$ ) (Figure 3) with a standard error of the estimate amounting 3.9 ml/kg/min.

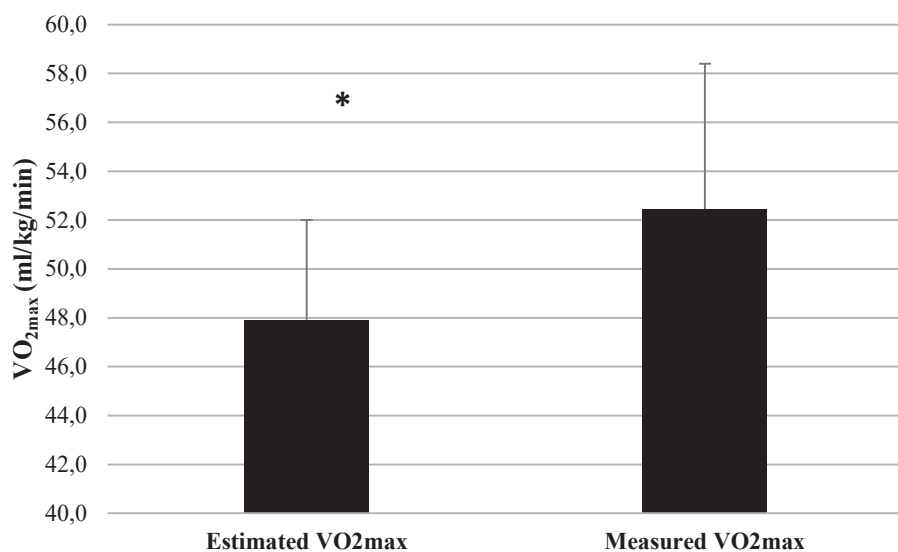


Figure 1. Estimated  $VO_{2max}$  calculated through equation from the results of the 30-15 intermittent fitness test and directly measured  $VO_{2max}$  through maximal incremental exercise test. \* Significantly different from measured  $VO_{2max}$  ( $p < .001$ ,  $ES = 0.6$ ).

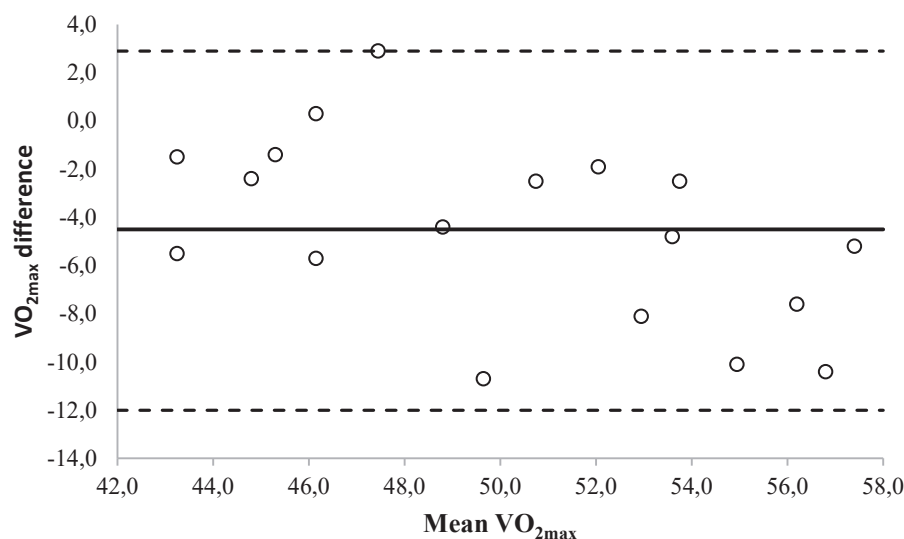


Figure 2. Bland-Altman plot of measured  $VO_{2max}$  through maximal incremental exercise test in the laboratory and calculated through equation from the results of the 30-15 intermittent fitness test

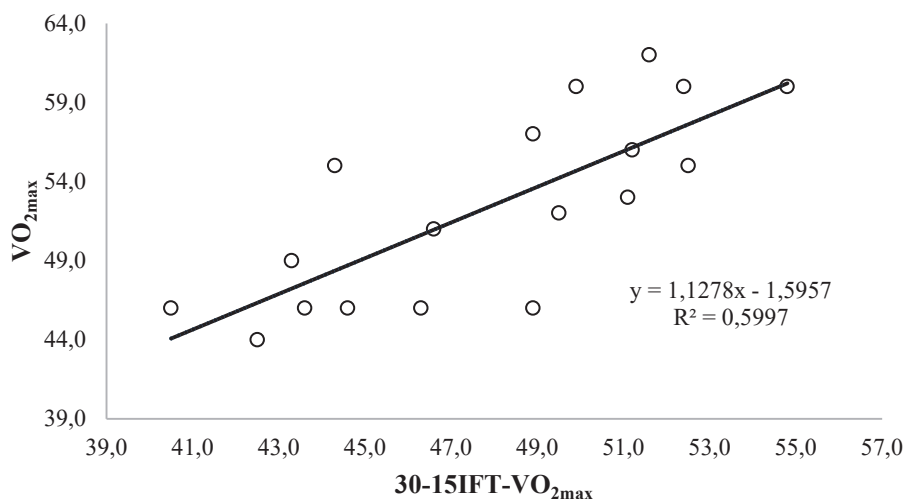


Figure 3. The association between estimated  $VO_{2max}$  derived from 30-15IFT and directly measured  $VO_{2max}$  through maximal incremental exercise test

## Discussion

The main findings of the study were that (1)  $VO_{2max}$  calculated from the results of the 30-15IFT significantly underestimates directly measured  $VO_{2max}$  values and, (2) despite large significant correlation between the estimated and directly measured  $VO_{2max}$  the 30-15IFT cannot be considered a valid test for estimation of  $VO_{2max}$  in physically active individuals. This is mostly due to the large intra-individual discrepancy between the measures as indicated by the wide range of LoA as well as a large SEE.

Large significant correlation ( $r=0.77$ ) between estimated and directly measured  $VO_{2max}$  was obtained in the study which was in accordance with the results from previous studies done in rugby ( $r=0.76$ ) (Scott et al., 2017), basketball ( $r=0.72$ ) (Jeličić et al., 2020) and soccer ( $r=0.67$ ) (Čović et al., 2016) players. A bit larger correlation coefficient found in this study might be explained by a greater heterogeneity of the subject sample as it is well known that correlation is influenced by subject's interindividual variation (Atkinson & Nevill, 1998). Anyway, the authors of these previous studies concluded that the 30-15IFT was valid test for estimation of  $VO_{2max}$  even though the correlation coefficients are not high enough to support convergent validity (Impellizzeri & Marcora, 2009). Namely, statistically significant Pearson correlation coefficient of  $>0.8$  is necessary to support sufficient convergent validity of the test (Atkinson & Nevill, 1998) and neither study, including this one, reported such high correlations.

On the other hand, the concept of using correlation coefficient as a measure of agreement in order to test convergent validity of a test has been heavily criticized and described as flawed a long time ago (Nevill, 1996). To compare the agreement between two variables a Bland-Altman plot with calculation of 95% limits of agreement was proposed as a better solution (Nevill & Atkinson, 1997). Namely, in addition to the suboptimal correlation coefficient, a large mean bias of  $-4.5$  ml/kg/min and large within-subject variability between two measures was clearly depicted in the Bland-Altman plot with 95% limits of agreement ranging from  $-12$  to  $2.9$  ml/kg/min. This low agreement is clearly exemplified with the notion that two subjects with identical estimated  $VO_{2max}$  of  $48.9$  ml/kg/min had largely different directly measured  $VO_{2max}$  of  $46$  and  $57$  ml/kg/min. Similarly, five subjects with directly measured  $VO_{2max}$  of  $46$  ml/kg/min presented estimated  $VO_{2max}$  values in the range between  $40.5$  and  $48.9$  ml/kg/min. These rather big mean bias and wide limits of agreement of  $\pm 7.5$  ml/kg/min appear too excessive to warrant acceptable convergent validity of the 30-15IFT even when applied in the population of physically active individuals. As predetermined cut-off values that would serve to demarcate acceptable level of mean bias and LoA do not exist, professional judgement should be exercised to decide whether the limits are practically acceptable (Nevill & Atkinson, 1997). Namely, the 20m shuttle run test was deemed unacceptable for estimating  $VO_{2max}$  as LoAs of  $\pm 6.3$  and  $\pm 7.2$  ml/kg/min between measured and estimated  $VO_{2max}$  were obtained in active young men (Cooper, Baker, Tong, Roberts & Hanford, 2005) and military personnel (Aandstad, Holme, Berntsen & Anderssen, 2011), respectively. On the other hand, mean bias of  $2.81$  ml/kg/min and LoA of approximately  $\pm 6$  ml/kg/min (available only through visual inspection of Bland-Altman plot) were deemed to be acceptable for the authors of the study to confirm criterion-related validity of the 30-15IFT in female basketball players (Jeličić et al., 2020). Despite their conclusions (Jeličić et al., 2020), we believe that the wide LoA found in this study do not support such claims and that the 30-15IFT should not be considered as valid instrument for estimating  $VO_{2max}$ , at least in physically active individuals. Moreover, when deciding about the practical acceptability of the agreement level it is important to apprise how it influences sensitivity of the test as well, especially if the intention of the practitioner is to use the test to evaluate improvement in  $VO_{2max}$  after a training intervention. Namely, as the average increase in  $VO_{2max}$  following several weeks of high-intensity interval training is shown to be around  $5.5$  ml/kg/min (Milanović, Sporiš & Weston, 2015) or in range between  $2.6$  and

7.3 ml/kg/min (Bok, 2019) in health adults, this clearly indicates that the 30-15IFT will not be able to detect such changes even if we assume that the reliability of the test is absolute.

The estimated  $VO_{2max}$  was significantly lower by 4.5 ml/kg/min or 8.6% than directly measured  $VO_{2max}$  and the ES of this difference was large. Interestingly, previous studies reported contrastive results as  $VO_{2max}$  was significantly underestimated by 2.81 ml/kg/min in basketball players (Jeličić et al., 2020) and overestimated by 5.3 ml/kg/min in soccer players (Čović et al., 2016) when calculated from vIFT. The reason for the contrasting results in the estimation direction is not clear as identical incremental exercise test protocols were used in both studies and the subject samples were all females of similar fitness levels; however, they could be related to the possibly greater specificity of the 30-15IFT to soccer in comparison to basketball training activities. Namely, soccer players could have been more accustomed to the test activity and this could have enabled them to outperform their incremental exercise test performance. This presumption could explain why in this study the real  $VO_{2max}$  was significantly underestimated with calculations from vIFT as the sample of participants were physically active individuals with their exercise background originating from a variety of different sports. Additionally, the seminal study in which the formula for estimation of  $VO_{2max}$  was introduced for the first time was done on young intermittent sport players who are probably more accustomed to the intermittent and shuttle nature of the test rendering them more economic in  $VO_2$  utilization during performance of the test (Buchheit, 2008). This would make the formula more fitting for the well trained young intermittent sport players than for just physically active individuals. Notwithstanding the conflicting results presented in the cited studies (Čović et al., 2016; Jeličić et al., 2020), it is therefore reasonable to assume that the vIFT estimated  $VO_{2max}$  would underestimate the real  $VO_{2max}$  values when physically active individuals are subjected to testing. Most importantly and congruently to previous studies, the difference between two measures obtained in this study was statistically significant, indicating again low convergent validity of the test.

Finally, low convergent validity of the test was further confirmed by the SEE of 3.9 ml/kg/min, although like for the LoA, there are no predetermined cut-off values reported in the literature that can be used to define the validity of a test. Instead, common sense and professional judgement should be engaged to define the acceptable level of SEE for a certain measure. Previous studies were not very consistent in reporting validity based on SEE. For example, 20-m shuttle run test was reported to be valid with SEE of 4.7 (Léger, Mercier, Gadoury & Lambert, 1988) and 5.4 ml/kg/min (Léger & Lambert, 1982), while Yo-Yo intermittent recovery test level 1 was defined as not valid for estimation of  $VO_{2max}$  with SEE of 4 ml/kg/min (Martínez-Lagunas & Hartmann, 2014). Unfortunately, there are no reported SEE for 30-15IFT in previously published studies so no comparison can be made at this point. Notwithstanding the confounding interpretations of SEE found for other aerobic field tests and reported in the literature, we believe that this SEE is not acceptable to warrant convergent validity of the test and, therefore, 30-15IFT is not recommended for assessment of the  $VO_{2max}$ . This can be further justified with the notion that other aerobic field tests, such as University of Montreal track test or Vam Eval test, have lower SEE (2.81 ml/kg/min) (Léger & Boucher, 1980) and are better solution when assessment of  $VO_{2max}$  is the primary goal of testing.

## Conclusion

The 30-15IFT is primarily developed for the purpose of training prescription of short format high-intensity interval training (Buchheit, 2008). Because of that, in addition to the cardiorespiratory function, several other fitness components, such as anaerobic capacity, inter-effort recovery and change-of-direction ability, are also reflected in the test (Buchheit, 2010). Because of this highly complex fitness structure of the test, which was due to its necessity to be highly specific to the high-intensity interval training sessions often performed in team sports, the test is unable to accurately capture only one fitness component, in this case the  $VO_{2max}$ . Therefore, contrary to the conclusions of the previously published studies (Čović et al., 2016; Jeličić et al., 2020; Scott et al., 2017), these results suggest that 30-15IFT cannot be used as a valid test to assess  $VO_{2max}$ , at least in physically active individuals.

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## THE EFFECTS OF MUSIC ON PHYSICAL ASPECTS OF ISOMETRIC STRENGTH EXERCISE – EXAMPLE OF PRONE PLANK

Nera Budalica, Marijana Čavala, Josefina Đuzel

*University of Split Faculty of Kinesiology, Croatia*

### Abstract

The aim of this study was to test the effect of motivational music on isometric plank exercise. The study was conducted on 74 students of the Faculty of Kinesiology in Split, of both sexes. The students performed the test with and without music and filled out a questionnaire containing some questions regarding their daily physical activity. Their anthropometric measures were also taken to calculate the somatotype, body fat percentage and body mass index.

The results indicate that most of the subjects achieved better results in the endurance test when they performed while listening to music. Thus, it can be concluded that listening to music during plank performance mostly helps the exercisers in a way that they feel better, but at the same time it allows for increased exercise efficiency. Somatotype of male and female students of the Faculty of Kinesiology was also calculated. The male students who achieved the best results in plank had ecto-mesomorphic characteristics, whereas the female students who achieved the best results in plank were characterized by endo-mesomorphic type of constitution. This study has applicability in kinesiological practice as it proves the effect of music as a motivational factor in exercise performance, in this case the plank. Thus, it can be concluded that music represents a stimulating factor, which can be helpful to coaches, and even physical education teachers, to apply in sport, recreation, education and kinesitherapy.

*Key words: music, plank, somatotype*

### Introduction

It is known that from ancient times music has been used for many purposes and that it has a unique effect on both mental and physical health. The effect of a certain type of music is manifested through human behaviour, expression and experiences. Listening to music during physical activity mostly helps the exercisers feel better, but also helps increase exercise efficacy.

Stability and development of core muscles is of great importance during performance of all types of physical activity, in elite sport, recreational activities and rehabilitation alike. The core musculature includes muscles of the trunk and pelvis that are responsible for maintaining the stability of the spine (Tse et al., 2005). In sport, core stability is defined as the ability to control the position and motion of the trunk over the pelvis to allow optimum transfer of energy from the trunk to the extremities during sports activity performance (Jin et al., 2008). It is believed that the development of core muscles is significant for many sports activities as it provides “proximal stability for distal mobility” (Jin et al., 2008), and allows transfer of force through extremities during physical activity. Furthermore, as the core strength increases, the probability of stifle joint (especially in women) and lumbar spine injury decreases, whereas core stability and sports performance improve (Myer et al., 2008; Zazulak et al., 2007). The gold standard for testing core muscles endurance and strength without endangering the locomotor system is yet to be found, but as an alternative solution, the prone bridge/plank exercise serves as a good indicator among the population of students and athletes (Tong et al., 2014; Mackenzie, 2005). The plank was found to be a valid and practical method for assessing core muscle function on the population of athletes, by performing a prone plank for a total of 3 minutes in 8 stages (Tong et al., 2014). In the population of student athletes, plank can be used to test muscle endurance by performing until collapse, and is equally reliable and practicable (Strand et al., 2014). Empirical findings suggest it can be pretty monotonous and requires high motivation. When it comes to motivation, it is known that motif, whether it be internal or external, has a positive effect on exercise (Vlachopoulos et al., 2000). Karageorghis and Lee (2001) investigated the effect of motivational music and imagery on isometric muscular endurance and proved that the combination of the two impacts improved endurance, whereas if only imagery was observed, there were no changes in muscular endurance. Karageorghis has investigated the effects of music on physical exercise for over two decades and has proved the positive effect of music on physical activity many times (e.g., Karageorghis & Priest, 2008; Karageorghis et al., 2008; Karageorghis & Terry, 1997). The aim of this study was to test the effect of motivational music on the isometric plank exercise.

## Methods

### Subject sample

The data were collected on a sample of 74 subjects, 47 of whom were female and 27 were male students of the Faculty of Kinesiology in Split, whose average age was 19.7 years. At the time of measurement, all the students were healthy and participated in the research project voluntarily.

### Variable sample

The main variable of this study was the test assessing core stability (plank), which was performed with and without music. The subjects were randomized into two groups. First, one group performed the test with the music while the other one performed it without music. After one week, the test was repeated so that those subjects who had performed the test with the music the first time, performed it now without the music. Furthermore, those subjects who had performed the test without the music the first time, performed it now with the music. The test was the same for both sexes. Before the testing, each group was instructed on how to perform the exercise and which determinants should be fulfilled for the prone plank to be correct. The selection of music used in this study as a motivational factor during test performance was based on the highest number of views of videos containing key words “motivational music for exercise” on the most popular social media platform for music – YouTube™. According to the information available on the internet, it has over 2 billion subscribers, and is visited daily by 30 billion users (<https://www.omnicoreagency.com/youtube-statistics/>). Many researchers have used the number of views on YouTube™ (e.g., Tao et al., 2012; Madathil, 2015).

At the end of the testing, the subjects were required to fill out a questionnaire based on IPAQ (International Physical Activity Questionnaire), containing some questions on daily physical activity, as well as questions related to the testing itself. Furthermore, anthropometric measures were taken so as to calculate the somatotype, body fat percentage and body mass index. Thus, the following was measured: BH – Body Height, BM – Body Mass, MUAC – Mid-Upper Arm Circumference, CC – Calf Circumference, ED – elbow diameter, KD – knee diameter, TSF – triceps skinfold, SSF – subscapular skinfold, ASF – Abdominal Skinfold 1, ASF 3 – Abdominal Skinfold 3, CSF – Calf Skinfold.

The anthropometric measurements were included to observe a potential effect of body mass and body height on the plank test performance.



Figure 1. Presentation of the prone plank exercise  
(source: <https://cdn.fitsociety.nl/wp-content/2019/11/Plank-oefening-op-kantoor-1024x683.jpg>)

### Statistical Methods

For the purposes of this study, basic descriptive statistics (AM, SD, MIN, MAX) and percentage calculation were applied.

### Results and discussion

Mean values, MIN and MAX results and standard deviations for the plank test with and without music, as well as other morphological variables are presented in Table 1. The mean value for the plank test with music in female students was 3 min 33 sec, whereas the mean value for the same test without music was 3 min 2 sec. The lowest result recorded was 1 min 12 sec, whereas the highest result was 9 min 24 sec.

The somatotype values were END=3.45, MES=3.13, ECT=2.98, therefore moderate values with slight predominance of the endomorphic component. Considering these are students of the Faculty of Kinesiology, such somatotypology is not quite desirable. The fat tissue percentage of 14.8 categorizes these subjects as athletes or recreational athletes.

Table 1. Descriptive statistics of the applied variables

FEMALE	AM	MIN	MAX	SD	SKEW	KURT
BH	170.14	158.00	181.00	5.85	-0.0957	-0.3940
BM	61.98	47.00	78.80	6.79	0.5058	0.2464
PLANK M	213.62	72.00	564.00	96.31	1.2820	2.4685
PLANK	182.20	55.50	392.00	85.13	0.7371	-0.0419
BMI	21.44	17.20	25.90	2.02	0.2820	-0.3266
BF%	14.79	7.70	23.10	3.24	0.3751	0.2435
SOM – END	3.45	2.10	5.40	0.82	0.5498	-0.1657
SOM – MES	3.13	1.20	4.80	0.88	-0.0958	-0.7580
SOM – ECT	2.98	1.00	5.70	1.10	0.0308	-0.3959
LBM	52.86	40.70	65.80	5.71	0.3213	-0.1767

Legend: BH – body height, BM – body mass, PLANK – M – plank with music, PLANK – plank without music, BMI – body mass index, BF% – body fat percentage, SOM – END – somatotype – endomorphic component, SOM – MES – somatotype – mesomorphic component, SOM – ECT – somatotype – ectomorphic component, LBM – lean body mass

The mean values for the plank test performance in men (Table 2) were higher than in women. For the plank with music the average was 5 min 27 sec and without music 4 min 41 sec. The best result was 23 min 6 sec. Male students have much lower values of fat tissue percentage than the female students (8.8%), whereas their somatotype is characterized by a moderate mesomorphic, somewhat less prominent ectomorphic, and the least prominent endomorphic component. The values of body mass index range within normal limits.

Table 2. Descriptive statistics of the applied variables

MALE	AM	MIN	MAX	SD	SKEWN	KURT
BH	183.90	167.50	200.00	6.86	-0.0742	0.9393
BM	79.24	66.50	106.00	9.40	1.3613	1.7464
PLANK-M	327.22	90.00	1386.00	235.37	2.6386	9.1542
PLANK	281.14	88.00	718.00	148.80	1.3652	2.0378
BMI	23.42	20.60	29.10	2.10	1.3385	1.8882
BF%	8.80	5.90	17.00	2.40	2.4150	6.3818
SOM – END	2.18	1.20	4.20	0.77	1.3452	1.9589
SOM – MES	3.41	2.00	5.80	1.06	0.7353	-0.5206
SOM – ECT	2.83	1.00	4.20	1.03	-0.6056	-0.8674
LBM	72.34	61.00	89.00	7.64	0.9143	0.2298

Legend: BH – body height, BM – body mass, PLANK – M – plank with music, PLANK – plank without music, BMI – body mass index, BF% – body fat percentage, SOM – END – somatotype – endomorphic component, SOM – MES – somatotype – mesomorphic component, SOM – ECT – somatotype – ectomorphic component, LBM – lean body mass

Percentage values are presented in Table 3 for male and female subjects who achieved better, i.e., poorer result in the plank test in relation to the use of music as a motivational factor. Of the overall number of female students, 77% performed the plank better when listening to music, whereas in male students this value is lower as music had no positive effect on a better test result in 30% of the male subjects.

Table 3. Percentages of differences between the plank with and without music

GENDER	TOTAL	IMPROVED	%
M	27	19	70.37
F	47	36	77.00

Table 4. Difference in the results of plank performance with and without music

	FEMALE	MALE
Plank m	213.7	327.2
Plank no m	190.2	281.14
Difference in sec / mus and no mus	31	46
Difference in %	16	14

It can be assumed that listening to music during the plank exercise performance helps exercisers in a way that they feel better, but it also allows for increased exercise efficiency. It should be noted that the best plank results among the first 20% ranked subjects among male students were achieved by those who were taller, i.e., characterized by the ecto-mesomorphic component and a lower percentage of fat tissue. In female students, the endo-mesomorphic component and lower body mass were determinants for achieving better results in the population tested. At the end of the testing, the subjects answered a question on whether the music had bothered them during plank performance, i.e., if they had felt comfortable, i.e., if it had had a motivational effect on them. Those subjects who achieved poorer result while listening to music answered that the music had bothered them in a sense of deconcentrating them and that the type of music applied was not as important as the fact that they could not concentrate on the task with the music. A completely different response was given by those subjects who achieved better results in this endurance test which is, apart from motor skills, unquestionably greatly affected by motivation.

Power and strength of abdominal musculature, which is most engaged in this motor task – plank, certainly improves the transfer of force from lower to upper extremities and vice versa, and it is extremely important in prevention of injury. Furthermore, strength and power of abdominal musculature are manifested in spine stability and safety.

## Conclusion

The aim of this study was to test the effect of music on a form of physical activity that implies isometric, i.e., static form of physical activity in the prone plank without time limit, i.e., until collapse. The data were collected on a sample of 74 subjects, 46 of whom were female and 27 were male students of the Faculty of Kinesiology in Split, whose average age was 19.7 years. Twelve anthropometric variables were measured which were used to calculate the somatotype, fat tissue percentage and BMI (body mass index). The anthropometric measurements were included to observe a potential effect of body mass and body height on the plank test performance. The endurance test – plank was performed twice, with and without music, seven days apart. The results indicate that most subjects achieved better results in the endurance test when they performed it while listening to music (78% of female students improved their result, i.e., 70% of male students). Somatotype of male and female students of the Faculty of Kinesiology was also determined. The male students who achieved the best results in plank had ecto-mesomorphic characteristics, whereas the female students who achieved the best results in plank were characterized by endo-mesomorphic type of constitution.

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## CHANGES AND DIFFERENCES IN BODY COMPOSITION AND STRENGTH ABILITIES OF ATHLETES IN FITNESS AND BODYBUILDING AT APPROPRIATE INTERVALS OF REST

**Jan Cazha, Jan Cacek, Tomas Vodicka**

*Faculty of sport studies, Masaryk University, Czech Republic*

**Introduction:** The paper deals with changes in body composition (muscle mass, adipose tissue and bone mass), and changes in manifestations of maximal strength of extensors and flexors of lower and upper limbs in relation to different periods of rest (30 s, 60 s, 120 s).

**Methods:** The research was carried out on 23 participants aged 18-30 years in natural bodybuilders of top performance, in a 5-week training intervention of bodybuilding training.

**Results:** At a statistical significance level of 5%, there was no significant difference in muscle tissue hypertrophy, although Group 3 (120 p.) achieved a four-fold increase in FFM compared to the other two groups, achieving a change of 1.8%.

**Conclusion:** At a statistical significance level of 5%, we noticed significant differences in the maximum force increase in knee joint flexors, and only in group 3 (120 s) by up to 11%. Significant differences in muscle strength increases were also observed in groups 2 and 3 in the elbow joint extensors and in the elbow joint flexors only in group 1.

## PREDICTING HIGH DEMAND SOLDIER TASK PERFORMANCE

Whitfield East, Michael McGurk, Kevin Bigelman

*US Army / TRADOC, United States*

**Introduction/Purpose:** The Baseline Soldier Physical Readiness Study was conducted to determine field test measures that best predict high demand Soldier task performance. The study used physically demanding Common Soldier Tasks (CST) as a proxy for high demand Soldier tasks. The purpose was to determine: (1) the physical constructs of CSTs; and (2) the physical fitness test events that most accurately predict Soldier task performance for men and women.

**Methods:** The study had three phases. In Phase I male (243) and female (47) Soldiers participated in the development of the Task Simulation Test (TST). The TST was a field-based functional task simulating the five critical and common Soldier tasks: move to contact, obstacle negotiation, build fighting position, react to contact, evacuate a casualty. In Phase II male (275) and female (46) Soldiers performed the TST and 23 common physical fitness test events. In Phase III male (136) and female (16) Soldiers performed eight (8) physical fitness test events, identified in Phase II. Physical fitness test events were regressed against the TST using multiple linear regression for male, female and combined samples.

**Results:** When the 23 predictor variables were regressed against the TST, researchers found a high correlation for eight (8) variables ( $R^2 = 0.737$ ;  $p = 0.000$ ): sled drag, 2-mile run, deadlift, sled push, push-ups, power throw, 300m shuttle run and leg tuck. The primary predictors for men were: sled drag, deadlift, and 2-mile run; for women: sled drag, deadlift, power throw and leg tuck. When the eight (8) test events were administered sequentially with no programmed rest, researchers found a higher correlation ( $R^2 = 0.832$ ;  $p = 0.001$ ).

**Conclusion:** To ensure Soldiers are prepared to execute physically demanding Soldier tasks, physical fitness should be assessed across all fitness domains. Test events measuring muscular strength (lower body and core), aerobic endurance, and explosive power were most predictive of task performance. The most predictive test events were relatively similar for men and women with the exception of the leg tuck, which was more predictive for women.

**Key words:** *physical, fitness, performance, strength, conditioning*

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## INJURIES OF CROATIAN BASEBALL PLAYERS IN THE 2018 SEASON

**Patrik Horvat, Filip Živković, Cvita Gregov**

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

The study included 59 male senior baseball players of the 1<sup>st</sup> Croatian Baseball League. The aim of the study was to determine the prevalence and the types of injuries, as well as the mechanisms and conditions of occurrence in senior players of the 1<sup>st</sup> Croatian Baseball League during the 2018. season. A total of 29 players were injured (47.46%). Injuries were predominantly of tendon (32.14%) and muscle origin (14.29%). The shoulder (32.14%), elbow (17.86%) and ankle (10.17%) were identified as the regions with the highest injury frequency, with 32.14%, 17.86% and 10.17%, respectively. Regarding the mode of onset of injuries, 60.71% of all injuries were classified as being sudden/acute, while the remaining 39.29% of injuries had a gradual onset. Of the injured players, 78.57% had to be absent from training due to injury. 28.75% of players were absent between 9 and 20 days, while an equal number of players were absent between 4 and 8 days and more than 20 days (25%). Players were most commonly injured at the beginning (57.14%) and during the middle of the season (32.14%). 57.14% of injuries occurred in competition and 57.14% during the middle of activity (training or competition). There were no statistically significant differences observed between injured and uninjured players in body height, body weight, body mass index and age.

**Key words:** *Prevention, Baseball, Shoulder, Elbow*

### Introduction

Baseball is a complex sport in which the major movements are unilateral and dominated by skill, power, speed and strength. There are three movements specific to baseball: throwing the ball, hitting with a bat and sliding. Those movements are complex and thus difficult to learn and refine which, when combined with fatigue and frequent repetition, creates an ideal scenario for injury occurrence (Fortenbaugh et al., 2009). The authors outline potentially aberrant body positions that lead to additional joint stress and increased risk of injury: “Some of the mechanisms that lead to extra strain on the arm and the shoulder girdle include an open foot position or angle, excessive or inadequate shoulder external rotation when the front foot contacts the ground, poor “timing” of pelvic and trunk rotation, and an angle of shoulder abduction significantly greater than 90 degrees at the time of ball release.”

According to Agresta et al. (2019), in addition to aberrant technique, frequent use of the upper extremities, i.e., excessive throwing volume, can lead to overuse injuries of the upper extremity, especially the shoulder and elbow, which account for nearly 50% of all baseball injuries. Injuries caused by excessive throwing volume are common at all levels of competition and tend to increase with age, starting with younger age groups where the prevalence of some form of shoulder and elbow pain reaches up to 75%. According to Melugin et al. (2018), 5% of players in younger age groups will go on to suffer a serious upper extremity injury (shoulder or elbow) in the next 10 years, and unsurprisingly, the biggest predictor is the number of balls thrown, i.e., throwing volume.

Severe shoulder injuries begin to occur as young as high school age. Up to 10% of high school baseball players in the U.S. suffered a shoulder injury that required surgical intervention (Melugin et al., 2018). Moreover, 14% of U.S. high school players had an injury that required more than a week of absence, and as many as 10% had to miss an entire season due to injury.

Although the level of baseball played at American colleges, particularly in the National Collegiate Athletic Association (NCAA) Division I, is close to the professional level in terms of team personnel, players are often exposed to excessive throwing volume. Combined with the increased throwing velocity as the player matures and the corresponding increase in forces on the muscles and connective tissues, it is not surprising that very high incidence rates of up to 5.78 injuries/1000 athlete-exposures occur during games. This was shown by Dick et al. (2013) in a paper that examined 16 years of NCAA Injury Surveillance Data for men’s baseball. They also found that up to 58% of all injuries involve the upper body, similar to what the data shows in children and high school players (Agresta et al., 2019; Shanley et al., 2011). The incidence rate is slightly lower in professional cohorts and is 3.61 injuries/1000 athlete-exposures (Posner et al., 2011). However, it is worth noting that the study only included players who were absent for more than 15 days, meaning that injuries requiring an absence of less than 15 days were not included. Posner et al. (2011) observed Major League Baseball (MLB) players

from 2002. to 2008. and found that on average during a season, the shoulder, elbow, and hand were the most frequently injured body regions, with 21.2%, 16.4% and 10%, respectively.

In recent years, the number of injuries has increased (MLB 2018 Injured Reserve Tracker | Spotrac, n.d.), regardless of better training conditions, prevention programs and throwing volume monitoring. Experts attribute this to an increase in throwing velocity, leading to a corresponding increase in forces acting on the player's body (Reinold et al., 2018).

Unlike other research that shows an increase in the number of injuries, Camp et al. (2018) conducted a study that covered the period from 2011. to 2016. and showed a different trend compared to previous research. The trend of injuries during these 5 years shows that there is actually no change in the total number of injuries. In other words, there is no trend of increase and the number of injuries is approximately the same each year. The highest number of injuries was actually in 2011., although it is still close to the other years. This study also differs from previous studies because the data was extracted from HITS ("Health and Injury Tracking System"), which was introduced to MLB in 2010. Until then, all studies extracted data from the DL ("Disabled list"), which was intended for club managers, according to Camp et al. (2018), i.e., the so-called "Roster list". However, there are several drawbacks of the DL system in terms of sports injury analysis. Namely, the system only takes into account players who have been absent for at least 15 days, which significantly alters the figures and undermines the significance of seemingly innocuous injuries.

In Croatian baseball no system of injury tracking or surveillance is present so far. Accordingly, no epidemiological data on injuries exist. Therefore, the aim of the study was to determine the prevalence and the types of injuries, as well as the mechanisms and conditions of occurrence in senior players of the 1<sup>st</sup> Croatian Baseball League during the 2018. season.

## Methods

### Subjects

The study initially included 60 senior respondents from 6 Croatian baseball league clubs. One respondent was unable to complete the questionnaire due to language barriers. All players were orally provided with the necessary instructions and information related to the questionnaire. A total of 59 subjects completed the questionnaire with a mean age of  $24.58 \pm 8.21$ , mean body weight of  $83.22 \pm 12.59$  kg and mean body height of  $181.75 \pm 7.18$  cm. The body mass index for Croatian baseball players was  $25.15 \pm 3.17$ .

Table 1. Descriptive characteristics of the Sample

	AS	MIN	MAX	SD	N
AGE (years)	24.58	14.00	45.00	8.21	59
BH (cm)	181.75	165.00	197.00	7.18	59
BMI (kg/m <sup>2</sup> )	25.15	20.02	35.73	3.17	59
BW (kg)	83.22	57.00	129.00	12.59	59

\*BH – Body Height; BMI – Body Mass Index; BW – Body Weight

### Procedures

A questionnaire in Croatian and, if necessary, in English language was constructed and used for data collection. The questionnaire consisted of two parts. The first part was a general one in which the respondents entered personal data such as age, height, weight, how long they have been playing baseball and what position they play. The second part of the questionnaire contained 21 questions related to injuries in the 2018. season: 1) What body region was affected; 2) What was the type of injury; 3) Can you name the exact injury; 4) Was medical care provided; 5) How the injury affected your training; 6) How long was the absence period; 7) Did the injury occur suddenly or gradually; 8) Was it a primary injury or a reinjury; 9) What did the treatment protocol consist of; 10) In which part of the season it occurred; 11) Did the injury occur in training or competition; 12) If in training, what was the type of training and in which part of the training session it occurred.

### Statistical analyses

The program *Statistica 13.5* was used for data processing, descriptive statistics, frequency tables and calculation. The T-test is a statistical procedure used to test the statistical significance of the difference between two arithmetic means (Portney & Watkins, 2002). The Mann-Whitney U Test is a frequently used nonparametric test and is analogous to the T-test, designed to compare differences between two independent samples when the variables are either ordinal or continuous, but not normally distributed (Portney & Watkins, 2002). Descriptive parameters used were arithmetic mean (AM), minimum (Min), maximum (Max) and standard deviation (SD).

## Results

### Prevalence and type of injuries

According to the survey, 28 out of 59 respondents (47.46%) were injured, meaning that slightly less than half of all players were injured that season.

Table 2. Number of injuries

INJURY STATUS	N	%
NO	31	52.54
YES	28	47.46

Table 3. Injury type

TYPE OF INJURY	NUMBER OF INJURED PLAYERS	%
1. UNIDENTIFIED	10	35.71
2. MUSCLE STRAIN/TEAR	4	14.29
3. TENDON STRAIN/TEAR	9	32.14
4. LIGAMENT SPRAIN/TEAR	3	10.71
5. OTHER	2	7.14

Out of the 28 injured players (Table 3), 10 were unsure about the type of injury, 4 reported muscle strain/tear, 9 subjects reported tendon strain/tear, 3 subjects reported sprain/tear of ligaments (or menisci) and 2 subjects reported injury of some other type. None of the respondents reported lacerations, cartilage damage and bone fractures. Although a considerable number of injured players could not specify the exact type of injury, tendon injuries were the most prevalent with 32.14%.

### Injuries by anatomical region

In the questionnaire, the respondents were asked to report the injuries according to the anatomical region and were given a choice of 17 regions: foot, ankle, lower leg, knee, thigh, quadriceps, hamstring, hip, groin, abdomen, lower back, upper back, shoulder/upper arm, forearm, elbow and hand (fingers). The 18<sup>th</sup> option was added in case the respondents wanted to report an injury in a region they felt was not listed as an option. Most injuries were in the shoulder region (N=9, 32.24%), followed by the elbow (N=5, 17.86%) and ankle (N=3, 10.71%).

Table 4. Injury by anatomical region

ANATOMICAL POSITION	N	%
FOOT	2	7.14
ANKLE	3	10.71
LOWER LEG	1	3.57
KNEE	2	7.14
THIGH	1	3.57
QUADRICEPS	1	3.57
HAMSTRING	1	3.57
GROIN	2	7.14
LOWER BACK	1	3.57
SHOULDER	9	32.14
ELBOW	5	17.86

### Injuries with regard to the mode of onset

60.71% of respondents did not have any pain or signs of tightening before the injury occurrence, i.e., the injury occurred suddenly. 39.29% had some milder symptoms (mild pain, tightening, and a gradual increase in pain), which eventually increased and led to a more severe injury.

Table 5. Mode of onset

MODE OF ONSET	N	%
SUDDEN (ACUTE)	17	60.71
GRADUAL (CHRONIC)	11	39.29

### The impact of injury on training availability

Within the questionnaire, one of the items was the influence of injury on training session availability. Of the 28 injured respondents, only 6 were able to participate in training with minor modifications, while the other 22 were forced to miss training sessions completely.

Table 6. Impact of injury on training availability

TRAINING SESSION MODIFICATIONS	N	%
MINOR	6	21.43
MAJOR	0	0.00
COMPLETE ABSENCE	22	78.57

Of the 28 players forced to miss training, 6 players were absent for 0 - 4 days, 7 players were absent for 5-8 days, 8 players were absent for 9 - 20 days and 7 players were absent from training for more than 20 days due to injury.

Table 7. Days of absence from training

ABSENCE (DAYS)	N	%
0 - 4	6	21.43
5 - 8	7	25.00
9 - 20	8	28.57
>20	7	25.00

### Injuries with regard to the annual training cycle

The annual training cycle was divided into 7 parts: the beginning and the end of preparatory period (pre-season), the beginning of the season, the middle of the season, the end of the season and the period after the season (post-season). Injuries most frequently occurred at the beginning of the season, accounting for 57.14%, while 32.14% of injuries occurred in the middle of the season. The remaining 10.71% occurred at the end of the season and in the post-season. No injuries occurred during the preparatory (pre-season) period.

Table 8. Injuries depending on the annual training cycle

TRAINING CYCLE	N	%
THE BEGINNING OF THE SEASON	16	57.14
MIDDLE OF THE SEASON	9	32.14
END OF THE SEASON	2	7.14
POST-SEASON	1	3.57

### Type of activity at the time of injury

In this case, it was specified whether an injury occurred during training, competition or during some other type of activity. For injuries that occurred during training, the type of training they were doing at that time was specified.

Table 9. Type of activity at the time of injury

TYPE OF ACTIVITY	N	%
TRAINING	10	35.71
COMPETITION	16	57.14
OTHER	2	7.14



As outlined in Table 9, most injuries occurred during competition (57.14%), slightly less occurred during training (35.71%) and 7.14% occurred outside training and competition. In terms of training, 58.33% of injuries were sustained in baseball training while practicing some type of technical or tactical elements. On the other hand, 41.66% of injuries occurred during some form of strength and conditioning training either in the gym or on the field.

Table 10. The type of training session in which the injury occurred

TYPE OF TRAINING SESSION	N	%
BASEBALL	7	58.33
STRENGTH AND CONDITIONING	5	41.66

### Timing of injury occurrence during activity

The study also examined at which time (part of session) injury occurred during activity. The activity was divided into three parts (beginning, middle and end), regardless of the duration of the entire training.

Table 11. Timing of injury occurrence during activity

TIMING OF INJURY OCCURRENCE DURING ACTIVITY	N	%
BEGINNING	3	10.71
MIDDLE	16	57.14
END	7	25.00

### Comparison of injured and uninjured players in anthropometric characteristics

T-test detected no statistically significant difference between the arithmetic means of the compared groups in either variable.

Table 12. Comparison of injured and uninjured players in anthropometric characteristics (T-test results)

VARIABLE	UNINJURED		INJURED		p
	AS	SD	AS	SD	
BH (cm)	181.87	7.11	181.61	7.39	0.89
BW (kg)	82.10	11.68	84.46	13.63	0.48
BMI (kg/m <sup>2</sup> )	24.76	2.81	25.58	3.53	0.33

\*BH – Body Height; BM – Body Weight; BMI – Body Mass Index

Utilizing the Mann-Whitney U-test, injured and uninjured athletes were compared in the age variable. The analysis showed no statistically significant differences between the groups in the age variable.

Table 13. Differences in age between injured and uninjured athletes (Mann-Whitney U test results)

VARIABLE	SUM (UNINJURED)	SUM (INJURED)	U	Z	P
AGE	898,50	871,50	402.50	-0.47	0.64

### Discussion

The primary aim of this study was to determine the prevalence and types of injuries as well as the conditions of occurrence among senior players in the 1<sup>st</sup> Croatian Baseball League during the 2018 season. 28 out of a total of 59 respondents were injured (47.46%), which is almost half of all players. 10% of injured respondents could not specify the exact type of injury, which is a limitation of this study and thus caution should be used when applying these results in prevention programs. The most common injuries were tendon strains/tears (N=9, 32.14%) followed by muscle strains/tears (N=4, 14.29%). The results obtained indicate that musculotendinous injuries are the most common, which is consistent with previous research (Camp et al., 2018). Therefore, it seems that injuries are caused by overuse of muscle and tendon tissues, either due to excessive frequency of repetitive movements or insufficient musculoskeletal capacity to tolerate high forces. Muscle-tendon injuries can also occur when a player encounters a ball that is moving at high speed. When a player is hit by a ball, the “soft” tissues are most frequently injured because they are normally unprotected. Further research that includes and differentiates mechanisms of injuries, i.e., both contact and non-contact injuries, is needed in

order to draw better conclusions. In terms of anatomical region, most injuries occurred in the shoulder (N=9, 32%) and elbow (N=5, 17%), which is consistent with previous research (Posner et al., 2011; Conte et al., 2016; Melugin et al., 2018; Dick et al., 2013; MLB 2018 Injured Reserve Tracker | Spotrac, n.d.).

Regarding the mode of injury onset, 17 players (60.71%) were injured suddenly, while as many as 11 (39.29%) were injured after experiencing pain or discomfort in the area. Sudden onset injuries (acute injuries) are almost impossible to prevent due to the absence of any symptoms or signs preceding the injury event. On the other hand, gradual onset injuries (chronic overuse injuries) are usually easy to manage and prevent from becoming severe if they are reported to the coaching staff in a timely manner. Unfortunately, coaches are usually part of the problem, thinking that players who report pain or discomfort are exaggerating and overestimating the true extent of the problem (Makhni et al., 2015). Their results show that up to 46% of players with an average age of 15 were encouraged to continue playing even though they reported pain while throwing that affected their performance. It is surprising and somewhat alarming that of 203 total respondents, only 26% never experienced pain while throwing.

The majority of injured players (78.57%) had to miss training completely due to injury. Most injured respondents (8) had to be absent between 9 and 20 days, while 7 respondents were absent for more than 20 days or between 4 and 8 days, which is consistent with previous findings (Camp et al., 2018) where the average duration of absence in the NLB was 16 days.

The period of the annual cycle in which an injury occurred also provides valuable data related to injury prevention efforts. According to the results, most injuries occurred at the beginning of the season (57.14%), followed by the middle of the season (32.14%), accounting for nearly 90% of all injuries. These results suggest that players enter the season inadequately prepared for pre-season or that the training loads imposed are inadequate. Therefore, the preseason (pre-season) should be the cornerstone of injury prevention efforts. The preseason training program should aim to match the volume and intensity of the upcoming games, followed by an adequate recovery period before entering the competitive season. The level of preparation acquired should then be maintained, but rarely increased due to the accumulated fatigue and stress of the games during the season. It is also a prudent strategy to constantly assess, screen, and monitor players throughout the preseason.

Injuries occurred more frequently during baseball training (58.33%) compared to strength and conditioning training sessions (41.66%). Interestingly, Croatian baseball players were much more likely to get injured during strength and conditioning training compared to MLB and MiLB (Minor League Baseball) players, where fitness-related injuries accounted for only 4.6% according to Camp et al. (2018). Other injuries, such as hamstring strains, were also less common during strength and conditioning training, accounting for only 6% of mild (strains) and 9% of moderate (mild tears) injuries (Okorohi et al., 2019). The discrepancy in fitness-related injuries can be attributed to an aforementioned problem of team personnel in Croatia, where one person is usually required to be a baseball coach, strength and conditioning specialist, and physical therapist at the same time. Controlling and monitoring every aspect of the team's health and performance is difficult, which ultimately leads to suboptimal program design and an increased likelihood of injury.

The T-test did not detect statistically significant differences in height, body weight, and body mass index between injured and uninjured players, suggesting that a possible change in morphological characteristics would not have a significant effect on the occurrence of injuries. The BMI of Croatian baseball players ( $25.15 \pm 3.17$ ) proved to be slightly higher than the average of elite athletes in other sports, who have an average BMI of  $23.78 \pm 1.4$ , according to Walsh et al. (2018). However, an even higher BMI is very common among elite American baseball players, whose average BMI in 2010. was 27.4 (Crotin et al., 2014). The Mann-Whitney U test revealed no statistically significant differences in age between injured and uninjured players. Therefore, it appears that age does not have a significant effect on the likelihood of injury, especially with a wide age range of Croatian senior baseball players (14 - 45). The priority should be to adequately prepare underage athletes competing with senior teams, whose increased participation is partly due to a general lack of players in Croatia. In addition, it is advisable to restrict playing time for underage players, due to possibly large differences in their experience, level of performance and capacity to tolerate stressful situations compared to more mature players.

In summary, results of this study suggest that injury prevention programs should place a strong emphasis on the shoulder and elbow region, primarily by strengthening the major muscle groups with a particular focus on shoulder external rotation strength and range of motion. However, the rest of the kinetic chain should not be neglected as injuries such as hamstring strains are on the rise. Continued refinement of technique while closely monitoring throwing volume and workloads is an important part of the injury prevention equation. In addition, extending the preseason to >8, preferably 12 weeks seems to be a prudent strategy.

## Conclusion

With a pioneering study on the epidemiology of injuries in Croatian baseball, the authors aimed to provide Croatian coaches with enough data to more effectively prevent injuries and refine their focus in terms of testing and assessment of injury risk. Clearly, long-term injury surveillance is necessary to monitor baseball injury trends in Croatia and to ensure that prevention programs are effective and continually refined. The main focus should be on the prevention of

shoulder and elbow injuries according to the aforementioned guidelines, but without neglecting other injuries that are on the rise, such as hamstring strain injuries. Children and young baseball players need special attention, primarily by protecting them from excessive and premature workloads, while ensuring that they do not accept pain during play as the norm. These recommendations represent a long-term investment, that would hopefully result in an increased number of (healthy) players. Long-term plans for Croatian baseball as opposed to results-oriented ones are the best guideline for a better future for the sport. Also, additional education of Croatian baseball coaches in strength and conditioning would probably raise competency levels and improve injury prevention efforts.

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## MORPHOLOGICAL ASSESSMENT OF INTERVENTION AND SPECIAL POLICE MEMBERS

Marijan Jozić<sup>1</sup>, Hrvoje Sertić<sup>2</sup>, Miroslav Zečić<sup>2</sup>

<sup>1</sup>Ministry of the Interior of the Republic of Croatia, Croatia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

Statistically significant differences among police officers, members of intervention and special police force were found on following body sites taken for measuring skinfold thickness - upper arm (ANNAD), back (ANL), abdomen (ANT) and chest (ANPR) (table 1 and 2). Scientific data on morphological characteristics of police members collected from domestic and foreign authors enable designed, scientifically based planning and programming of various kinesiology operators, with the aim of improving training and situational efficiency level of police members. One of the basic scientific foundation for planning a process of specialized physical training (hereinafter specialized training) is to get quality feedback information on morphological characteristics (anthropometric characteristics) of tactical population, tactical employees, and in particular if possible, to compare results analysed by scientists and collected from various countries. To ensure a successful results and high situational efficiency level of tactical employees/population, in this context police officers, appropriate anthropometric characteristics are needed because they provide professional proceedings in most urgent situations and in all kinds of weather. Adequate or preferable anthropometric characteristics could be defined as psychological stabilizers and motivators of utmost level contributory to execution of combat specific duties in situations where deadly force is used.

**Key words:** *intervention and special police, morphological characteristics, skinfold thickness, body mass index (BMI), anthropometric indicators*

### Introduction

Morphological characteristics are also presented in the equation of police officer's specification and should be taken into account in processes of selection, planning and programming of training elements of specialized training. According to domestic authors, police officers who carry out physically dynamic specialized training on a daily basis have statistically significant smaller upper arm, abdomen and chest skinfold thickness. Certain groups of authors detected that morphological characteristics of police officers in a considerable amount define situational efficiency of police officers. Underlying anthropometric indicators are foundation for a specialized physical training instructor, head of police unit or kinesiologist in a relevant planning, a direct and scientifically based evaluation of working program, and basic factors that belong here are as follows: body mass index, skinfold thicknesses, index for assessment of obesity type, abdominal circumference and body fat percentage. Anthropometric parameters, like body height, body mass, skinfold thicknesses, body mass index (BMI) and body composition could have relevant impact on police officer's ability to perform official duties of various complexity. Police officers, members of intervention and special police force, police service for special purposes, need to improve their morphological characteristic levels with the aim of improving level of situational efficiency by applying supervised exercise programs created for police officers.

### Previous research

Group of domestic and foreign authors (Mišigoj – Duraković, 2008; Vanderburgh, 2008; Bakker, Dijkstra, Lemmink and Groothof, 2010; Rossommano, C.I., Herrick, Jeffrey, E. Kirk, M. and Kirk, P., 2012; Jozić and Zečić, 2017) indicated that objective of morphological characteristics in a frame of functional-diagnostic procedure is not only determination of body dimension but their quality final valorization too. Another group of authors (Burton, 2007; Sporiš, Jukić, Bok, Vuleta J. and Harasin, 2009; Kukić, Čvorović, Dawes and Korpanovski, 2017) scientifically confirmed that anthropometric parameters, like body mass index (BMI) and body composition could have relevant impact on abilities of police and naval force members in realization of their official duties. Increased levels of BMI and body fat could create greater physiological burden during performing professional tasks and thus have a negative impact on endurance. So far body mass index (BMI) has been used plenty of times as a health assessment indicator, for assessment of nutritional status

among police force members and also as a preliminary data for assessment of body composition (Sorensen et al. 2000; Boyce et al., 2008; Dopsaj and Vuković, 2015).

### Objective

The aim of the presented paper was to identify differences among intervention and special police members using some crucial morphologic indicators.

### Methods

#### The sample

The sample was consisted of 160 police officers, of whom 80 were members of intervention (riot police) and the others were members of special police force. All participants are Croatian citizens and in good shape.

#### Variables

Seven variables for assessment of morphological characteristics which were used in this research were as follows: body height (ATV), body weight (ATT), skinfold thickness of the upper arm (ANNAD), skinfold thickness of back (ANL), skinfold thickness of abdomen (ANT), skinfold thickness of chest (ANPRS) and test for assessment of body mass index (BMI).

#### Methods of statistical data analysis

Descriptive statistical parameters were calculated for intervention and special police members. For a purpose of determining distribution normality for all variables central and dispersive parameters will be determined: Arithmetic mean (Ar. Mean), standard deviation (S.D.), minimal result (Min), maximal result (Max), skewness, coefficient of asymmetry (a3), Kurtosis – coefficient of curvature (a4). T-test will be used for determination of differences between groups. Statistical significance was set at  $p < .05$ .

### Results and discussion

Table 1. Results for descriptive statistics

Variables	N	Ar. Mean	Min	Max	S.D.	a3	a4	
ATV	80	181,94	170,00	195,00	5,65	0,02	-0,62	G_1
ATT	80	90,39	70,00	110,00	9,27	0,08	-0,35	
ANNAD	80	9,96	4,20	25,13	3,71	1,20	2,76	
ANL	80	14,88	6,83	37,93	6,07	1,55	3,01	
ANT	80	20,48	7,23	40,10	7,97	0,34	-0,58	
ANPRS	80	13,18	5,13	35,73	5,91	1,06	1,56	
ITM (BMI)	80	27,29	22,90	33,80	2,36	0,42	-0,30	
ATV	80	180,58	170,00	192,00	4,73	0,24	-0,17	G_2
ATT	80	87,75	70,00	110,00	8,40	0,60	-0,05	
ANNAD	80	7,20	3,80	14,60	2,33	0,87	0,46	
ANL	80	12,47	6,73	26,20	3,94	1,01	1,17	
ANT	80	14,52	5,20	29,07	5,80	0,65	-0,52	
ANPRS	80	9,15	4,07	20,67	4,27	0,88	-0,12	
ITM (BMI)	80	26,89	21,50	32,10	2,07	0,34	0,05	

(G1 – intervention police; G2- special police): N (number of subjects), Ar. Mean (arithmetic mean), min (minimal result values), max (maximal result values), S.D. (standard deviation), a3 (coefficient of asymmetry, skewness), a4 (measure of exposure of distribution – kurtosis)

Results of descriptive parameters for applied variables for intervention police members are presented in table 1 (G\_1). By observing other morphological variables it could be seen that intervention police members have higher skinfold values and calculated higher BMI levels (BMI). Intervention police members have higher levels of body mass (ATT) when compared to special police members. Table 1 (G\_2) presents results of descriptive statistics for morphological variables for special police members. Results indicated that special police members are little bit shorter and weigh less when compared to intervention police members (table 1). Lower body mass detected among special police members



could be attributed to impact of specialized training where aerobic exercises are applied in a sufficient manner which eventually impact on full psycho-somatic system of special police officers (Šalaj and Šalaj, 2011). Results of the following anthropometric measures: skinfold thickness of the upper arm (ANNAD), skinfold thickness of back (ANL), skinfold thickness of abdomen (ANT), skinfold thickness of chest (ANPRS) and test for assessment of body mass index (ITM) demonstrated that special police members obtained relatively good results in presented measurements, though they were better when compared to members of intervention police.

Table 2. T-test for difference of arithmetic means

	Ar.Mean. G1 intervention police	Ar.Mean. G2 Special police	t	df	p
ATV	181,94	180,58	1,65	158	0,10
ATT	90,39	87,75	1,89	158	0,06
ANNAD	9,96	7,20	5,65	158	0,00
ANL	14,88	12,47	2,97	158	0,00
ANT	20,48	14,52	5,41	158	0,00
ANPRS	13,18	9,15	4,95	158	0,00
ITM (BMI)	27,29	26,89	1,14	158	0,26

T-test (differences among arithmetic means calculated for intervention and special police members in a field of anthropometric variables). Ar. Mean. G1 (arithmetic mean for a group of intervention police), Ar. Mean. G2 (arithmetic mean for a group of special police), t (t-test), df (degrees of freedom), P-value (error in conclusion,  $p < 0.05$ ).

Values obtained from measuring skinfold thickness of the upper arm (ANNAD), back (ANL), abdomen (ANT) and chest (ANPRS) (table 2) lead us to conclude that special police members have statistically significant lower levels of all applied skinfolds variables, that is, they are statistically significantly different from intervention police members. Differences among intervention and special police members could be attributed to official programs of specialized training, as well as to intensity and volume of this type of training which is saturated with quality aerobic training elements. Optimal levels of body mass and skinfold values merged into quality aerobic training, individual and in a group, improve aerobic endurance of intervention and special police officers. When body mass results (ATT) obtained by intervention and special police officers, members of Ministry of Interior of the Republic of Croatia (mean value of body mass (ATT)  $90.39 \pm 9.27$  kg for intervention police members and  $87.75 \pm 8.40$  kg for special police members) were compared to body mass results (ATT) obtained by special police members, tactical employees from Australia (mean value of body mass  $88.8 \pm 8.25$  kg) Robinson et al., 2018., it was observed that our/Croatian special police members on average weigh less, but on the other hand, our intervention police members weigh more when compared to special police members, Australian tactical employees. Furthermore, when body mass index (BMI) of intervention and special police members of the Ministry of the Interior of the Republic of Croatia was compared to those values obtained by S.W.A.T. team members (Pryor, 2012) it was observed that for S.W.A.T. teams body mass index (BMI) was 27,1 and standard deviation (S.D.) was 2,5, so we may now summarize that special police officers, members of the Ministry of the Interior of the Republic of Croatia displayed lower body mass index (BMI) which was 26.89 and standard deviation (S.D.) was 2.07. Intervention police members have slightly higher values of BMI than S.W.A.T. team members, that is, BMI of 27,29 and 2,26 for standard deviation (S.D.). Preferable, optimal body mass (ATT) and certain anthropometric variables improve quality of procedures carried out by intervention police officers particularly while performing official duties such as providing security & protection during public gatherings, conducting investigations of complex crime, tactical measures and acts (pursuit, inspection of facilities and premises, ambush, execution of a raid, blockade of an area, act of arresting dangerous felons and so on).

## Conclusion

Differences in morphological characteristics in all four applied skinfold measurements among intervention and special police members could be attributed to structure and frequency of specialized training designed for intervention and special police. In a specialized training, designed for special police members and carried out on a more frequent basis following elements prevail: aerobic and anaerobic exercises, elements of self-defence, different types of loaded marches, various running/sprints, load carriage, military obstacle courses, marching on snow covered terrain, skiing with full equipment, swimming, diving and alike (Šalaj and Šalaj, 2011; Joseph et al., 2018). Differences among intervention and special police members could be outcome of official programs of specialized training, range of regular official duties and also intensity and volume of specialized training programs saturated with quality training elements, with or without special equipment. Aerobic elements that are optimally intense and extensive, various running types, long and medium-long running distance, running on specific types of terrain with or without special equipment and weapons cause characteristic changes, adaptations of organism to workloads that are headed toward progress of training levels of officers, particularly visible in special police members.



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## THE INFLUENCE OF RAPID WEIGHT LOSS ON MOOD STATE IN JUDO ATHLETES

Nemanja Lakicevic<sup>1</sup>, Roberto Roklicer<sup>2</sup>, Ambra Gentile<sup>1</sup>, Maria Isabel Cardona<sup>3</sup>

<sup>1</sup> PhD Program in Health Promotion and Cognitive Science, University of Palermo, Italy

<sup>2</sup> Faculty of Sport and Physical Education, University of Novi Sad, Serbia

<sup>3</sup> German Center for Neurodegenerative Diseases – Greifswald, Germany

**Purpose:** To monitor the effect of rapid weight loss (RWL) on mood state in judo athletes via Profile of Mood State (POMS) questionnaire [1,2]. This questionnaire examined the feeling of anger, confusion, depression, fatigue, tension and vigor. Since RWL is practiced regularly by majority of judo athletes [3], psychological impact should be considered as potentially performance determining factor.

**Methods:** We defined RWL as 5% weight reduction achieved over a seven day period. Eighteen male judo athletes (mean age: 25.3±5.4 years; mean height: 179±6.7 cm) volunteered to participate in this study. Subjects used self-chosen techniques to reduce weight as they usually do before the competition. Mood state assessment was performed on each morning of the study. Statistical analysis included ANOVA repeated measures carried out through IBM SPSS Software (v. 20.0) for Windows.

**Results:** On average subjects lost 3.8±0.38 kg during the experiment. Concurrently, significant increase in fatigue (p=0.049), feeling of tension (p=0.016) and anger (p=0.029) was detected. Other variables such as confusion, depression and vigor changed slightly but remained statistically insignificant.

**Conclusion:** Psychological effects induced by RWL likely have negative impact on performance. Considering that judo athletes perform RWL on multiple occasions annually, RWL can also potentially produce detrimental effects on mental health both acutely and chronically.

**Key words:** mood state, mental health, weight reduction, martial arts

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## RELATIONSHIP BETWEEN COUNTERMOVEMENT JUMP CHARACTERISTICS INCLUDING REACTIVE STRENGTH INDEX-MODIFIED AND MEASURES OF STRENGTH

Chaoyue Ma<sup>1</sup>, Tom Comyns<sup>2</sup>, Yapu Liang<sup>1</sup>

<sup>1</sup>Beijing Sport University, China

<sup>2</sup>University of Limerick, Ireland

### Abstract

The purpose of this study was to research the relationship between characteristics derived from a countermovement jump (CMJ) and measures of strength (isometric mid-thigh pull [IMTP] and isometric squat [ISqT]). Sixteen male collegiate field sports athletes participated in this study. RSI<sub>mod</sub>, peak force (PF), relative peak force (RPF), peak power (PP), relative peak power (RPP), jump height (JH), time to take off (TTT), and peak velocity (PV) were collected from the CMJ. Maximal force, absolute PF, RPF, and allometric scaled PF were calculated from the IMTP and ISqT respectively. The CMJ TTT showed a large positive correlation with IMTP RPF ( $r = .616$ ;  $P \leq .05$ ), IMTP AlloPF ( $r = .598$ ;  $P \leq .05$ ), ISqT absolute PF ( $r = .521$ ;  $P \leq .05$ ), ISqT RPF ( $r = .684$ ;  $P \leq .001$ ), and ISqT AlloPF ( $r = 0.645$ ;  $P \leq 0.001$ ). The CMJ RPF showed a large negative correlation with ISqT maximal PF ( $r = -.608$ ;  $P \leq .05$ ) and absolute PF ( $r = -.575$ ;  $P \leq .05$ ). The CMJ RPP showed a large negative correlation with ISqT maximal PF ( $r = -.516$ ;  $P \leq .05$ ). The stronger group showed a large TTT difference with the weaker group based on the IMTP RPF (Cohen  $d = 1.38$ ;  $P \leq .05$ ). This research found the CMJ TTT, RPF, and RPP may be more correlative with maximal strength than other characteristics. Plus, the CMJ TTT is the quality that differs most between the stronger and weaker groups.

**Key words:** maximal strength, SSC, isometric mid-thigh pull, isometric squat

### Introduction

The reactive strength index (RSI) has been proved to be reliable in assessing reactive strength (Flanagan et al. 2008). Recently, Ebben and Petushek (2010) introduced the reactive strength index-modified (RSI<sub>mod</sub>) as an alternative. RSI<sub>mod</sub> is calculated by dividing flight time by time to take off (TTT) which allows for more plyometric exercises such as CMJ to be tested. The ease and common use of CMJ could make it more useful than the drop jump.

Maximal strength is the ability to generate maximal force during muscle contraction without a time limit and is another important performance characteristic. It can be measured dynamically or isometrically. Isometric tests can be less risky in injury, have greater force and high test-retest reliability compared with dynamic tests (Beckham et al., 2012). The isometric mid-thigh pull (IMTP) and isometric squat (ISqT) are commonly used to measure maximal strength.

The purpose of this study was to research the relationship between characteristics derived from a CMJ and measures of strength for male participants. The secondary purpose was to investigate the differences between relatively stronger and weaker athletes. It was hypothesized that RSI<sub>mod</sub>, jump height, time to take off, peak power, peak force, relative peak power, and/or relative force from a CMJ would have correlations with strength and there would be differences between stronger and weaker groups in RSI<sub>mod</sub>, peak force, relative peak force, peak power, relative peak power, jump height, and/or time to take off.

### Methods

#### Subjects

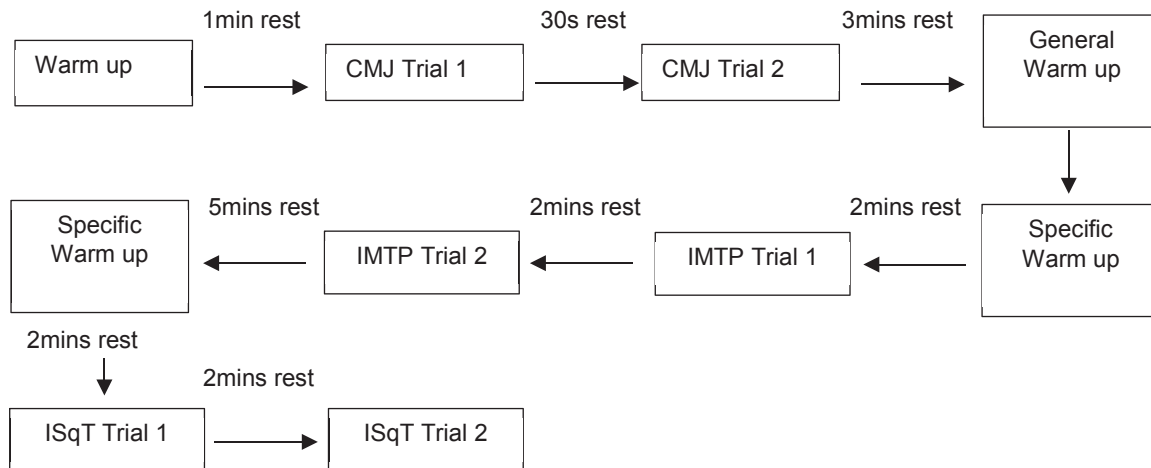
Sixteen male collegiate field sports (GAA, rugby and soccer) athletes participated in this study. The table 1 lists participants' characteristics (mean  $\pm$  SD).

Table 1. Participants' characteristics (mean  $\pm$  SD)

Age	Height	Body Mass	Strength Training
22.4 $\pm$ 4y	178.8 $\pm$ 5.7cm	79.6 $\pm$ 12.2kg	4.7 $\pm$ 4.05y

### Procedures

This study involves in the CMJ, IMTP and ISqT tests, which include 6 trials in total. So, the figure 1 shows the testing procedures for a better understanding.



### Data Analysis

Jump height was calculated from the flight time of the center of the mass from equation by Flanagan and Comyns (2008). The RSImod was determined by dividing JH by TTT. The peak power was calculated by multiplying peak force by maximal vertical velocity, vertical velocity was calculated by the established method (Moir 2008). The relative PF and relative PP were reported as dividing PF and PP by subject's body mass (kg) respectively. The absolute peak force (excluding body mass) from the IMTP and ISqT was collected from the force-time curve. The maximal force was reported as the absolute peak force plus the athlete's body mass. The relative PF was calculated by dividing absolute PF by participant's body mass. The allometric scaled PF was computed by dividing absolute PF by participant's body mass<sup>0.67</sup>, which takes into account the increase of body mass leading to a non-linear growth in athletes' strength ability (Beattie et al., 2017). All the CMJ and strength variables were then averaged for statistical analysis.

### Statistical Analysis

Data was normally distributed for all conditions, as assessed by the Shapiro-Wilk's test ( $p > 0.05$ ). Relationships between countermovement jump characteristics (RSImod, peak force, relative peak force, peak power, relative peak power, jump height, time to take off, and peak velocity) and maximal strength (absolute PF, relative PF, and allometric scaled PF) were analyzed by Pearson product-moment correlation with SPSS software (version 25.0, IBM Corp, Armonk, NY). The magnitude ranges for correlation are 0.1-0.3 (small), 0.3-0.5 (medium), 0.5-0.7 (large), 0.7-0.9 (very large), 0.9-1.0 (nearly perfect), and 1.0 (perfect). Additional analysis included dividing participants into two groups (stronger and weaker) with a median split method to investigate their countermovement jump ability based on their relative PF (N/kg) both in the IMTP and ISqT. Two-tailed independent-samples t tests were used to assess the differences between means of the stronger and weaker groups for the IMTP and ISqT. The effect sizes (Cohen d) were used to determine the magnitude of differences between groups and were categorized as trivial ( $g < 0.2$ ), small ( $0.2 \leq g < 0.5$ ), moderate ( $0.5 \leq g < 0.8$ ), and large ( $g \geq 0.8$ ).

### Results

The CMJ TTT (ICC = 0.51; TE = 9.1%) showed a large positive correlation with IMTP RPF ( $r = .616$ ;  $P \leq .05$ ), IMTP AlloPF ( $r = .598$ ;  $P \leq .05$ ), ISqT absolute PF ( $r = .521$ ;  $P \leq .05$ ), ISqT RPF ( $r = .684$ ;  $P \leq .001$ ), and ISqT AlloPF ( $r = 0.645$ ;  $P \leq 0.001$ ). The CMJ RPF (ICC = 0.81; TE = 4.7%) showed a large negative correlation with ISqT maximal PF ( $r = -.608$ ;  $P \leq .05$ ) and absolute PF ( $r = -.575$ ;  $P \leq .05$ ). The CMJ RPP ( $r = 0.95$ ; TE = 3.4%) showed a large negative correlation with ISqT maximal PF ( $r = -.516$ ;  $P \leq .05$ ). The stronger group showed a larger difference in TTT than the weaker group when based on the IMTP RPF (Cohen d = 1.38;  $P \leq .05$ ).

## Discussion

### IMTP and CMJ

According to the results, there were no significant correlations between the absolute PF and the CMJ PF, RPF, PP, RPP, PV, and JH, which are in accordance with previous studies (Haff et al., 2005; 2011; Nuzzo et al., 2008). There were also no correlations found between the relative PF and the CMJ PP, RPP, JH and PV, which are in agreement with past researches (Haff et al., 2005; Nuzzo et al., 2008;). However, this study found large correlations between the TTT and the RPF and AlloPF, which no researches to date have compared.

### ISqT and CMJ

When considering the ISqT, there were no correlations between the maximal PF and the CMJ PV and CMJ JH and no correlations between the RPF and the CMJ RPF, RPP, PV, and JH, which are in line with Nuzzo et al. (2008). This study found correlations between the maximal PF and the CMJ RPF and RPP which are different from Nuzzo et al. (2008) who found correlations between the maximal PF and the CMJ PF ( $r = 0.639$ ;  $P \leq .05$ ) and PP ( $r = 0.706$ ;  $P \leq .05$ ). What's more, Loturco et al. (2016) found a correlation between the absolute PF and the CMJ JH ( $r = 0.79$ ;  $P \leq .05$ ).

### Group Differences

As shown from the results, the relatively stronger group demonstrated a large difference with the weaker group in TTT. When comparing with the previous research, Kraska et al. (2009) only compared the difference in CMJ JH, even though they found a moderate difference ( $d = 0.6$ ;  $P = 0.33$ ) between the stronger and the weaker group based on the IMTP AlloPF, the P value was above 0.05.

This study found no notable correlations especially among the RSImod, CMJ PF and PP, IMTP and ISqT. It is possible that isometric tests are less correlative with the CMJ performance when compared with the dynamic tests such as the 1 RM test. As stated by Baker et al. (1994), the reasons why the isometric assessment may not be valid when assessing athletic performances are because of the neural and mechanical differences between isometric and dynamic tests. When a muscle group moves through a specific movement, it maybe recruit different motor units at different angles, however, the isometric tests are fixed angles. Even though the size principle should regulate them to be synchronized, this principle may be more suitable for the isometric test but not the dynamic test. So, the muscle length changes in the dynamic test are more similar with the CMJ, which makes them more correlative. In terms of the mechanical aspect, the dynamic movement such as the CMJ includes the stretch shortening cycle (SSC) which utilizes the elastic energy to improve performance, but the SSC won't be triggered during the isometric test (Baker et al., 1994).

## Conclusions

This research found the CMJ TTT may be more correlative with maximal strength than other characteristics. Plus, the CMJ TTT is the quality that differs most between the stronger and weaker groups. The isometrics qualities or the limitations of this study such as the sample size and level, familiarisation and experiment control could be the reasons why no significant correlations among other characteristics were reported. The further study can recruit more advanced athletes or female as participants, adopt more strict experiment control and more precise testing equipment to investigate these relationships. The results from this study may indicate that the isometric tests are not correlated well to the most CMJ variables except for the CMJ TTT, RPF and RPP, but future research is needed that overcomes the limitations of this study before a definitive conclusion is reached.

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## AEROBIC ENDURANCE OF JUNIOR FOOTBALL PLAYERS

**Vlad-Alexandru Muntianu, Florin-Petruț Trofin**

*Faculty of Physical Education and Sports, Romania*

**Introduction:** From a physiological point of view, we can say that, as an activity, football represents the sport with a dynamic or variable intensity, from the maximum and submaximal to the moderate one.

**Purpose:** The purpose of this paper is to assess and influence the endurance in the aerobic effort of some football players based on specific effort tests and training programs.

**Methods:** The control group subjects performed a program based on long runs at an intensity between 75-85% of  $vVO_{2max}$ . The experimental group subjects performed a progressive program, based on the interval method, at an intensity equal to or higher than the level of  $vVO_{2max}$ .

**Results:** In the exercise state, in the control group, the heart rate decreased from 135.43 b / min to 129.43 b / min, HR a decrease of 4.63%, statistically insignificant. In the experimental group, the average heart rate of effort decreased from 131.25 b / min to 120.75 b / min, in percentages this being 8.69%, a statistically significant difference. In the post-exercise state, in the control group, the heart rate decreased from 84 b / min to 78 b / min, HR a decrease of 7.69%, statistically insignificant. In the experimental group, however, the average heart rate decreased from 73.75 b / min to 66.94 b / min, a percentage of 10.17%, a statistically significant difference. The final tests showed a resting heart rate of 62.57 beats/minute and an effort of 129 beats/minute and the maximum oxygen consumption ( $VO_{2max}$ ) 52.54 ml.kg<sup>-1</sup>.min<sup>-1</sup>. Thus, an improvement of the heart rate is observed both in effort and at rest, and the consumption of ( $VO_{2max}$ ) registered an increase of approximately 1ml.kg<sup>-1</sup>.min<sup>-1</sup>

**Conclusions:** Given this fact, we emphasize the need for evaluation in the preparation process of VAM ( $vVO_{2max}$ ), which allows scientific planning of the volume and especially the intensity of running distances, to increase the capacity and aerobic power of effort.

**Key words:** *football, evaluation, aerobic capacity, maximal aerobic speed*

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Bryantara Oktian F. (2016). Factors That Are Associated to Physical Fitness ( $VO_2$  Max) of Football Athletes. *Jurnal Berkala Epidemiologi*, vol. 4, no. 2, pp. 237-249.

## FACTOR STRUCTURE OF THE FUNCTIONAL MOVEMENT SCREEN TEST COMPLEX IN YOUNG COMPETITIVE ATHLETES

Kirsti Pedak, Indrek Rannama, Boriss Bazanov, Kristijan Port

*School of Natural Sciences and Health, Tallinn University, Estonia*

### Abstract

The purpose of the current study was to identify the internal consistency and factor structure of the FMSTM test complex in young competitive athletes of different sports. Participants of the current study included 333 young competitive athletes (98 females and 235 males with a mean age of  $17.7 \pm 2$  years). The musculoskeletal status of athletes was evaluated with the FMS test package. Descriptive statistics performed and the factorability of the data was estimated. The FMS test average score was  $14.8 \pm 1.8$  when using normal scoring guidelines. Exploratory factor analysis extracted three factors. In our young athlete sample, the trunk stability push-up (TS), in-line lunge (ILL) and hurdle step (HS) loaded on the first component and shoulder mobility (SHM) and active straight leg raise (ASLR) loaded on the second component. The deep squat (DS) sub-test loaded almost equally to the first and second factor. Almost all initial variability of rotary stability (RS) sub-test loaded on the third component and variation of other sub-tests was insignificant in that factor. Based on our results may be considered partially justified to use two movement patterns groups to interpret the results of the FMS test. The sub-test RS did not fit together into any group in our approach and should be treated as completely separate. Support on the findings of this research, future studies will be required to better define the role of movement patterns model for performance exercises.

**Key words:** *Principal Component Analyse, Musculoskeletal evaluation, Kinovea*

### Introduction

Sports performance requires demanding functional movement control abilities in areas such as total body control under increasing load, single leg jumping and landing abilities, and other complex movement challenges that underpin sports performance. Muscle imbalances, inadequate core stability, and altered kinematics due to fatigue and/or muscle strength imbalances can readily lead to dysfunctional neuromuscular control, impaired movement patterns, and increased risk for musculoskeletal injury (Teyhen et al., 2014). Assessment of fundamental movements can help the professional determine who possesses or cannot perform a wide variety of essential movements and evaluation of fundamental or composite movements is necessary before the assessment of highly specific or specialised motion or movement (Hoogenboom et al., 2014). The FMS<sup>TM</sup> test battery has been worked out to describe movement patterns quality of whole body movements with a simple grading system (Cook et al., 2014a, 2014b). The FMS<sup>TM</sup> is designed to the identification of an individual's weakest link(s) as it relates to fundamental mobility and stability compared to normative data (Cook et al., 2014a). The FMS<sup>TM</sup> test has become popular screening tool used to provide an objective assessment of movement in sports performance research because of the low-cost, user-friendly management and acceptable reliability (Onate et al., 2012; Parenteau et al., 2014). In the same time, the sensitivity and validity of the FMS<sup>TM</sup> test to predict injury risk are low (Whittaker et al., 2017; Trinidad-Fernandez et al., 2019).

The FMS<sup>TM</sup> test consists of 7 standardised movements involving multiple muscle groups. Cook and co- authors (2010) proposed to interpret the results of the FMS<sup>TM</sup> test using two movement patterns groups. The first three tests (squat, hurdle step, in-line lunge) have been referred to as the "higher-level" movement patterns and the subsequent four movements (active straight leg raise, shoulder mobility test, trunk stability push-up, rotary stability test) are referred to as the primitive movement patterns (Cook, 2010). Thus the initial developers of FMS<sup>TM</sup> test have inferred that there are at least two separate latent components on the FMS<sup>TM</sup> battery (Cook et al., 2010). Some investigators have used exploratory factor analyses on the FMS<sup>TM</sup> test complex to identify the internal consistency and factor structure of the test battery in adult males and female (Kelleher et al., 2017; Koehle et al., 2016), adult athletic (Kelleher et al., 2017; Li et al., 2015) and male military (Kazman et al., 2014) populations. All of them observed factor instability, low factor congruence, and inconsistent factor structure of the FMS<sup>TM</sup> (Li et al., 2015; Kazman et al., 2014; Kelleher et al., 2017). In the same time, no similar study has conducted on young athletic population who are still developing their movement patterns and potential.

The purpose of the current study was to identify the internal consistency and factor structure of the FMS<sup>TM</sup> test complex in young competitive athletes of different sports.

## Methods

**Participants** of the current study include 333 young competitive athletes, 98 females (age  $17.71 \pm 2$ , height  $172.1 \pm 8.3$  cm, weight  $66 \pm 10.4$  kg, BMI  $22.2 \pm 2.8$ ) and 235 males (age  $17.9 \pm 1.9$ , height  $182 \pm 14$ , weight  $76 \pm 11$ , BMI  $22.5 \pm 2.6$ ) from different fields of sport. All athletes had focused on performance sport and participated both in national- level competitions and an international level. They had not any serious injuries in the past six months and were involved in regular training on average 6 times per week. The total sample size 333 is a good sample size for factor analysis (Tabachnick & Fidell, 2007).

**Procedures** The musculoskeletal status of athletes was evaluated with the FMS test package (Cook et al., 2014a, 2014b). Before FMS™ sub-tests participants performed a 5-10 minutes warm up on riding ergometer and 5 minutes of light dynamic mobilisation and activation exercises targeting the main muscle groups. All subjects were informed about nature and study procedures and provided written informed consent. Ethical permission was provided for the study by the official ethics committee. Participants were screened using the standard protocol of the seven movement patterns: deep squat (DS), hurdle step (HS), in-line lunge (ILL), shoulder mobility (SHM), active straight leg raise (ASLR), trunk stability push-up (TS), and rotary stability (RS) (Cook et al., 2014a, 2014b). Participants performed three trials of each subtest. At least 3 attempts for all tests were captured by two computer-controlled HD cameras (frame rate 30 Hz) and saved for impending analysis. Recordings were analysed with video analysis software Kinovea 0.8.25 by an experienced (30 years of practice) physical therapist with 8 years of experience with the FMS™. FMS™ 21point scoring system was used for evaluation of athlete functional state along a 4-point scale for individual exercise. The functional movement screen was explained and demonstrated to the athletes as described by Cook et al. (2014a; 2014b).

**Data analysis** was performed by using IBM SPSS Statistics 25.0 for Windows. Descriptive statistics were computed for all variables and expressed as a mean  $\pm$  SD. The factorability of the data was estimated using the Kaiser-Meyer-Olkin (KMO) index and Bartlett's test of sphericity. The Principal Component Analysis with Varimax rotation was conducted in the whole sample, and factors with an eigenvalue greater than one were computed.

## Results

The FMS test average score was  $14.8 \pm 1.8$  when using normal scoring guidelines (referred to as with pain). The frequencies and percentages of each task are presented in Table 1.

Table 1. Frequencies (percentage) of different scores.

Scores	DS	HS	ILL	ASLR	RS	TS	SHM
0	2 (0.6%)				2 (0.6%)	2 (0.3%)	1 (0.3%)
1	39 (11.75)	26 (7.8%)	27 (8.1%)	32 (9.6%)	15 (4.5%)	48 (14.4%)	70 (21%)
2	289 (86.8%)	256 (76.9%)	229 (68.8%)	164 (49.2%)	314 (94.3%)	117 (35.15%)	171 (51.4%)
3	3 (0.9%)	51 (15.3%)	77 (23.1%)	137 (41.1%)	2 (0.6%)	166 (49.8%)	91 (27.3%)
Mean $\pm$ SD	1.8 $\pm$ 0.4	2.1 $\pm$ 0.5	2.1 $\pm$ 0.5	2.3 $\pm$ 0.6	1.9 $\pm$ 0.3	2.3 $\pm$ 0.7	2.1 $\pm$ 0.7

Notes: DS = deep squat, HS = hurdle step, ILL = inline lunge, SM = shoulder mobility, ASLR = active straight leg raise, TSPU = trunk stability push-up, RS = rotary stability

The highest percentages of the score below 2 were SHM (21%) and TS (14.4%). Task score 0 percentage was low in this group. Exploratory factor analysis extracted three factors with eigenvalues greater than 1, that accounted for 53.6% of initial variability of the dataset. Bartlett's test of sphericity was statistically significant ( $p = 0.00$ ), suggesting that the variables were sufficiently correlated and, therefore, acceptable for principal components analysis. The KMO was higher than 0.6, that is an acceptable level for factor analyses. The rotated factors are presented in Table 2. The first two factors accounted both approximately near to 20% and third one less than 15% of the initial variation. In our young athlete sample, the TS, ILL and HS loaded on the first component and SHM and ASLR loaded on the second component. The DS sub-test loaded almost equally to the first and second factor. Almost all initial variability of RS sub-test loaded on the third component and variation of other sub-tests was insignificant in that factor.

Table 2. Rotated factor loadings.

N=333	KMO=0.628; p=0.000			
	Eigenvalue % of Variance	Component 1	Component 2	Component 3
		1.41 20.1	1.33 19.0	1.01 14.5
FMS subtest	Communalities			
TS	0.586	0.70	-0.31	-0.05
ILL	0.527	0.67	0.23	0.16
HS	0.278	0.50	0.16	-0.04
SHM	0.600	-0.10	0.77	0.01
ASLR	0.439	0.23	0.62	0.01
DS	0.342	0.40	0.43	0.06
RS	0.981	0.02	0.02	0.99

Notes: DS = deep squat, HS = hurdle step, ILL = inline lunge, SM = shoulder mobility, ASLR = active straight leg raise, TSPU = trunk stability push-up, RS = rotary stability.

## Discussion

The original authors of FMS test battery have grouped FMS sub-tests in to two main groups: first three tests (squat, hurdle step, in-line lunge) have been referred to as the “big three” or “higher-level” movement patterns (Cook, 2010). Some of previous studies have been performed factor analyses on different samples to control the common structure of FMS sub-tests, but have been failed to demonstrate similar component structure of different exercises (Li et al., 2015; Kazman et al., 2014; Kelleher et al., 2017; Koehle et al., 2015). Similarly with the idea of original FMS test authors in our study, the HL, ILL and DS loaded to the first factor, but additionally was most strongly loaded on that component also the TS sub-test and the loading of DS was weakest on that component. Those results are very similar with a study of Kelleher et al. (2017), who found that TS, ILL and HS are loaded in one factor according to exploratory factor analyses (Kelleher et al., 2017). A recent study of young, predominately male (94%), military personnel was a two-factor structure to the 7-point FMS™, with DS loading highest on the first factor, and shoulder mobility loading highest on the second factor (Kazman et al., 2014). Our results were similar in the case of SHM test, but the DS test shared its variability almost equally between the first and second factor.

The subsequent four movements (active straight leg raise, shoulder mobility test, trunk stability push-up, rotary stability test) are referred to as the “little four” or primitive movement patterns (Cook, 2010). In this case, ASLR and SHM tests loaded on the second factor and similar results have also shown two previous studies (Kelleher et al., 2017; Koehle et al., 2015). In addition to two mobility tests (ASLR and SHM), in our study also the DS was loaded on the second group. The factor structure according to Koehle and co-authors (2015) study divided SHM and ASLR as *basic movement factor* and DS, HS, ILL and TS concentrated in a *complex movement factor*. Our exploratory factor analysis showed that *basic movement factor* was formed by SHM, ASLR and part of DS, a *complex movement factor* by TS, ILL HS and part of DS and Rotation stability loaded alone on the separate factor. The results of the present study indicate that in population of young competitive athlete the first factor is formed from FMS sub-tests that describe postural control and stability capability and the second factor is composed of exercises that characterise the mobility of performers. The DS test includes both components because the lower scoring can be caused by reason of shortened acilleus tendons or lack of shoulder mobility, but also because of pure postural control during squatting (Cook et al., 2014a). The reason for separate factorisation of RS test is probably due to the homogeneity in performance of this test because 94.3% of young athletes can performe the simplified version of this test without large compensations (Cook et al., 2014b) and it indicates low sensitivity of this test for young athletes population.

## Conclusion

The purpose of the current study was to identify the internal consistency and factor structure of the FMSTM test complex in young competitive athletes of different sports. Based on our results may be considered partially justified to use two movement patterns groups to interpret the results of the FMS test. The sub-test RS did not fit together into any group in our approach and should be treated as completely separate exercise. Depending on the findings of this research, future studies will be required to better define the role of movement patterns model for performance exercises.

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## NON-INVASIVE INVESTIGATION ON HEART RATE VARIABILITY AND ENERGY EXPENDITURE DURING COMPETITION AND PHYSICAL ACTIVITY OF CHESS PLAYERS

**Coskun Rodoplu, Ramiz Arabaci**

*Bursa Uludag University Faculty of Sports Sciences, Turkey*

### Abstract

A chess game represents a legitimate psychophysiological stress and it is a challenging and high cognitive demand task that requires full attention and energy over the course of the game. In order to monitor performance of chess players, one of the most popular psychophysiological markers is the heart rate variability (HRV) to date (Fuentes et al., 2018). Alongside with the HRV parameters, heart rate (HR) can also be used as a non-invasive measure of calorie expenditure for chess players to monitor their performance. Therefore, the aim of present study was to compare the HRV and calorie expenditure of chess players before-during-after the chess competition and running exercises.

The sample group consists of 10 volunteer men and women between the ages of 15-40 who have been playing chess regularly for at least 5 years. According to the physical activity readiness survey (FAHOA), healthy chess players were included in the current research. The participants' chess competition and running exercises took place in 3 different time periods; HRV and HR values were taken before (15 min), during (30 min) and after (15 min). HRV, HR and body composition were obtained from the participants. According to the results of the present study, There was a significant difference between HRV [RR (ms)] before ( $742.5 \pm 115.3$ ), during ( $730.8 \pm 151.1$ ) and after ( $794.5 \pm 126.8$ ). In addition to this, there was a significant difference was found between the calorie expenditure ( $138.1 \pm 65.8$  kcal) during the chess game and the calories ( $260.5 \pm 109$  kcal) spent during the running exercise. Results show that running exercise causes more energy consumption than chess competition. In conclusion, psychophysiological measurements have an impact on the monitoring chess players' performance.

**Key words:** *Physical Activity, Mental Activity, Autonomic Nervous System, Parasympathetic Activity*

### Introduction

Chess game is one of the very old intelligence games. Chess has long been a model system for studying complex thought processes (Sigman, et al., 2010). This game contributes many issues in a positive way such as problem solving, analytical thinking, fast and accurate thinking. It is well known to be a purely mental game (Reti, 2000). However, chess players face intense visual and mental burden during and before the competition. Many psycho-social stressors are accompanied by visual and mental loading. Stressors can cause a decrease in high frequency oscillations reflecting the effect of parasympathetic nervous system on heart rate variability (HRV) (Tok, et al., 2018). This game that covers mental processes has a significant impact on parameters such as heart rate (HR), HRV, and calorie expenditure where players compete over time (Fuentes-García, et al., 2019).

In particular, heart rate variability (HRV) has become a widely used tool by researchers to study the autonomous control of the heart (Serrador, et al., 1999). HRV is an indicator that reveals the interaction between the brain and the heart. HRV can be used to evaluate the autonomic functions of the heart (Kaikkonen, et al., 2008). Accordingly, the Autonomic Nervous System (OSS) has a regulatory effect on heart work and provides information about the evaluation of OSS, cardiac sympathetic and vagal balance (Chen, et al., 2011). On one hand, parasympathetic activity, physical and mental activities can become dominant in resting time, on the other hand sympathetic activity can be more effortful in stressful situation (Aras, et al., 2014). In sport science related HRV literature different methods have been used for analyzing HRV parameters. For example, these are time-domain, frequency-domain and nonlinear measurements (Shaffer, & Ginsberg, 2017). In recent years, there is a growing body of research related with HRV in sports science, physical activity and motor control studies (Gorgulu, Cooke, & Woodman, 2019).

Therefore, the aim of the current study was to compare the relationship between chess players' HRV and calories expenditure before-during-after the chess competition and basic running exercises.



## Methods

*Participants:* A total of ten male ( $n = 8$ ) and female ( $n = 2$ ) chess players (age  $28 \pm 8.1$  years; weight  $74.5 \pm 18.3$  kg; height  $176.3 \pm 7.6$  cm; bmi  $22.5 \pm 7.1$  kg / m<sup>2</sup>; bmr  $1826 \pm 371$  kcal; tbf  $16.4 \pm 7.6\%$ ; fm  $12.8 \pm 8.2$  kg; ffm  $58.7 \pm 12.8$  kg and tbw  $45.2 \pm 9.5$  kg) constituted the sample group of the study. According to the physical activity readiness questionnaire (FAHOA), healthy ones were included in the study. Patients with any disorders in the cardiovascular, digestive and respiratory systems, those who use addictive substances such as cigarettes, alcohol, and those who use drugs that affect mental and physical performance before the competition were not included in the study. This research was carried out in accordance with the Helsinki Declaration of human rights. The study was carried out in accordance with the decision of Bursa Uludağ University Ethics Committee dated 16 December 2019 and numbered (2019-20 / 15).

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*Experimental Design:* In this study, HRV measurements and calorie expense were determined in 3 different time periods (15 minutes before the competition, 30 minutes and 15 minutes after the competition) during the chess competition and running exercise. Before the chess competition, each participant was given a personal information form, and each participant wore a chest strap Polar H7 device. Participants of the study were determined by TANITA device, height, weight and body composition. After giving information about the applications to be made to the participants, a chess match was held on the 1<sup>st</sup> day. The chess clock (Schach Queen E410) was used as time in competitions. Each player was given 15 minutes per person and HRV recordings were analyzed. If the chess game ends before 30 minutes, a chess match was held again without a break. 15 minutes passive rest before the competition, 30 minutes after the chess match and 15 minutes passive rest again, the records were taken. The other application of the study was done on the 2<sup>nd</sup> day after 24 hours of physical activity. A participant FAHOA questionnaire was made before physical activity. According to FAHOA, the athletes that were eligible were put into practice after being selected. In the physical activity, participants were given a passive rest for 15 minutes and then walking and running on the treadmill for 30 minutes (6 km/h speed).

### Measurements

*Body Composition:* The lengths of the participants who participated in the study were measured using the Mesitaş height meter (Germany) device. Body composition was analyzed with TANITA BC-418MA (Japan) Segmental Body Analysis Monitor. The device was analyzed for total body weight, BMI, basal metabolic rate, BMH (kj and kcal), impedance (ohms), fat rate (%), fat amount (kg), lean mass (kg) and total body fluid (kg).

*HRV:* It is a parameter that reflects the harmony of the signals between the brain and heart. In the study, HRV was measured with Polar H7 (Polar Electro, Kempele, Finland) device. Mental and physical activity HRV values were analyzed with these chest-worn devices.

*Physical readiness questionnaire:* A test was applied to understand that the participants in the research were physically healthy. This test consists of 7 questions and will allow athletes to participate in the research without any health check.

*Statistical analyses:* The data was analyzed with SPSS in Windows 23.0 (SPSS Inc, Chicago, USA) statistics program. Cohen's impact dimensions (d) were calculated to compare the magnitude of the difference between the groups. In two different experiments (chess competition and physical activity), the comparison of the differences in HRV and Energy expenditures was made with the Two-way ANOVA (variance analysis for repeated measurements) test. The level of significance was set at  $p < 0.05$ .

## Results

The data obtained in this study were analysed with the chess competition, the time-consuming, frequency-taking and nonlinear measurement parameters of the running exercise, and the amount of energy spent. Information on the effect size is shown in Table 1.

According to results showed in Table 1, there was a significant difference on time domain measurements of HRV such as RR (ms) between chess competition and running exercises ( $p < 0.001$ ). A significant difference was found in the Calorie ( $p < 0.001$ ) variable in energy expenditure before, during and after chess and running training competitions.

Table 1. Heart rate variability parameters and energy expenditure values of chess competition and running exercise.

Variable		Pre-test	Test	Post-test	F	$\eta^2$	Cohen's d
		Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD			
RR (ms)	CE	742.5 $\pm$ 115.3	730.8 $\pm$ 151.1	794.5 $\pm$ 126.8	23.57***	0.567	2.2886ttt
	RE	808.3 $\pm$ 108.1	547.9 $\pm$ 108.6	775.8 $\pm$ 143.5			
SDNN (ms)	CE	54 $\pm$ 12.8	43 $\pm$ 14.1	56.9 $\pm$ 12.3	7.038**	0.281	1.2503ttt
	RE	52.3 $\pm$ 11.8	19.2 $\pm$ 10.2	58.9 $\pm$ 12.3			
RMSSD (ms)	CE	38.6 $\pm$ 11.2	31.6 $\pm$ 13.9	39.8 $\pm$ 12.5	3.777	0.173	0.9147ttt
	RE	37.2 $\pm$ 14.4	14.8 $\pm$ 10.5	46.3 $\pm$ 35.7			
NN50 (beats)	CE	152.4 $\pm$ 67.8	247.2 $\pm$ 214	194.1 $\pm$ 109.9	6.886**	0.277	1.2379ttt
	RE	179.1 $\pm$ 119.6	42.3 $\pm$ 48.5	165.1 $\pm$ 128			
PNN50 (%)	CE	14.1 $\pm$ 8.3	11.2 $\pm$ 10.4	18.2 $\pm$ 11.6	3.058	0.145	0.8236ttt
	RE	17.1 $\pm$ 12.4	1.4 $\pm$ 1.7	15.8 $\pm$ 13.7			
RR TRIANGULAR-INDEX	CE	13.6 $\pm$ 2.9	11.7 $\pm$ 4.9	14.6 $\pm$ 2.9	9.002***	0.333	1.4132ttt
	RE	12.6 $\pm$ 2.7	4.6 $\pm$ 2.6	13.3 $\pm$ 4.2			
TINN (ms)	CE	293.4 $\pm$ 82.4	290.5 $\pm$ 58.8	301.5 $\pm$ 57.7	2.634	0.128	0.7663ttt
	RE	290.5 $\pm$ 58.8	274.4 $\pm$ 86	328 $\pm$ 164.2			
VLF (log)	CE	5.2 $\pm$ 0.5	4.3 $\pm$ 0.9	5.2 $\pm$ 0.4	4.729*	0.208	1.0249ttt
	RE	5.3 $\pm$ 0.7	3 $\pm$ 1.2	4.9 $\pm$ 0.6			
LF (log)	CE	7.4 $\pm$ 0.5	6.7 $\pm$ 1.1	7.6 $\pm$ 0.4	7.741**	0.301	1.3124ttt
	RE	7.5 $\pm$ 0.4	5.1 $\pm$ 1.2	7.4 $\pm$ 0.8			
HF (log)	CE	6.1 $\pm$ 0.6	5.7 $\pm$ 1.4	6.3 $\pm$ 0.6	14.66***	0.449	1.8054ttt
	RE	6.3 $\pm$ 0.6	3.5 $\pm$ 1.4	6.2 $\pm$ 1			
SD1 (ms)	CE	27.3 $\pm$ 7.9	22.3 $\pm$ 9.8	28.2 $\pm$ 8.8	4.290*	0.192	0.9749ttt
	RE	28.2 $\pm$ 10.2	10.5 $\pm$ 7.4	32.7 $\pm$ 25.2			
SD2 (ms)	CE	71.4 $\pm$ 17.3	56.4 $\pm$ 18.3	75.2 $\pm$ 16	7.458**	0.293	1.2875ttt
	RE	68.2 $\pm$ 14.3	25 $\pm$ 12.7	76.3 $\pm$ 33.9			
SD2/SD1	CE	2.7 $\pm$ 0.6	2.7 $\pm$ 0.8	2.7 $\pm$ 0.5	0.073	0.004	0.1267t
	RE	2.5 $\pm$ 0.5	2.7 $\pm$ 0.6	2.7 $\pm$ 0.9			
PNS INDEX	CE	-0.9 $\pm$ 0.7	-0.8 $\pm$ 1.3	-0.7 $\pm$ 0.9	15.66***	0.465	1.8646ttt
	RE	-0.6 $\pm$ 0.8	-2.6 $\pm$ 0.9	-0.6 $\pm$ 1.5			
SNS INDEX	CE	1 $\pm$ 1	1.3 $\pm$ 1.5	0.6 $\pm$ 1	2.878	0.138	0.8002ttt
	RE	-4.5 $\pm$ 16.3	5.3 $\pm$ 3.2	0.8 $\pm$ 1.4			
EE (kcal)	CE	59.5 $\pm$ 25.1	138.1 $\pm$ 65.8	49.5 $\pm$ 23.8	15.194**	0.458	1.8385ttt
	RE	44.8 $\pm$ 22.1	260.5 $\pm$ 109	54.7 $\pm$ 34.5			

Note: CE: Chess Exercise; RE: Running Exercise; pretest: 15 minutes before exercise; test: 30 minute During exercise; posttest: 15 minutes after exercise; RR: time between RR intervals in milliseconds; SDNN: standard deviation of all normal to normal RR intervals RMSSD: root mean square of successive RR interval differences; NN50: number of successive RR interval pairs that differ more than 50 msec; pNN50: the percentage of intervals >50 ms different from preceding interval; Triangularindex: The integral of the RR interval histogram divided by the height of the histogram; TINN: Baseline width of the RR interval histogram; VLF: very low frequency; LF: low frequency; HF: high frequency; SD1: In Poincaré plot, the standard deviation perpendicular to the line-of-identity; SD2: In Poincaré plot, the standard deviation along the line-of-identity; SD2/SD1: Ratio between SD2 and SD1; PNS INDEX: Parasympathetic nervous system activity compared to normal resting value; SNS INDEX: Sympathetic nervous system activity compared to normal resting value; EE: energy expenditure;  $p < 0.05^*$ ;  $p < 0.01^{**}$ ;  $p < 0.001^{***}$ ;  $\eta^2$ : effect size; d: Cohen's effect size (effect size: t- small effect, tt- intermediate effect, ttt- large effect).

## Discussion and Conclusion

In sport science settings, HRV analysis are used to assess the acute or chronic physiological effects of exercise, and the responses obtained here are accepted as an important parameter in the autonomous regulation of the heart despite the genetic differences (Kaikkonen, et al. 2008). According to the study conducted by Aras et al. (2014), the values taken after 30 minutes and 24 hours after the 1 hour running exercise of the adults who participated in the study were significantly higher than before the running exercises.

According to the results of the present research, a significant difference was found between HRV measured during the chess competition and running exercise. Although we hypothesized that the chess players would have a similar HRV indications during the competition and continuous running exercise, HRV was found to significantly differ according to

the results of the current study. Furthermore, a significant difference was found between the energy (calories) expenditure during the chess game ( $138.1 \pm 65.8$  kcal) and the running exercises ( $260.5 \pm 109$  kcal) of the participants. Therefore, the energy expenditure during the chess competition is not as high as during running exercises.

In conclusion, according to the heart rate variability data, chess competition and running exercise are significantly different from each other. Running exercise is lower than HRV chess game. Another result is that running exercise requires more energy than chess game.

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## THE EFFECTS OF RAPID WEIGHT LOSS ON HAND GRIP IN JUDO ATHLETES

Roberto Roklicer<sup>1</sup>, Nemanja Lakicevic<sup>2</sup>, Valdemar Stajer<sup>1</sup>, Tatjana Trivic<sup>1</sup>, Antonino Bianco<sup>3</sup>, Patrik Drid<sup>1</sup>

<sup>1</sup>*Faculty of Sport and Physical Education, University of Novi Sad, Serbia*

<sup>2</sup>*PhD Program in Health Promotion and Cognitive Sciences, University of Palermo, Italy*

<sup>3</sup>*Sport and Exercise Sciences Research Unit, University of Palermo, Italy*

**Purpose:** To observe the effect of rapid weight loss (RWL) over seven days on hand grip strength in judokas. Judo is weight-categorized, high-intensity intermittent combat sport, consisted of different techniques and actions employed during a match [1]. It is reported that nearly 90% of judokas engage in RWL on multiple occasions per year [2]. The one-week period was monitored as judokas usually start cutting weight for the competition within this time frame. It is expected that RWL practice will impair the handgrip strength in judokas.

**Methods:** Eighteen judokas volunteered to participate in the study (mean age: 25.3±5.4 years; mean height: 179±6.7 cm). They used self-determined methods to lose weight in a short duration of time, as they usually perform it prior to the competition. Subjects' hand grip strength was measured for both hands on seven consecutive days, whereas the first four days presented the weight-maintenance phase and the last three days presented RWL phase. Rapid weight loss procedures were conducted with an aim to reduce ≥5% of their body weight. Maximum handgrip strength was measured with a portable Takei handgrip dynamometer. The analysis was conducted via repeated measures ANOVA using IBM SPSS Statistics for Windows.

**Results:** According to the results, participants' body mass did not change during first four days nor did the handgrip performance. Significant weight loss within the last three days was detected (84.22±12.53 vs. 80.49±11.43 kg, 4<sup>th</sup> vs. 7<sup>th</sup> day, respectively;  $p<0.001$ ). Although the certain body mass was reduced, handgrip strength increased significantly over time for the right hand (62.60±7.97 vs. 67.90±10.26 kgf, 1<sup>st</sup> vs. 7<sup>th</sup> day, respectively;  $p<0.05$ ) while for the left hand those changes remained insignificant ( $p=0.073$ ).

**Conclusion:** Contrary to expectations, right handgrip strength increased significantly in judokas as the body mass decreased. The hand dominance may play a role in understanding these results although it was not reported prior to the investigation. Nevertheless, it is still indefinite why the handgrip strength increased as the body weight dropped. This phenomenon might be explained as psychological arousal of achieving their competitive weight, which positively affected the handgrip strength.

**Key words:** *isometric strength, weight-cutting, judokas, combat sports*

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## INJURY ANALYSIS IN THE CROATIAN FIRST WOMEN'S BASKETBALL LEAGUE DURING 2017/2018 SEASON

Matilda Šola, Cvita Gregov

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

Research has been carried out on a sample of 86 examinees from Croatian first women basketball league. The purpose of this paper was to determine the cause and the frequency, severity and place of origin of injuries in women basketball. Consequently, research findings should give main guidelines to coaches in making proper prevention and fitness programs. Basketball players filled retrospective questionnaire forms about former injuries. It has been noted 79 injuries in total. Acute injuries prevail with 39 registered cases (70%). Ligament injuries, precisely, ligament strain and tear were the most common injury among candidates (34%). Most common were ankle and knee injuries, which are predominant and consist 57% of all injuries based on locality. Ankle distortion of any classification (32%) and anterior cruciate ligament tear (16%) dominate among types of injuries according to diagnosis. Injuries of mid to high severity that caused more than a week absence from training dominate (71%). There was statistically significant difference between injured and not injured players in height variable ( $t=3,16$ ;  $p=0,002$ ). Best teams in the league reported highest percentage of injured players, but correlation between ranks was not statistically significant ( $r= -0,60$ ;  $p<0,05$ ).

**Key words:** injuries, basketball, women, prevention

### Introduction

Basketball is a globally popular team sport. As the sport grows, in terms of numbers of participants and intensity, so does the number of injuries (van Mechelen et al., 1992). High participation rates in basketball have led to a large number of injuries, especially considering that basketball possesses one of the highest risks of injury in team sports (Agel et al., 2007). Basketball is a contact sport characterized by multidirectional complex movements which can lead to a muscle and skeletal injuries (Andreoli et al., 2018). This sport requires specific movements that differentiate its risk factors and mechanisms of injury from other sports. These demands include the numerous jumps, landings, rapid changes of the movements, accelerations and decelerations. High number of studies have investigated the epidemiology of basketball injuries in various populations. Regardless of the large number of studies published, analysis on the incidence and nature of injuries among female basketball players are scarce. In addition, most of the studies published have been conducted outside of the Europe, and knowledge about basketball-related injuries in Europe, especially in Croatia, is still insufficient (Cumps, Verhagen, Meeusen, 2007). The level of evidence in Croatia concerning the epidemiology of basketball injuries is very low, especially a lack of research exists for women's professional basketball. Therefore, the aim of this study was to investigate the injuries among the First women's national league players and to supply knowledge on injuries that occur frequently. Furthermore, to describe their aetiology in order to provide a basis for preventive measures. For this purpose, a retrospective cohort study in a population of Croatian elite female basketball players was conducted.

### Methods

#### Subjects

A total of 9 first Croatian national league teams were asked to participate in the research and all nine clubs agreed to participate in the study. A total of 89 female basketball players completed the questionnaire covering the information about injuries during the previous season 2017/2018.

#### Variables/ procedures

The questionnaire was modified following the model of the study conducted by Fuller et al. (2006), in which they made recommendations on how to record and collect information about football injuries. The survey was composed of two sections with the total of 17 questions. Section one pertained to the athlete's background and general information

about their participation. These questions were related to athlete's personal information (age, weight, height), team they play for and position on the court.

Section two covered information about basketball injury history within the preceding 12 months related to the previous season 2017/2018. If the athlete sustained an injury, they were asked to report the number, exact location of injury (if known), type of injury, exact diagnosis (if there was any), time/part of the training /competition and season. They were also asked to describe the type of the training and movement pattern when an injury occurred. All measurements were self-reported and injuries were not confirmed via diagnosis from a medical professional.

### Statistical procedures

All statistical procedures were performed using the *Statistica 13.4* programme. Descriptive statistics were calculated (mean values, min, max, SD), Mann-Whitney tests, Spearman correlation ( $r$ ) and independent T-tests. A p-value of 0.05 was used to determine statistical significance. Independent t-tests were used on continuous variables to compare athletes with and without injury in the previous season. The graphs were prepared in *Microsoft Excel*.

### Results

Eighty-six athletes were surveyed in this study. In Table 1 are presented participant characteristics. Mean age of the participants was 19.4 ( $\pm 4,66$ ), height 176,7 ( $\pm 7,09$ ) and weight 67,1 kg ( $\pm 9,55$ ).

Table 1. Baseline characteristics of the sample

	N	Mean	Min	Max	SD
<b>AGE</b>	86	19,41	12,0	34,0	4,66
<b>HEIGHT</b>	86	176,7	158,0	189,0	7,09
<b>WEIGHT</b>	86	67,12	41,0	98,0	9,55
<b>BMI</b>	86	21,44	14,88	29,01	2,35

The most frequent injury locations were ankle and knee with 57 % of all injuries while the most frequent type of injury was ligament injury 34% followed by muscle injuries 16% and fractures 7%. *Figure 1* shows the frequency of injury sites.

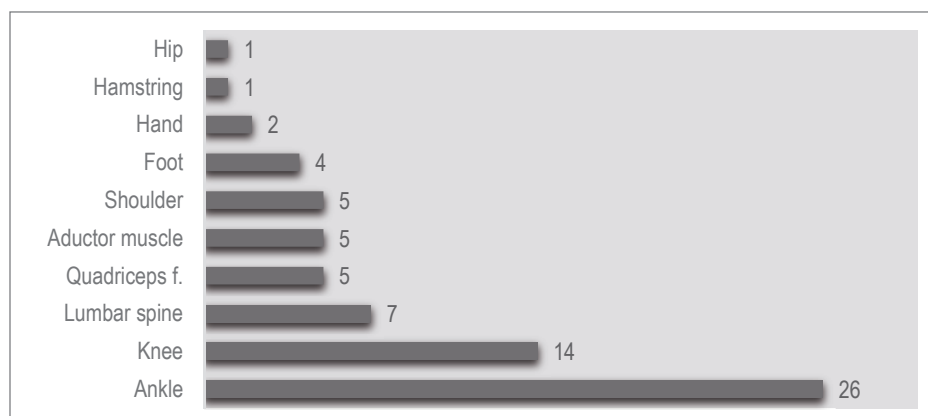


Figure 1. Frequency of injuries by location

Most of the injuries (43%) occurred during the mid-season period. To the question about the type of the activity 54% of the participants answered that an injury occurred during the basketball training, technical and tactical training to be exact. Based on a part of the training/competition participants indicated that the most injuries occurred in the middle part of the training/competition. 70% of the injuries were traumatic - occurred acutely whereas a smaller proportion were described as a chronic in nature (30%). More than a half of the participants indicated that their injury caused the cessation in training for more than 20 days. If cessation for more than a week is considered then the proportion increases up to 70% of all injured players. Half of the injured players indicated that their injury did not dramatically affect their training regimen while 44% indicated that their reported injury caused them to stop their exercise/training.

Nine Croatian national league teams participated in this study. Based on a showed results it is very concerning that in seven out of nine clubs more than 50% of players reported an injury during the previous season. Furthermore, even though correlation results were not significant, they showed that the more successful the club is the higher the injury rate is ( $r = -0,60$ ;  $p < 0,05$ ).



Regarding individual risk factors, T tests were calculated to establish the differences among injured and uninjured players. The results showed that injured athletes significantly differed from uninjured athletes only in height ( $t=3,16$ ;  $p=0,002$ ) (Table 2).

Table 2. Differences by anthropometric characteristics (T-test results)

	Injured		Uninjured		p-value
	MEAN	SD	MEAN	SD	
<b>AGE</b>	19,23	3,78	19,7	5,87	0,80†
<b>HEIGHT</b>	178,51	5,84	173,79	8,0	<b>0,002*</b>
<b>WEIGHT</b>	67,62	5,45	66,3	13,89	0,54
<b>BMI</b>	21,23	1,56	21,76	3,25	0,31

## Discussion and conclusion

53 out of 86 players sustained an injury during the previous season. A total amount of 79 injuries was registered and that number divided by a total number of players results in injury rate of 0.92 per player. The most frequently injured were ankle and knee accounting for 57% of all reported injuries. Agel et al. (2007) with the proportion of 68.4%; Deitch et al. (2006) - 65%; Andreoli et al. (2018) - 63.7%, Zuckermann et al. (2018) - 59.0% also showed that the most frequently injured were lower extremities accounting for more than a half of all injuries reported. This is not surprising because the basketball requires a high number of unilateral jumps, landings and rapid changes of movement which can cause an injury (Deitch et al., 2006). Ligament injuries were the most frequently reported type of injuries in this questionnaire (37%). The causes may be the specific movements during the basketball game including 45 +/-12 various jumps, 105 +/- 52 high-intensity runs and sprints every 21 seconds during the active time of play (McInnes et al., 1995), and 652 +/- 128 rapid changes of movement (Matthew and Delextrat, 2009).

Regarding location of injury, results of various studies indicated that the ankle is the most injured body part in basketball (Karen et al. 2017, Agel et al. 2007) which is confirmed on a sample of 86 Croatian elite basketball players as well (37% of all injured locations). Female players are generally 4 to 8 times more likely to sustain an ACL injury compared with male players (Gregov et al., 2014 according to Hewett, 2007). The high incidence of ACL rupture is confirmed in this study, as it is in the study of Deitch et al. (2006) and Prodromos et al. (2007). Typical mechanisms of injury are rapid changes of movement (plant and cut), body rotations, accentuated accelerations and decelerations (Wetters et al., 2016), jumping and landings with a knee in hyperextended or hyperflexed position (Feagin, Lambert, 1985; Boden et al., 2000). With regard to injury severity, most injuries were acute (70%), preventing an athlete from training or competing for at least 7 days (71%). This is very concerning because the injuries were severe and may have a serious impact on the health of the injured athletes and consequently, on the success of the club for which they play (Podlog et al., 2015). Moreover, the most injuries occurred during the middle part of the season (43%) which is in agreement with Zuckerman's et al. (2018) study in which 69.4% of the injuries occurred during the same period. The potential risk factors may be high loading, high frequency of competitions and spikes in training loads. However, although 'spikes' and 'troughs' in workload may increase injury risk, at times they may also be necessary to elicit greater physiological adaptations for enhanced performance (e.g., shock blocks, unloading blocks). High training monotony and high training strain are also related to increased injury risk so the need for variability within training microcycles, mesocycles and macrocycles should be considered as well as proper load monitoring during the season (Gabett, 2020). Even though high training loads are usually associated with an increased injury incidence, reductions in workloads may not always be the best approach to protect against injury. This is because protective effect seems to arise from physiological adaptations to high training loads and well-developed physical qualities (Gabett, 2020). Clearly, for athletes to develop the physical capacities required to provide a protective effect against injury, they must be prepared to train hard and that's why high training loads are not always the cause for higher injury rates (Gabett, 2016) which can be easily misinterpreted from the studies. Developing athlete monitoring systems, integrating internal and external load assessment and effective implementation of these systems should assist coaches to better control and optimize the training process (Impellizzeri, Marcora and Coutts, 2019).

T-test analyses of anthropometric measures showed that injured athletes were significantly taller than uninjured athletes ( $t=3,16$ ;  $p=0,002$ ) while there was no significant difference in weight, body mass index and age (table 4). The study from Vanderlei et al. (2013) also confirmed that the height is a risk factor for basketball players so it should be considered when planning and programming trainings for taller athletes. It is very concerning proportion of more than 50% of total amount of players sustained an injury in 7/9 clubs included in this study. In Spearman's rank correlation with the ranking at the end of the season it is found that the better teams had more injured players. It is quite shocking because the injuries are known to be a major factor affecting team's performance since they affect players ability to perform. This finding may be explained by the higher level of play, higher intensity of the games and physiologic factors affecting high level players.

This retrospective study is the first study of this kind among the Croatian elite female basketball players and it showed relatively high frequency of injuries. 53/86 players sustained an injury and 79 injuries were reported in total. Taken all together, the results obtained in this study point out the need to introduce the strategies for the prevention of injuries among the elite female basketball players as almost every player is likely to sustain an injury during the 12 months period. However, limitation of the study was the retrospective factor. Future research on injury epidemiology should be prospective as recommended by Keogh and Winwood (2016). To reduce the risk of injury in basketball future research should identify which movement patterns, conditions, or modifiable factors result in injury, especially to the ankle and knee. Consequently, research findings should give main guidelines to coaches in making proper prevention and fitness programs which should be implemented to reduce the incidence of injuries in this specific population.

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## ASSOCIATION BETWEEN REACTIVE AGILITY AND SPEED AND POWER CHARACTERISTICS IN WOMEN'S BASKETBALL

Tomas Vencurik, Dominik Bokuvka, Jiri Nykodym, Ivan Struhar

Faculty of Sports Studies, Masaryk University, Czech Republic

### Abstract

*Purpose:* This study aimed to ascertain the association between reactive agility and selected speed and power characteristics in women's basketball.

*Methods:* Twelve elite female basketball players of 1<sup>st</sup> division participated in this research. Players performed various tests to assess power (countermovement jump, drop jump), linear speed (5, 10, 20 m linear sprint), change of direction speed (505 test), and reactive agility (Y-shaped test).

*Results:* Pearson's correlation coefficient showed: almost perfect association between Y test and countermovement jump ( $r = 0.91$ ); a very large association between Y test and DJ ( $r = -0.81$ ) and 20 m linear sprint ( $r = 0.79$ ); and a large or small association between Y test and other variables. *Conclusion:* Based on these results, basketball coaches of female players can benefit from the performance of reactive agility when developing power and linear speed.

*Key words:* Basketball, Y-shaped test, power, linear speed, change of direction speed

### Introduction

In a basketball game, successful solving of game situations is conditioned by a high level of strength and conditioning and coordination skills. From this point of view, basketball puts high demands on the cardiovascular and neuromuscular system of players. These demands have been documented in several studies based on heart rate monitoring and time-motion analysis. (Ben Abdelkrim et al., 2007; Matthew & Delextrat, 2009; Narazaki et al., 2009; Rodríguez-Alonso et al., 2003; Scanlan et al., 2011; Scanlan et al., 2012; Svilar et al., 2019; Vencurik, 2014). In these time-motion analysis studies, the frequency of performing physical activities (walking, running, sprinting, jumping, etc.) varied between 21.2 and 56.9 movements per minute. Thus, changes in movement activity occur every 1 to 3 seconds, with players having to respond to various stimuli from the environment (movement of a teammate, movement of an opponent, movement of a ball, etc.). Successful handling of game situations assumes a high level of not only speed and power, but also agility and cognitive processes (decision making), which are one of the components of agility. Agility is considered by Sheppard & Young (2006) to be an independent motor ability and defined as a rapid movement of the whole body with a change in speed or direction in response to a particular stimulus. Agility testing, therefore, plays a vital role in determining the player profile. Traditionally, tests such as the T-test, the Illinois agility test, or the 505 test have been used to test agility in basketball (Ben Abdelkrim, et al., 2010; Delextrat & Cohen, 2009; Chaouachi et al., 2009).

However, these tests provide information on the rate of change of basketball players' direction, and their pre-planned closed-skill construct does not consider the cognitive components of agility performance (Scanlan et al., 2014). Recently, the number of studies in which researchers have attempted to develop protocols for testing agility has increased. The main feature was the incorporation of the cognitive component (decision making) into test protocols (Farrow et al., 2005; Gabbett et al., 2008; Lockie et al., 2014; Matlák et al., 2016; Oliver & Meyers, 2009). These tests also use perception and decision-making and are characterized by open-skill construct. Moreover, they are known as reactive agility tests. The cognitive measures have the most substantial influence on the performance in the reactive agility test while the impact of speed, change of direction speed, strength, and power is in some research unclear. (Gabbett et al., 2008; Paul et al., 2016; A. Scanlan et al., 2014; Sheppard et al., 2006).

The study aimed to determine the speed and power components that are associated with reactive agility performance in elite female basketball players.

## Material and methods

### Subjects

Twelve elite female basketball players participated in this study (mean age  $23.7 \pm 4.7$  years, mean body height  $178.5 \pm 8.7$  cm, mean body weight  $70.8 \pm 6$  kg). Players played 1<sup>st</sup> division of the Czech basketball competition. They completed 5 to 8 training sessions per week and played 1 or 2 games per week. Players participated voluntarily and signed informed consent before the study. The Research Ethics Committee of Masaryk University approved the study.

### Procedures

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#### Procedures

Players participated in tests to assess power, linear speed, change of direction speed, and reactive agility. All tests were conducted on an indoor basketball court with a wooden floor. Before the testing procedure, players performed 15 minutes of group warm-up led by the coach. The warm-up consisted of 4 minutes jogging with the ball, 8 minutes of dynamic stretching, and 4 progressive speed runs over the length of half court. After a few minutes of break, players completed field tests in the following order: countermovement jump (CMJ), drop jump (DJ), Y-shaped test (Y test), 20 m linear sprint with 5- and 10-m split, and 505 test.

CMJ and DJ were measured using Kistler dual portable force plates, type 9260AA6 (Kistler Group, Winterthur, Switzerland). Players were instructed to keep the hands on their hips for the entire movement and jump as high as possible. Three attempts were completed with 2 minutes rest interval between trials (Chaouachi et al., 2009). From CMJ, the jump height (cm) and relative maximal power (W/kg) of the best attempt were used for statistical analysis. DJ players performed from a 40 cm high box. From DJ, the jump height (cm) of the best attempt was used for statistical analysis.

For assessment of the Y test (Lockie et al., 2014), a timing-light system Speedlight (Swift Performance, Wacol, Australia) was used. Players started 30 cm behind the starting line and ran maximally through the first two gates (positioned at the starting line and 5 m). After passing the second (trigger) gate, players visually scanned for the flashing gate and performed a 45° cut to sprint through the gate. Players had 3 trials with 3 minutes rest between; the fastest trial was used.

In 20m sprint, the gates of the Speedlight system (Swift Performance, Wacol, Australia) were placed at 0 m, 5 m, 10 m, and 20 m (Lockie et al., 2013). Players started 30 cm behind the starting line and performed 3 trials with 3 minutes rest. The best time from each distance was used for statistical analysis.

In the 505 test, players sprinted 15 m, made a 180° change of direction, and sprinted 5 m back (Nimphius et al., 2018). One gate of the Speedlight system was placed 10 m from the starting line. Players performed 3 trials with 3 minutes rest. The fastest trial was used.

### Statistical analysis

Data are presented as mean  $\pm$  standard deviation. Shapiro-Wilk's test checked the normality of distribution. Data were normally distributed; therefore, parametric statistics were used. Pearson's product-moment correlation ( $r$ ) determined the association between variables. The magnitude of the association between variables was interpreted as trivial (0–0.1), small (0.11–0.3), moderate (0.31–0.5), large (0.51–0.7), very large (0.71–0.9), and almost perfect (0.91–1.0) (Hopkins, 2000). The proportion of the variance was defined by the coefficient of determination ( $r^2$ ). All statistical tests were performed using IBM SPSS Statistics (IBM Corporation, Armonk, NY, USA).

### Results

Descriptive statistics of performances in selected tests are presented in Table 1. A small correlation was found between the Y test and 5 m sprint ( $r = 0.16$ ), 10 m sprint ( $r = 0.58$ ), 505 test ( $r = 0.51$ ), and relative maximal power ( $r = -0.69$ ) produced large correlation with Y test. Correlation between jump height in CMJ ( $r = -0.91$ ) and DJ ( $r = 0.81$ ), and Y test was very large. Association between Y test and speed and power characteristics is shown in Table 2.

Table 1. Descriptive statistics of performances in selected tests

	Mean	Std. Deviation
Y-test [s]	2.84	0.18
5 m [s]	1.14	0.06
10 m [s]	1.96	0.06
20 m [s]	3.43	0.11
505 test [s]	2.40	0.07
CMJ [cm]	27.56	3.99
Relative max P [W/kg]	39.53	4.78
DJ [cm]	26.73	3.21

Table 2. Association between Y test and speed and power characteristics

	Correlation coefficient	p value	Coefficient of determination	Magnitude descriptor
5 m [s]	0.16	0.062	0.03	Small
10 m [s]	0.58	0.047	0.34	Large
20 m [s]	0.79	0.002	0.62	Very large
505 [s]	0.51	0.093	0.26	Large
CMJ [cm]	-0.91	0.00004	0.83	Almost perfect
Relative max P [W/kg]	-0.69	0.012	0.48	Large
DJ [cm]	-0.81	0.001	0.66	Very large

## Discussion

The presented study discovered a large and very large association between reactive agility and linear sprint tests for 10 m ( $r = 0.58$ ) and 20 m ( $r = 0.79$ ). Similar findings are presented by Gabbett et al. (2008) and Scanlan et al. (2014), where correlation increased with sprint distance. On the other hand, these findings are in contrast to other studies, in which a nonsignificant relationship was found between reactive agility and linear sprint for 10 m (Sheppard et al., 2006; Young et al., 2015). It appears that a selection of a specific reactive agility test or type of team sport could influence the association between linear sprint and reactive agility. Based on these results, basketball coaches of female players can benefit from the performance of reactive agility when developing power and linear speed.

Jump height in CMJ and DJ show almost perfect and very large correlation ( $r = -0.91$  and  $r = -0.81$ , respectively) with reactive agility. Between relative maximal power and reactive agility was a large correlation ( $r = -0.69$ ). These associations are different in studies of Matlák et al. (2016), Northeast et al. (2019), and Young et al. (2015). The variance between our results and those mentioned in these studies may be caused by the difference in sex, level of skill, etc. of the athletes tested. However, based on these findings, developing power abilities is highly recommended when coaches want to increase performance in the reactive agility of female basketball players.

In this study, a large correlation ( $r = 0.51$ ) was recorded between reactive agility and CODS test, which is following previous findings (Gabbett et al., 2008; Henry et al., 2011). Therefore, it is possible to suggest that the performance in a reactive agility test is influenced by the change of direction speed of athletes. Performances in both tests include one change of direction but in different angles ( $45^\circ$  in the Y test and  $180^\circ$  in 505 test). Nevertheless, only 26% of the common variance between reactive agility and CODS suggests that performance in reactive agility is also influenced by factors other than CODS (Scanlan et al., 2014).

## Conclusion

Based on this study, in women's basketball, the association between Y test of reactive agility and CMJ, relative maximal power, DJ, 10 m sprint, 20 m sprint, and change of direction speed is almost perfect, large, very large, large, very large, and large, respectively. If coaches develop the mentioned speed and power abilities of female basketball players, they will also indirectly develop reactive agility. Nevertheless, a more extensive research sample and the inclusion of more performance variables are needed to reach more generally applicable conclusions.



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## ANALYSIS OF METABOLIC DEMANDS IN SIDEWAYS RUNNING

Vlatko Vučetić, Jere Gulin, Stipo Dajaković

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The purpose of this study was to investigate the differences in energy consumption of the sideways running to the right and to the left side and to provide information on other physiological demands of such movement in relation to frontal running. A total of 16 physically active male subjects, with a background in team sports, completed a progressive incremental test running forward and two steady-state protocols running sideways to the left and to the right on the treadmill. Variables monitored were oxygen consumption, heart rate, minute ventilation, tidal volume, and breathing frequency. The main findings show that there is no significant difference in oxygen consumption while running sideways to the right and sideways to the left. The same results were found for the measured heart rate as well as ventilation parameters except for minute ventilation ( $p < 0,05$ ). The energy demand for sideways running was approximately 84% of  $RVO_{2max}$ . In conclusion, results suggest that sideways running to the left and to the right is equally demanding and produces the same energy exertion. These findings should help in better understanding of this form of movement since sideways running is very common in many team and individual sports.

**Key words:** lateral, multidirectional, energy demand, oxygen uptake

### Introduction

In many team sports, such as basketball, football, handball or rugby, there is an interchange between high-intensity and low-intensity activities. Usually, high-intensity activities are more sport-specific, while low-intensity activities are more fundamental. Very common types of activities that occur during match play are different modalities of running, jumping, etc. (Bloomfield, Polman, & O'Donoghue, 2007; Póvoas et al., 2017; Stojanović et al., 2018). The main modality of running is forward running since that is the economical way of locomotion for humans. Running in other directions is very often, i.e. in top-level football around 25% of the time is spent in running that is not directly forward (Bloomfield et al., 2007). In a review article by Taylor et al., it was reported that the highest frequency of lateral movement (sideways running) demands were found during basketball games, but with most studies not clearly reporting the definitions of lateral motion (Taylor, Wright, Dischiavi, Townsend, & Marmon, 2017). There is not enough evidence in terms of the energy demands of such movements. In the seminal paper of Reilly and Bowen, the energy expenditure of backward and sideways running was presented (Reilly & Bowen, 1984). It was found that the backward and sideways running have much higher energy demands than running forward and that with higher intensity the difference was greater. Williford and colleagues reported higher metabolic demands in terms of  $VO_2$  consumption during sideways and backward movement in tennis players of both sexes (Williford, Olson, Gauger, Duey, & Blessing, 1998). Results from these studies suggest that if an athlete moves sideways the energy consumption of such movement is up to 30% higher in comparison to forward movement. Also, similar conclusions are made considering backward movement in comparison to the frontal movement. The study from Kuntze et al. investigated ground reaction forces during sidestepping and crossover stepping tasks common in tennis and badminton. They found that such form of movement does not contribute to overuse injuries since the ground reaction forces were less than in forward movement. However, moving constantly in only one form of sideways movement could contribute to the potential muscular imbalances which could lead to overuse injuries (Kuntze, Sellers, & Mansfield, 2009). In accordance with these findings, Scott and colleagues suggested that the use of speed data as a form of assessing the physiological demands of athletes could be limited, because unorthodox movements, along with sport-specific actions, impose much greater energy demands (Scott, Lockie, Knight, Clark, & Janse de Jonge, 2013).

The purpose of this study is to investigate the energy consumption of different modalities of running (sideways to the left and to the right side). It is hypothesized that sideways running to the left will not exert more energy in comparison to sideways running to the right and that there will not be any significant difference in any of the monitored variables.

## Methods

### Subjects

Participants for the present study were recruited from the Faculty of Kinesiology, University of Zagreb. Inclusion criteria were: (i) male gender, (ii) background in team sports, (iii) previous experience in treadmill running, (iv) no cardiovascular diseases or acute musculoskeletal and neurological impairments. A total of 16 young, healthy and physically active male participants (Table 1) were included in the study. Written informed consent was obtained before the start of the study by all participants.

Table 1. Descriptive parameters of participants

	Mean±SD
Age (yrs)	23,6±1,4
Height (cm)	182,8±6,6
Weight (cm)	79,7±9,1
RVO <sub>2max</sub> (ml/kg/min)	55,0±4,2

RVO<sub>2max</sub> (relative maximal oxygen uptake)

### Experimental design

The study consisted of two randomly (coin flip) performed 5 minutes sideways running tests (SS5MIN) and one progressive incremental test to volitional exhaustion. Protocol SS5MIN required from participants to run at the same pace (8 km/h) for 5 minutes (sideways running to the right and to the left). The duration of the pause between two measurements was defined by the time needed for heart rate to drop under 50% of HR<sub>max</sub> or at least 30 minutes. Maximal oxygen uptake (frontal running) was determined on a modified incremental test (Sentija, Vucetic, & Markovic, 2007) 24 hours after the SS5MIN protocol. Equipment used for data collection of physiological parameters was the Quark CPET system (Cosmed, Rome, Italy) with the accompanying software package. The model of motorized treadmill used was Pulsar 3p 190/65 (h/p/cosmos sport&medical gmbh, Nussdorf, Germany). All tests were conducted under the supervision of trained staff in the controlled environment of the Sports diagnostics center at the University of Zagreb, Faculty of Kinesiology, Croatia. The participants were instructed not to perform any vigorous exercise, to maintain their usual hydration, dietary habits and sleep patterns in the twenty-four hours before measurement, and to refrain from any caffeine ingestion at least four hours before the testing session.

### Statistical analysis

For the evaluation of the normality of distribution, a Shapiro-Wilk test was performed. If the normality was confirmed, the difference between oxygen consumption while running sideways to the right and to the left was determined with a paired t-test, the significance set at  $p < 0,05$ . All analyses were performed using the Statistica software (StatSoft; Tulsa, OK, USA). All data are presented as mean ± standard deviation.

## Results

Comparison of means (Table 2) of oxygen consumption while sideways running to the right and to the left demonstrated no significant difference. The same results were found for the measured heart rate as well as ventilation parameters except for minute ventilation ( $p < 0,05$ ).

Table 2. Results of paired t-test for metabolic demands of running sideways.

	Right side	Left side	t	p
VO <sub>2</sub> (ml/min)	3,6±0,5	3,7±0,6	-1,00	0,33
RVO <sub>2</sub> (ml/kg/min)	45,7±3,8	46,0±3,6	-0,76	0,46
HR (bpm)	176,2±11,9	178,3±10,0	-1,77	0,10
V <sub>E</sub> (l/min)	111,1±12,5	117,1±11,2	-3,32	0,01
Bf (breaths/min)	46,0±9,5	47,9±8,9	-1,92	0,08
V <sub>T</sub> (l)	2,7±0,6	2,7±0,4	0,19	0,85

VO<sub>2</sub> (oxygen uptake); RVO<sub>2</sub> (relative oxygen uptake); HR (heart rate); V<sub>E</sub> (minute ventilation); Bf (breathing frequency); V<sub>T</sub> (tidal volume).

## Discussion and conclusion

The main finding of the study suggests that energy demand is the same regardless of the direction of sideways running which confirms our hypothesis. Furthermore, the results show that running sideways requires around 84% of  $RVO_{2max}$  of frontal running (83% and 84% while running to the right and to the left, respectively). These results support the findings of previous studies on this matter (Reilly & Bowen, 1984; Williford et al., 1998). Running forward at the intensity of 8 km/h is usually considered as a regeneration zone of intensity at around 55-65% of  $VO_{2max}$  (Stølen, Chamari, Castagna, & Wisløff, 2005). This implies that running sideways is less economical than running forward at the same intensity. A similar conclusion was found when comparing the energy expenditure of walking forward and sideways at the same intensity (Handford & Srinivasan, 2014). A study on a stride length variation reported that changing preferred stride length will cause an increase in oxygen consumption in forward running (Cavanagh & Williams, 1982). Stride frequency is much higher while running sideways than forward running at the same intensity while the stride length is shorter (Kuntze, 2008; Yamashita, 2014). This change in stride length and stride frequency in comparison to forward running is also noted in backward running (Uthoff, Oliver, Cronin, Harrison, & Winwood, 2018). But the reason for this discrepancy of energy demand, or oxygen consumption, when changing the direction of movement cannot be solely based on the changes of stride length and frequency, other biomechanical and neuromuscular differences should be taken into consideration (Kuntze et al., 2009; Thorstensson, 1986; Uthoff et al., 2018; Williford et al., 1998; Yamashita, Shinya, Fujii, Oda, & Kouzaki, 2013).

Even though no significant difference was found in most variables, slightly higher values occur while running to the left. Since for most participants, the right leg is the dominant one, this may suggest that the preferred running side could play a role in the energy demand. But this should be thoroughly investigated before any conclusions. Since many sports have a substantial amount of lateral movement or running sideways (Bloomfield et al., 2007; Kuntze, 2008; Póvoas et al., 2017), these findings could be useful to coaches for a better understanding the demands of such type of movement. Future studies should focus on investigating energy demands of sideways running on higher speeds (i.e. >10km/h), or even short high-speed bursts in such type of movement. Also, it would be interesting to compare the energy demand of sideways and backward running to the forward running at the same intensity.

In conclusion, results suggest that sideways running to the left and to the right is equally demanding and produces the same energy exertion. These findings should help in better understanding of this form of movement since sideways running is very common in many team and individual sports.

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## THE EFFECT OF LIFTING STRAPS ON PULL-UP REPETITION NUMBER

Saša Vuk<sup>1</sup>, Leo Bašić<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Atletski klub Perpetuum Mobile, Croatia

### Abstract

Interruption of work in basic exercises occurs when the weakest muscles participating in the exercise reach muscle failure. In pulling exercises, this most often pertains to grip flexor muscles, i.e., muscles that ensure a firm grip. In order to avoid this, there are different methods and aids that can amplify it. One of them is the use of lifting straps. Thus, this paper aimed to establish whether and to which extent the use of lifting straps in the performance of bodyweight pull-ups to failure can increase the number of repetitions in relation to the performance of pull-ups without the use of lifting straps in one set. Physically active male population ( $n = 10$ ; age:  $19.9 \pm 1.1$  years; height:  $178.4 \pm 5.9$  cm; body mass:  $78.2 \pm 10.9$  kg; mean  $\pm$  SD) performed the maximum number of pull-ups with or without the use of straps. The differences were established in a t-test for dependent samples and the increase and effect sizes were calculated. The t-test results point to a statistically significant difference ( $t = 4.64$ ;  $p = 0.001$ ) in results of the performance of pull-ups with and without the use of straps ( $11.6 \pm 3.95$  vs.  $9.9 \pm 4.12$ , respectively). The increase size reaches 17.17%, whereas the effect size is 0.41. The results obtained show that the increased number of repetitions performed with straps allows for an increase in the total work and muscle time under tension, which can be important for the development of muscle strength and hypertrophy. Therefore, a dosed use of straps in a safe way in line with precisely defined objectives of a training process is recommended.

**Key words:** muscle strength, hypertrophy, fitness straps

### Introduction

It is considered that the muscle strength increase and hypertrophic response to resistance training can be best achieved through an adequate manipulation of the training programme variables (Kraemer & Ratamess, 2004). The most important variables, which are most often manipulated, include the choice of exercises, order of exercises, rest interval duration, training intensity and volume (Kraemer & Ratamess, 2004). Training volume represents the total number of sets and repetitions performed during one training (Bird, Tarpinning, & Marino, 2005). The higher volume, the greater the fatigue of motor units and metabolic stress, specifically because of the increased time under tension (Schoenfeld, 2011). Therefore, training to muscle failure engages motor units to the maximum and better develops muscle strength (Fisher, Steele, Bruce-Low, & Smith, 2011) and hypertrophy (Fisher, Steele, & Smith, 2013), so the idea of achieving an even greater muscle fatigue to maximize the muscular adaptation seems logical. The point of momentary muscular failure in a compound exercises occurs when the weakest muscles included can no longer apply the force necessary for the continuation of the exercise (Jones, 1970). Most often this refers to forearm muscles which are expected to ensure a firm grip (Church, Allen, & Allen, 2016), notably in pulling exercises, such as dead lift, diverse free weight pulling exercises, pull-ups etc. (Coswig et al., 2015). This is the reason why various methods and aids that can “strengthen the weakest link” have been developed and in this way the number of repetitions in a set, and consequently the overall training volume, can be increased (Coswig, Freitas, Gentil, Fukuda, & Del Vecchio, 2015). Some of these ergogenic methods and aids are: inverted (mixed) grip, alteration of bar thickness, magnesium carbonate powder (chalk) and the use of lifting straps (Coswig et al., 2015).

Lifting straps are textile or leather bands which wrap around the wrist and the bar, creating, thus, a strong connection between them (Church et al., 2016). It is commonly thought that lifting straps significantly increase the overall grip strength as a result of the combination of the muscle force and the friction of the strap (Church et al., 2016). They are most often used in exercises in which external loading is so heavy that the target muscles can master it, but the grip is too weak (Schwarzenegger & Dobbins, 2012), or in final sets when the grip strength is lessened due to fatigue (Stoppani, 2008).

Previous studies have found that the application of lifting straps can increase the number of repetitions per set. Thus, for example, the research by Werneck et al. (2011; according to Coswig et al., 2015) shows that the use of lifting straps in the performance of a cable pull-down exercise allows for a greater number of repetitions compared to the same exercise without the use of straps. The research by Stoppani et al. (2008) conducted among trained bodybuilders suggests that the use of lifting straps increases the number of repetitions in all sets of pulling exercises (including pull-ups), and it



underlines that the use of straps gives them a better feeling and enables activation of back muscles. It is considered that lifting straps allow for a direct transfer of force to the bar or the prop used, whereas the training load is transferred to the hand wrist and forearm, and consequently they eliminate possible deficits relating to the strength of the fist flexors and put greater focus on the active musculature (Saavedra, 2001).

It turns out that lifting straps are very useful and applicable in strength and hypertrophy training. However, even though the benefits of their use have been extensively presented in professional and populist literature, scientific research is scarce, especially in pull-up exercise.

Therefore, the objective of this study was to evaluate the effects of lifting straps on maximum number of repetitions during single pull-up set to failure.

## Methods

### Subjects

Subjects were physical education male students (age:  $19.9 \pm 1.1$  years; height:  $178.4 \pm 5.9$  cm; body mass:  $78.2 \pm 10.9$  kg; mean  $\pm$  SD). They had at least one-year experience in bodyweight strength training (pull-ups) through the regular academic program.

Before the study was conducted, an assessment of a sample size was made with the help of the *G\*Power* (v. 3.0.10). A pilot study ( $n = 6$ ) was carried out and the obtained sample standard deviation was used for the calculation the effect size (ES) (Lachin, 1981). Based on a statistical power of 0.8, alpha level of 0.05, and calculated within-individual pull-ups variation, it was estimated that 13 % more repetitions with the help of lifting straps than without them requires three subjects per condition (i.e. six subjects). We conservatively recruited 10 subjects for this study. It is necessary to emphasize that a randomized AB/BA crossover study design (repeated measurements) was used, which means that all participants were included in both experimental conditions. Such a statistical method has some advantages over the parallel group methods (Candel, 2012; Milas, 2009; Reed, 2003). In particular, it reduces the sample size, offers greater statistic power, eliminates personal differences from the intergroup differentiation, which improves the internal validity, and controls variance of personal differences within the conditions, reducing the experimental mistake, which increases the validity of the statistical conclusion.

All participants gave written informed consent to the experiment, which was in accordance with the Declaration of Helsinki and approved by the local IRB board. Participants had not had a history of injuries of the musculoskeletal system or any existing musculoskeletal disorders or conditions in the past year.

### Testing procedure

Participants were tested twice: (1) testing of the first condition and (2) testing of the second condition after a week. They were randomly assigned to perform pullups either with a lifting straps first (condition A) followed by performing pullups without lifting straps (condition B), or performing pullups without lifting straps first (condition B) followed by performing pullups with lifting straps (condition A). A suitable washout period between individual tests was seven days, which is long enough for the potential effect of the testing of the first condition not to affect the results of the testing of the second condition (Milas, 2009). In that period subjects were asked not to participate in any systematic training; however, they regularly participated in physical activity courses through a standard academic program.

### Pull-ups – test of maximum number of repetitions to failure

The pull-up testing was carried out in line with the standardized protocol described in the paper by Sánchez-Moreno et al. (2017). In brief, both conditions were carried out on a fixed horizontal bar of 2.5 cm in diameter. Correct performance of pull-ups implied lifting of the chin above the bar from the hanging position with arms fully extended. The grip width was approximately 150% of the biacromial width distance. Subjects were asked to perform the eccentric phase of movement in a controlled manner and to hold the initial position for about one second before the next concentric phase of movement. The testing was performed at the same venue and time of day for each subject, under the same environmental conditions. During the testing of the both conditions, a strong verbal support was given to ensure the participants perform as many repetitions as possible.

The testing was preceded by a standardised warm-up consisting of jogging at a self-selected easy pace with joint mobilization exercises lasting for four minutes, which was followed by a specific warm-up with cable pull-downs (10 repetitions with approximately 60% of a subject's body mass).

Lifting straps were attached on a subject's both wrists and firmly wrapped around the bar, ensuring a firm and stable grip (Shimano et al., 2006). The number of pullups with and without lifting straps were counted by professional staff.



## Statistical analysis

Effects of conditions within subjects were assessed using a Student's t-test for dependent samples. The statistical significance level was set at  $p < 0.05$ .

Magnitude of effects within conditions were estimated by Cohen's effect size ( $d = (M_E - M_C) / SD_C$ ; where  $M_E$  = mean of pull-ups with lifting straps,  $M_C$  = mean of pull-ups without straps,  $SD_C$  = standard deviation of pull-ups without straps).  $d < 0.35$  was considered as a trivial effect, 0.35-0.8 as a small effect, 0.8-1.5 as a moderate effect and  $d > 1.5$  as a large effect (Rhea, 2004).

The magnitude of the difference between conditions were expressed by percentage increase ( $\%_{\text{increase}} = (M_E - M_C) / M_C$ ; where  $M_E$  = mean of pull-ups with lifting straps,  $M_C$  = mean of pull-ups without straps).

The assessment of the sample size was carried out with the help of the *G\*Power* (version 3.0.10). The data processing and statistical analysis were carried out in the Statistica (TIBCO Software Inc. (2018), Statistica (data analysis software system), version 13. <http://tibco.com>). Descriptive statistics were calculated for all experimental data as mean and standard deviation ( $\pm$  SD).

## Results

The number of pull-ups with and without lifting straps were  $11.6 \pm 3.95$  and  $9.9 \pm 4.12$  (mean  $\pm$  SD), respectively. The t-test results indicate a statistically significant difference ( $t = 4.64$ ;  $p = 0.001$ ) in the performance of pull-ups with the use of lifting straps and without the use of lifting straps among subjects ( $ES = 0.41$ , which is 17.7 % more).

## Discussion and Conclusions

The main finding of this study indicates a significantly higher number of performed pull-ups with the use of lifting straps than without them, which confirms the set research hypothesis. In other words, we can conclude that the use of straps directly influences exercise performance that requires manual grip strength, increasing the amount of work performed by the target muscles.

However, prior to the discussion on the main finding, it is necessary to mention the possible limitation of the research, and that is the result variability, i.e., the wide range of the maximum number of repetitions among included participants (condition without straps: 3 to 17; and condition with straps: 5 to 18 repetitions). Even though the population from which the sample is drawn is homogenous in terms of age, gender and training history, it seems relatively heterogeneous in terms of the number of performed pull-ups with and without straps.

Results of this research indicate that the use of lifting straps has a direct impact on the maximum number of pull-ups. It is possible to achieve 17.17% more repetitions with the help of lifting straps than without them. The results obtained show that the increased number of repetitions performed with lifting straps allows for an increase of the total work and muscle time under tension, two variables relevant for the development of muscle strength and hypertrophy. Although the size effect of 0.41 among physically active population represents a small effect (Rhea, 2004), an average increase of 1.7 pull-ups per set can imply a significant practical importance.

The findings of the research are in compliance with the results of the research testing the impact of straps in other activities, as well. Research by Werneck et al (2011; according to Coswig et al., 2015) suggests that the use of straps in cable-pull downs exercise at 75% of 1RM with a neutral grip enables 30.62% more repetitions ( $AS \pm SD$ :  $27.3 \pm 3.2$ ) in comparison with the performance of the same exercise without the use of straps ( $AS \pm SD$ :  $20.9 \pm 2.4$ ). One of possible reasons for a greater increase size in the mentioned research in comparison with this study is the intensity. The load in the pull-ups is significantly bigger than in cable-pull downs, so we can expect a lower number of pull-ups, and accordingly, the possibility to raise the increase size is lower.

Research by Stoppani et al. (2008) showed that bodybuilders performed one to two more repetitions with the use of straps, not only in pull-ups, but also in the cable pull-downs, dumbbell rows and seated rows exercises. They also underlined that using straps allowed them to better concentrate on their backs and less on their arms. It is believed that lifting straps ensure a direct transfer of force to the bar or prop used, whereas the training load is transferred to the wrist and forearm, whereby they eliminate possible deficits relating to the strength of the fist flexors and in this way put greater focus on the active musculature (Saavedra, 2001). Thus, when the grip strength deficit is eliminated, bigger, targeted muscle groups can perform better, e.g. perform a higher number of repetitions.

However, it is necessary to point out that some research suggests that the use of lifting straps can have some negative effects, as well. Firstly, it is worth mentioning that the use of straps lowers the need for activation of the forearm muscles responsible for the hand grip, so continuous use of straps can result in a decreased training adaptation, or decreased strength of these muscles. This can be contra productive because many everyday activities, such as carrying laundry, turning a doorknob, and vacuuming, require a high level of activities of these very muscles (Visnapuu and Jürimäe,

2007). Moreover, a certain level of the hand grip strength is necessary in sports such as wrestling, judo, tennis, football or basketball.

Secondly, exercises that develop the grip strength can also play a role in injury prevention and rehabilitation (Bassi, Sharma, Kaur, & Sharma, 2016; Visnapuu and Jürimäe, 2007; Budoff, 2004). For example, golf and tennis elbow can be prevented by strengthening the muscles responsible for the hand grip. The mentioned inflammations are often caused by uneven strength ratios between elbow flexor muscles and forearm muscles (Poliquin, 2006, according to Koley & Pal Kaur, 2011). If elbow flexors are too strong for the forearm flexors, uneven tension accumulates in the soft tissue and results in elbow pain.

Therefore, it is recommended that the use of straps: 1) is limited to training with submaximal and maximal loads (greater than 80% of 1 RM) in order to strengthen forearm muscles (Church et al., 2016; Coswig et al., 2015); 2) only in the last sets when forearm muscles have declined due to fatigue (Stoppioni, 2008); or 3) when using specialized exercises which target the hand grip muscles.

Even though the use of straps for the bodyweight pull-up training can potentially be useful, along with all the mentioned benefits and potential negative effects of the use of straps, a dosed use of straps in a safe manner in line with precisely defined training process goals is recommended.

In conclusion, this research paper studied the effect of the use of lifting straps in performance of pull-ups. The research results suggest that the use of straps is more efficient than pull-ups performed without straps. In particular, an increase of 17.17%, which is nearly two pull-ups per set in practical terms, which can have a significant potential impact on the development of muscle strength and hypertrophy, if implied in the training process. However, given that a frequent use of straps can result in declining of the hand grip, which is necessary for most sports activities, as well as for everyday life, it is advised to use straps in activities whose primary goal is not to develop the hand grip strength, but some other bigger muscle groups (such as back muscles) and which require mastering of a big training load, bigger than 80% of 1RM.

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## RELATION BETWEEN BODY COMPOSITION AND AGILITY OF FEMALE HANDBALL PLAYERS

Mila Vukadinović Jurišić, Jelena Obradović, Dušan Rakonjac

*Faculty of sport and physical educations, Serbia*

**Introduction:** In handball, motor, morphological and physiological characteristics play an important role in achieving success in sports (Ciplak, Eler, Joksimović, & Eler, 2019). The aim of this study was to determine the impact of body composition on change of direction speed and reactive agility of female handball players.

**Methods:** Forty-five female handball players (age=16.07±1.27 years; body height 166.84±5.56 cm, body weight: 65.10±9.27). The body composition was analysed using a bioelectrical impedance method and included the following variables: fat free mass (%), fat mass (%) and muscle mass (kg). Change of direction speed (CODS) was measured using a T-test while Reactive agility was measured using RAT test (Trecroci et al., 2016). The data were evaluated with the SPSS 20 statistics software, Regression analysis was carried out in the statistical analysis and the significance level was determined as  $p \leq 0.05$ .

**Results:** The results of the regression indicated that system of predictor variable (fat free mass (%), fat mass (%) and muscle mass (kg)) no statistically significant influence on CODS ( $p=0.27$ ) and RAT ( $p=0.28$ ) in female handball players. The results also indicate that no statistic significant influence fat free mass ( $p=0.37$ ), fat mass ( $p=0.62$ ) and muscle mass ( $p=0.31$ ) on CODS. Also no statistic significant influence fat free mass ( $p=0.65$ ), fat mass ( $p=0.93$ ) and muscle mass ( $p=0.25$ ) on RAT.

**Conclusion:** The results of regression analyses were noted that body composition of handball players in this age group no influence on change of direction speed and reactive agility.

**Key words:** *Change of direction speed, reactive agility, morphological characteristics*

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## POST-ACTIVATION POTENTIATION EFFECT OF DIFFERENT RESISTANCE EXERCISES COMBINED WITH BLOOD FLOW RESTRICTION ON SUBSEQUENT SPEED AND POWER PERFORMANCE

Hongwen Wei, Junjie Zhang

*School of strength and Conditioning Training, Beijing Sport University, China*

**Purpose:** To compare the post-activation potentiation (PAP) effects of blood flow restriction (BFR) combined the low-intensity (LI) with either back squat (BSQ) or barbell hip thrust (BHT) training protocol to the high-intensity (HI) BSQ or BHT, respectively, on subsequent sprint and power performance.

**Methods:** Fifteen resistance-trained men were recruited and randomly allocated to complete 15 testing sessions separated by 72h. Each session, participants either undertook a control session (CON) consisting of a dynamic warm-up protocol followed by performance test, or separated sessions involving one of the following interventions subsequently in the following testing sessions, that is, HI-BSQ, HI-BHT, LI-BSQ combined with BFR, and LI-BHT combined with BFR. One of the performance tests which included 20m sprint, countermovement jump (CMJ), static jump (SJ), drop jump (DJ) was conducted in one session. The jumping performance parameters of the height, rate of force development (RFD), maximal speed (Max-S), peak power (Peak-P) and peak force (Peak-F) were collected using a Kistler Quattro Jump force plate.

### Results:

- (1) 90%BHT and 30%BHT+BFR resulted in significant greater 20m sprinting performance compared with CON ( $P<0.05$ , both).
- (2) 90%BHT and 30%BSQ+BFR significantly improved CMJ height compared with CON ( $P<0.05$ , both).
- (3) 90%BHT significantly increased the measurements of both  $CMJ_{Peak-F}$ ,  $CMJ_{RFD}$ ,  $CMJ_{Max-S}$ ,  $CMJ_{Peak-P}$  ( $P<0.05$ , all), and  $SJ_{Peak-F}$ ,  $SJ_{RFD}$ ,  $SJ_{Max-S}$  and  $SJ_{Peak-P}$  ( $P<0.001$ , all) compared with CON.
- (4) 90%BSQ significantly improvement both  $CMJ_{Peak-F}$ ,  $CMJ_{RFD}$ ,  $CMJ_{Peak-P}$  ( $P<0.001$ , all), and  $SJ_{Peak-F}$ ,  $SJ_{RFD}$ ,  $SJ_{Max-S}$  and  $SJ_{Peak-P}$  ( $P<0.01$ ,  $P<0.05$ ,  $P<0.05$ ,  $P<0.001$ , respectively) compared with CON.
- (5) 30%BHT+BFR significantly increased the measurements of both  $CMJ_{Peak-F}$ ,  $CMJ_{RFD}$ ,  $CMJ_{Max-S}$ ,  $CMJ_{Peak-P}$  ( $P<0.05$ ,  $P<0.01$ ,  $P<0.05$ ,  $P<0.05$ , respectively), and  $SJ_{Peak-F}$ ,  $SJ_{RFD}$ ,  $SJ_{Peak-P}$  ( $P<0.001$ ,  $P<0.01$ ,  $P<0.001$ , respectively) compared with CON.
- (6) 30%BSQ+BFR significantly improved the measurements of both  $CMJ_{Peak-F}$ ,  $CMJ_{RFD}$ ,  $CMJ_{Max-S}$ ,  $CMJ_{Peak-P}$  ( $P<0.001$ ,  $P<0.01$ ,  $P<0.01$ ,  $P<0.001$ , respectively), and  $SJ_{Peak-F}$ ,  $SJ_{RFD}$ ,  $SJ_{Peak-P}$  ( $P<0.001$ , all) compared with CON.
- (7) 90%BHT had significant either lower  $CMJ_{Peak-F}$  and  $CMJ_{Peak-P}$  ( $P<0.05$ , both) or higher  $SJ_{Peak-F}$  and  $SJ_{RFD}$  ( $P<0.01$ , both) than 90%BSQ.

### Conclusions:

- (1) 30%BHT+BFR presented the PAP effect indicated faster 20m sprinting performance, which was associated to the improved both  $CMJ_{Peak-F}$ ,  $CMJ_{RFD}$ ,  $CMJ_{Max-S}$ ,  $SJ_{Peak-F}$ ,  $SJ_{RFD}$ ,  $SJ_{Peak-P}$ .
- (2) 30%BSQ+BFR showed the PAP effect presented greater CMJ height, which was related to the elevated both  $CMJ_{Peak-F}$ ,  $CMJ_{RFD}$ ,  $CMJ_{Max-S}$ ,  $CMJ_{Peak-P}$ ,  $SJ_{RFD}$ ,  $SJ_{Peak-P}$ .

**Key words:** Postactivation Potentiation; Resistance Exercises; Blood Flow Restriction

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# Physical Education

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## CORRELATION BETWEEN MOTOR ABILITIES AND SETTING FROM THE MIDDLE VOLLEYBALL POSITION IN ELEVEN-YEAR-OLD FEMALE PUPILS

Bojan Babin<sup>1</sup>, Lidija Vlahović<sup>1</sup>, Melis Mladineo Brničević<sup>2</sup>

<sup>1</sup>University of Split, Faculty of Humanities and Social Sciences, Croatia

<sup>2</sup>University of Split, Faculty of Law, Croatia

### Abstract

This research was conducted to determine correlation between motor abilities and motor skills test on setting from the middle volleyball position in fifth grade primary-school female pupils. A set of 21 motor tests and a test on setting from the middle volleyball position were applied on a sample of 152 female pupils aged 11 ( $\pm$  6 months). The results of a multiple regression analysis showed a high correlation between motor abilities and motor skills test on setting from the middle volleyball position ( $R = 0.63$ ). Analysis of the partial influence indicated a significant contribution of seven motor variables and the most relevant ones were 20m high-start run, standing on the feet along the balance bench with eyes closed, feet tapping against the wall and half squats. The results gave guidelines for selecting setting from the middle volleyball position in programming Physical Education lessons and for achieving best grade when evaluating this motor skill.

**Key words:** motor skills, fifth grade primary-school female pupils, evaluation, Physical Education, planning and programming

### Introduction

Quality of the process of kinesiological education depends on an entire range of factors and one of the crucial ones is being introduced to current condition, abilities, characteristics and skills of pupils as well as to transformational values of specific kinesiological operators, that is the teaching content itself (Findak, 2003). Motor skills in kinesiological education represent motor structures of movement with the main task of not only teaching certain skills but also developing specific dimensions of anthropological status, above all those regarding morphological and motor characteristics of pupils. Since the primary value of motor skills is their immediate influence on transformation of specific anthropological characteristics, it is utterly important to select teaching topics while planning and programming Physical Education lessons, aiming to enable maximum changes of specific anthropological characteristics of female pupils up to reaching the desired final condition. The term motor information or motor skills refers to the formed “command algorithm”, positioned in adequate motor areas of the Central Nervous System, enabling achievement of purposeful motor structures of movement. The “command algorithm” is responsible for activation and deactivation of different muscle groups considering the order, intensity and duration of certain activity, resulting in performance of a motor operation (Findak et al., 2000; Gallahue i Donnelly, 2003). When considering the usefulness and application of the process of learning motor skills, it is extremely important to take into account the age of an individual which should be based on the biological degree of development of certain abilities in each phase of growth and development. Namely, solely adequate motor skills can be acquired efficiently which represents a prerequisite for those skills to assume simultaneously the function of an adequate kinesiological stimulus (Babin et al., 2013). Determining correlation between motor abilities and motor skills has still not been sufficiently studied, but is an ongoing theoretical and practical issue of great importance, above all, due to the possibility of forming rational steps for planning and programming, as well as for monitoring and evaluating during PE classes. It is, furthermore, rather significant for orientation and selection of young athletes; planning, programming and controlling of the training process and efficient monitoring of the development of relevant anthropological features of both athletes and students (Mraković et al., 1993; Findak, 2003).

This research was conducted with the aim of determining correlation between motor abilities and the motor skill *Setting from the middle volleyball position* which was taken as a representative teaching topic from the Physical Education syllabus for fifth grade primary-school female pupils and it was used for constructing a motor skill test. The results of the research will provide an insight into specifying motor abilities that will reveal which particular motor abilities contribute to the highest extent to the efficiency of performing motor skill *Setting from the middle volleyball position* in fifth grade primary-school female pupils.

## Methods

The sample of subjects included 152 fifth grade primary-school female pupils at the chronological age of 11 ( $\pm$  6 months). The pupils attended regular Physical Education classes held in accordance with the primary school curriculum (Primary school curriculum, 2006). Subjects were clinically healthy participants without any aberrant conditions.

For the purpose of this study a set of motor tests was used to assess primary motor abilities including thus certain dimensions of the hierarchical model of motor abilities (Vlahović, 2012; Findak et al., 1996; Metikoš et al., 1989). This led to designing a set of 21 motor tests for assessing the following motor abilities:

- coordination – 1) *Polygon backwards* (MRPOL), 2) *Coordination with the stick* (MKOSP), 3) *Side steps* (MAKUS),
- balance – 4) *Standing on a foot along the balance bench with eyes opened* (MBU10), 5) *Standing on a foot along the balance bench with eyes closed* (MBU1Z), 6) *Standing on the feet along the balance bench with eyes closed* (MBU2Z),
- flexibility – 7) *Over-arm flip* (MFISK), 8) *Bow forward* (MFPRR), 9) *Side steps* (MFBR),
- frequency of movement – 10) *Hand tapping* (MBTAP), 11) *Foot tapping* (MBTAN), 12) *Feet tapping against the wall* (MBTAZ),
- explosive strength – 13) *Standing jump* (MESDM), 14) *Backward medicine ball throw* (MEBML), 15) *20m high-start run* (ME20V),
- static strength – 16) *Bent arm hang* (MSVIS), 17) *Backward horizontal hold* (MSHIL), 18) *Half squat standing* (MSIZP),
- repetitive strength – 19) *Sit-ups* (MRDTS), 20) *Knees push-ups* (MRSNK), 21) *Half squats* (MRPLC).

The motor skill test *Setting from the middle volleyball position* (Babin et al., 2019) was applied by seven independent trained assessors who immediately observed the pupils' performance. Assessors previously underwent an additional training regarding methods and the coordination of evaluation criteria, and the test was formed as follows:

*Aids:* Volleyball, a picture representing the task.

*Place of performance:* School gym.

*Task:* The test included making several consecutive settings above the head from the volleyball middle position.

*Description and correct test performance:* The subject stands in a diagonal position with weight equally distributed on the feet, knees and are slightly bent. Palms holding the volleyball are in front of the forehead, slightly pulled back and towards each other, fingers are separated and slightly tense. At this point the subject throws the ball over their head and starts setting it by stretching the legs, body and hands towards the ball, ending with active finger extension. The ball lies mostly on the thumbs, forefingers and middle fingers, while the ring finger and the small finger only support it. The ball is first slowed to a stop, then hit with fingers by a swift hand extension and then set straight up above the head. Arm work should be assisted by leg stretching. Before setting the ball, the subject stands in such a position in space that they can set the ball above the head multiple times.

*Grading system:* The test is performed once and graded on a 1-5 scale (Table 1).

Table 1. Criteria for evaluating variable *Setting from the middle volleyball position*

GRADE	DESCRIPTION OF MOTOR SKILL TEST PERFORMANCE
5 (excellent)	- student performs correct, accurate and clean setting without any mistakes - student is well positioned under the ball and has the correct posture, footwork, hands and fingers motion
4 (very good)	- student has stiff fingers while setting, so during the contact with the ball an unclear hit on the ball can be heard
3 (good)	- arms and legs are rigid and motions are cut off, not fluid - fingers are stiff, so due to weak amortization a hit on the ball can be heard
2 (sufficient)	- student is incorrectly positioned under the ball - fingers are stiff as well as the entire body movements - sets the ball very stiffly or with too stiff fingers
1 (insufficient)	- student is incorrectly positioned under the ball - sets the ball incorrectly, "carries it" - sets the ball with the palms, pushes it - sets the ball with a double hit - has stiff knees - waits for the ball with stiff or overly bent arms - has no control over the ball



Multiple regression analysis was applied with the aim of obtaining indicators for correlation between variables on manifest motor abilities and the motor skill variable *Setting from the middle volleyball position*, and the following calculations were done: *multiple correlation coefficient (R)*, *coefficient of determination (R<sup>2</sup>)*, *standard error of the estimate ( $\sigma$ )*, *F-test value (F)*, *standardized regression coefficient ( $\beta$ )*, *predictor variable linear correlation coefficient (r)*, *t-test value (t)* and *the significance level (p)*. Software package *Statistics for Windows 13.3* was used for analysis of the obtained data.

## Results

Table 2. Multiple regression analysis; criterion variable – *Setting from the middle position in volleyball*, set of predictor variables – motor variables

R = 0.63	R <sup>2</sup> = 0.40	$\sigma_e$ = 0.91	F = 3.86	p = 0.00
Variables	$\beta$	r	t	p
MRPOL	-0.19	-0.14	-1.59	0.11
MKOSP	-0.10	-0.09	-0.98	0.33
MAKUS	-0.10	-0.08	-0.94	0.35
MBU1O	-0.13	-0.13	-1.40	0.16
MBU1Z	0.09	0.09	1.05	0.29
MBU2Z	<b>0.27</b>	<b>0.28</b>	<b>3.18</b>	<b>0.00</b>
MFISK	0.14	0.14	1.58	0.12
MFPRR	<b>0.22</b>	<b>0.20</b>	<b>2.29</b>	<b>0.02</b>
MFBR	-0.15	-0.14	-1.57	0.12
MBTAP	<b>0.23</b>	<b>0.21</b>	<b>2.38</b>	<b>0.02</b>
MBTAN	-0.03	-0.02	-0.25	0.80
MBTAZ	<b>-0.27</b>	<b>-0.25</b>	<b>-2.84</b>	<b>0.01</b>
MESDM	0.19	0.14	1.56	0.12
MEBML	-0.04	-0.04	-0.42	0.67
ME20V	<b>0.31</b>	<b>0.26</b>	<b>2.98</b>	<b>0.00</b>
MSVIS	0.08	0.06	0.68	0.50
MSHIL	-0.03	-0.03	-0.34	0.73
MSIZP	-0.07	-0.08	-0.88	0.38
MRDTS	<b>0.23</b>	<b>0.21</b>	<b>2.38</b>	<b>0.02</b>
MRSNK	0.11	0.09	1.00	0.32
MRPLC	<b>-0.25</b>	<b>-0.23</b>	<b>-2.59</b>	<b>0.01</b>

Legend: R – coefficient of multiple correlation; R<sup>2</sup> – coefficient of determination;  $\sigma_e$  – standard deviation of the error; F – F-test value;  $\beta$  – standardized regression coefficient; r – linear correlation coefficient of the predictor variable and the criterion; t – t-test value; p – significance level; MRPOL – Backwards obstacle course; MKOSP – Coordination with the stick; MAKUS – Side steps; MBU1O – Standing on a foot along the balance bench with eyes opened; MBU1Z – Standing on a foot along the balance bench with eyes closed; MBU2Z – Standing on the feet along the balance bench with eyes closed; MFISK – Over-arm flip; MFPRR – Bow forward; MFBR – Side steps; MBTAP – Hand tapping; MBTAN – Foot tapping; MBTAZ – Feet tapping against the wall; MESDM – Standing jump; MEBML – Backward medicine ball throw; ME20V – 20m high-start run; MSVIS – Bent arm hang; MSHIL – Backward horizontal hold; MSIZP – Half squat standing; MRDTS – Sit-ups; MRSNK – Knees push-ups; MRPLC – Half squats.

Results of the multiple regression analysis (Table 2) indicated a high level of correlation between the set of predictor variables on motor abilities and criterion variable *Setting from the middle position in volleyball*. Coefficient of multiple regression (R = 0.63) indicated that a significant quantity of variance of the criterion variable could be attributed to the influence of the set of predictor variables.

The statistical significance of defined regression model was confirmed by the results of the F-test (F = 3.86; p = 0.00) leading to a conclusion that defined set of predictor variables on motor abilities enabled a valid estimation of the value of criterion variable *Setting from the middle volleyball position*. Coefficient of determination indicated to values which showed that the criterion variable could be explained by 40 % of variance of the set of predictor variables. The value of standard deviation of the error ( $\sigma_e$  = 0.91), as an indicator for standard deviation of dispersion of the measured results around the regression line, indicated an unsatisfactory level of representativeness of the regression model.

Analysis of partial contribution of specific predictor variables in defining significance of the regression model led to noticing a statistically significant correlation in seven predictor variables, and, listed according to the level of significance, these tests were *20m high-start run* (ME20V), *Standing on the feet along the balance bench with eyes closed* (MBU2Z), *Feet tapping against the wall* (MBTAZ) and *Half squats* (MRPLC) with negative values, and *Hand tapping* (MBTAP), *Sit-ups* (MRDTS) and *Bow forward* (MFPRR) with positive values.

## Discussion and conclusion

Conducted research on 152 fifth grade female pupils from primary schools in Split showed that a significant level of variance of criterion variable *Setting from the middle volleyball position* could be attributed to the influence of the set of predictor variables on manifest motor abilities, while in partial contribution there were seven predictor variables showing significance for defining the regression model. Results indicate the importance of explosive strength and balance for performance of this motor skill in the first place. However, a meaningful interpretation for tests *Feet tapping against the wall* (MBTAZ) and *Half squats* (MRPLC) which showed a negative, but statistically significant correlation with the criteria, in this case can not be logically interpreted, and a more advance research analysis is required in order to obtain the mentioned interpretation.

Analysing the obtained values for contribution of the motor variables in the efficiency of performing motor skill *Setting from the middle volleyball position* indicated the importance of these values for an efficient planning and programming of Physical Education lessons. Also, the results showed the importance of specific motor abilities on a successful performance of this teaching topic, and thus on the necessary information as to which motor abilities should be primarily influenced in order for female pupils to get a better grade in the evaluation process of the teaching topic *Setting from the middle volleyball position*.

From the above mentioned it is clear that the results obtained from this research gave an insight into the structure of the correlation of motor skill *Setting from the middle volleyball position* as a representative of the teaching unit *Games* for fifth grade primary-school female pupils, which represents basics for understanding transformation of efficiency of the mentioned topic for planning and programming, and thus for monitoring and evaluating in Physical Education classes (Vlahović, et al., 2016). Therefore, during the process of selection of the teaching topics for Physical Education, it is necessary to respect the quantitative element of selection which includes motor abilities that are dominant for acquiring a certain motor skill, as well as the qualitative one which includes correlation between most dimensions of the anthropological status of female pupils from the aspect of acquiring a certain motor skill.

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## INFLUENCE OF WORKING CONDITIONS ON MOTOR SKILLS OF ELEMENTARY EDUCATION CHILDREN

Zvonimira Biondić, Mateja Kunješić Sušilović

*University of Zagreb, Faculty of Teacher Education, Croatia*

### Abstract

The aim of this research is to determine if there are differences in motor skills with respect to the material conditions in which students work. The research participants were students of two elementary schools in Zagreb. The surveyed schools differed in material working conditions: school with excellent working conditions (gym hall, requisites, sports equipment, etc.) and school with very poor working conditions (adapted classrooms instead gym hall, lack of exterior surfaces, limited equipment only on balls, mats, etc.). One class from the first, second, third and fourth grade participated in the research (total 8 grades, ie. 152 pupils). The tests of motor skills that were carried out in the study are: hand tapping, standing long jump, sit and reach and steps aside. Basic descriptive parameters were calculated in all variables (arithmetic mean, standard deviation, minimum and maximum score) for both schools and the difference in motor skills with respect to grade shown by the T-test. In most tests in all grades, students with excellent working conditions achieved better results. It can be concluded that material working conditions have an impact on the development of motor skills.

*Key words: speed, flexibility, strength, children*

### Introduction

One of the main goals of physical education is transformation of student's anthropological status. However, to achieve this, the result depends largely on the technical and material conditions in which the teaching takes place. The physical education class has specific needs considering the space, materials and / or conditions required to work with the body in motion (Mota, Torres, Alves, Ferreira, 2017). Some things that affect the quality of teaching performance are precisely inadequate material working conditions and poor space for practice (Vieria, Beuttemuller & Both, 2018). Findak (1999) states that the implementation of physical exercise in inappropriate conditions, with unsuitable equipment, and without the props and resources, it cannot guarantee the successful implementation of the curriculum, thus not achieving the goals and tasks of physical and health deferment educational areas. From the above sentence the material conditions have an impact on the ultimate goal and task of the physical education class. Inadequate space and insufficient equipment interfere with the implementation of all educational content. While it is clear that material conditions are important, we cannot say that the above factor is sufficient "on its own" (Findak, 1999). A key role in understanding, learning and mastering particular movement is played by the teacher. "It depends on the teacher, his knowledge and ability to make use of the available space, equipment and resources" (Findak, 1999, pp 261).

There are major differences in the Republic of Croatia in this area. From schools that have well-equipped large gyms to schools that provide PE classes in the classroom. Moreover, Osborne, Saraiva Belmont, Portal Peixoto, Santos de Azevedo and Paiva de Carvalho Junior (2016) in their research stated that the PE class is devalued, space allocated is undisturbed and treated as a measure of recreation. The role of the classroom teacher is to have a positive impact on the development of the student throughout the physical and health education classes and to monitor the development of his or her anthropological characteristics. Can teachers equally influence the development of students' motor skills if their working conditions limit them? The main objective of this research is to determine the impact of material working conditions on the motor skills of primary education children.

### Methods

A study aimed at examining the impact of working conditions on the motor skills of primary education children was conducted in two primary schools. In both schools where research was conducted, one class from the first, second, third and fourth grade participated. In a school with good working conditions (A1), a total of 72 children participated in the study. In a school with poor working conditions (A2), a total of 80 children were tested.

For the purpose of investigating the impact of material working conditions on the motor skills of primary education children, four tests of motor skills were conducted: hand tapping, standing long jump, sit and reach and steps aside.



Elementary school with excellent working conditions has open and closed facilities where PE is provided. The school with excellent working conditions has not only a suitable working gym but equipment, devices, and means of work that allow for more creative and better-quality teaching.

Elementary school with poor working conditions in Zagreb is a school that does not have adequate material working conditions. The school is 160 years old and has no auditorium for as many years. The school has neither an indoor nor an open facility that would provide quality PE classes. PE has been organized from the very beginning of the school by classrooms.

The Statistica 13 software package was used to analyze the collected data. The basic descriptive parameters were calculated, the arithmetic mean (AS), the lowest value (MIN), the highest value (MAX) and the standard deviation (SD). Finally, a T-test determined whether there was a statistically significant difference between first, second, third, and fourth grade students who practice PE classes in poor or in good material working conditions.

## Results

Table 1. Results of tests of motor skills of elementary school with excellent working conditions (A1) and elementary school with poor working conditions (A2)

Variables	School	AM	MIN	MAX	SD
Hand tapping	A1	24,64	15	32	3,46
	A2	23,44	15	34	4,12
Standing long jump	A1	132,51	80	184	23,04
	A2	110,33	65	163	21,22
Sit and reach	A1	57,48	26	94	15,05
	A2	53,98	28	85	10,97
Steps aside	A1	14,15	10	21	2,25
	A2	16,08	12	40	3,52

Legend: AM-arithmetic mean, MIN- minimum value, MAX-maximum value, SD-standard deviation

Table 1 shows that the values of arithmetic mean in the area of motor skills: explosive strength, flexibility and speed are better in primary school with excellent material working conditions, but table 2 shows whether there are differences by grade.

Table 2. Results of tests of motor skills of students from 1<sup>st</sup> to 4<sup>th</sup> grade

Variables	Grade	A1 (great conditions) AS ± AD	A2 (poor conditions) AS ± AD	P
Hand tapping	1	22,83 ± 1,95	19,77 ± 2,74	0,00*
	2	22,11 ± 2,74	22,58 ± 2,76	0,61
	3	26,84 ± 2,85	24,67 ± 3,58	0,04*
	4	26,76 ± 3,25	27,39 ± 3,15	0,57
Standing long jump	1	121,96 ± 18,27	105,56 ± 15,40	0,00*
	2	119,19 ± 22,10	105,89 ± 22,18	0,99
	3	141,18 ± 20,25	108,56 ± 21,31	0,00*
	4	148,12 ± 18,62	122,89 ± 22,85	0,00*
Sit and reach	1	43,63 ± 10,54	52,08 ± 9,55	0,01*
	2	65,31 ± 10,57	48,11 ± 7,56	0,00*
	3	51,32 ± 7,65	57,59 ± 12,21	0,06
	4	70,75 ± 13,64	58,28 ± 11,48	0,00*
Steps aside	1	13,56 ± 1,29	16,73 ± 2,78	0,00*
	2	15,17 ± 1,95	17,16 ± 5,80	0,17
	3	12,58 ± 1,74	16,29 ± 1,90	0,00*
	4	15,47 ± 2,62	13,89 ± 1,13	0,00*

Table 2 shows that in the first grade, in most tests (hand tapping, steps aside and standing long jump), students who had good working conditions achieved better results, while students from the second school performed better in sit and reach. In second grade there was only one significant difference, in test sit and reach in favor of a school with worse working conditions. In third grade, results were the same as in first grade, but there was no difference in sit and reach. In fourth grade, students with good working conditions were better in standing long jump and sit and reach, while students from school with bad working conditions were better in steps aside.

## Discussion

The topic conducted through this research has not been a common subject of study, but there are many researches that seeks to examine the influence of certain characteristics on motor skill. Good motor skills are very important for developing children social, psychological and physical way (Gallahue & Ozmun, 2002). Material conditions of work are just one of the problems in many sectors including education. It is an aggravating circumstance when material conditions, ie devices, requisites, and workspace, are an integral part without which it is unthinkable to carry out the set topics prescribed by the Curriculum. Prskalo, Ružić and Mašić (2007) on valuation of teachers of 1st and 2nd class concluded that working conditions for the implementation of the organizational forms of work are not the same in the central and regional schools. Poorer material conditions are in regional schools. The school with poor material working conditions in which the research covered by this paper was conducted, is not a regional school, but regardless, the material working conditions do not allow it to carry out all organizational forms of work, or all the mandatory topics of PE classes, qualitatively. According to the research by Prskalo and Babin (2009), the results confirmed that poor material conditions could not enable the involvement of students in various organizational forms of work.

In this study, the most statistically significant differences can be seen in the first grade. In three of four tests of motor skills (hand tapping, steps aside and standing long jump) students with better working conditions have achieved better results. In the first grade, students from a school with worse working conditions achieved a better result in the sit and reach test. Such results of repetitive strength were confirmed in their research by Petrić and Blažević (2008) who conducted research in rural schools which in most cases do not even have a sports hall, let alone good working conditions. The most significant difference in the results can be seen in the standing long jump test, where the results of 1st grade students with poor material working conditions are poor according to orientation values for the whole of Croatia (Findak et al., 1996).

In the second grade, a statistically significant difference was seen only in the test of sit and reach where the students with better working conditions achieved better results.

In third grade, a statistically significant difference was achieved in hand tapping, steps aside and standing long jump. All these tests showed better results for students with better material working conditions. The most significant difference is again evident in the standing long jump test where students with poor material working conditions (by orientation values for the whole of Croatia) achieved a poor result (Findak et al., 1996).

In the fourth grade, a statistically significant difference can be seen in the sit and reach and the standing long jump all in favor of the students of the school with better material conditions, while students with poor conditions were better in step aside. After four years of research, Jurak, Kovač and Strel (2007) have shown that in students who have participated in a physical exercise program, progress has been achieved most in those motor skills that can be significantly improved by exercise. Better progress in coordinating whole-body movements, lifting troops and running 600 m has been confirmed in sports classes. This is also shown by the results of this research in the fourth grade, where students with better material working conditions achieved better results precisely in the sit and reach and in standing long jump. In the research of Šumanović, Rastovski, Tomac, (2008), which examined the motor skills of rural and urban school students, it was confirmed that in motor skills of flexibility, coordination and explosive strength, urban students had better results, while rural students had better results in tests of repetitive and static strength. The results of their research partly coincide with the results of this research, if we consider that most rural schools do not even have a gym hall, so we can say that they have poorer working conditions than most children in urban areas. Thus, students with better working conditions in most classes had better results in flexibility, coordination, and explosive strength.

Material working conditions, although important, are not crucial because the teaching process depends more on the teacher's knowledge and ability to use the available space, props and equipment (Blažević, Benassi & Šterpin, 2020).

## Conclusion

The results of this research proved that students who have better working conditions, in most classes achieved better results in motor skills. However, we cannot claim that this is just because they had better working conditions. On the one hand, it can be concluded that good material working conditions are something that every educational institution should have, while on the other hand, a more important factor than material working conditions is a good teacher who must find good ways to make up for the shortcomings. Material conditions should not be something that inhibits students and teachers in their work, but an additional means of motivation. Each educational institution should be a place that is focused

to the progress of each student and that will meet all methodical principles, and according to this research, primarily the principle of health and individuality.

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## EXPLORING STUDENTS' PREVIOUS EXPERIENCES AND EXPECTATIONS ABOUT PHYSICAL EDUCATION AT THE UNIVERSITY

Romana Caput-Jogunica, Sanja Ćurković

University of Zagreb, Faculty of Agriculture, Croatia

### Abstract

Within the framework of Physical Education (PE), we conducted an experimental study on the sample of 168 first-year students at the Faculty of Agriculture with the aim of knowing the experiences of first-year students in PE in their previous education, as well as investigating their expectations and interest in sports activity. The study was conducted through an anonymous questionnaire at the beginning of the winter semester 2019/2020 ac. year. The data was analyzed using SAS 9.4. The analysis confirmed the data from previous studies conducted on the sample of students in the Faculty of Agriculture (2008; 2017), where the majority of students, especially females, participated only in PE classes (2019/2020: 45.83%), the studies emphasized the PE role in the university. Previous experience in PE classes was rated as: very good and good by the majority of first-year students. The quality of PE was determined by the PE organization and implementation of different types of teaching methods and motor tasks. Conclusion: except for cycling, all the sport activities preferred by the freshmen have already been implemented in the PE curriculum, which is a good start to meet their expectations.

*Key words: freshmen, experience, expectations, Physical Education*

### Introduction

The aim of Physical Education (PE) at the University of Zagreb is to learn theoretical and practical knowledge from certain sports activities, depending on the interest of the students, with the aim of stimulating exercises in their free time. Each of the faculties at the University of Zagreb has autonomy in deciding on the organization of PE and its evaluation by ECTS. Only 3 out of 34 faculties that have obligatory PE at the University have assessed PE from 0.5 to 1 ECTS per semester. The factor that influenced the decision of the University of Zagreb to make PE compulsory was the results of the analysis on students' participation in physical activity (PA) conducted in the academic year 2000/2001. According to the data, 80% of students participated only in PE classes. Another factor that influenced the decision was the concern about students' health caused by insufficient physical activity (higher percentage of overweight students, students with hypertension and with diagnosed chronic diseases and musculoskeletal diseases) (Caput et al, 2008).

According to epidemiological studies of PA participation in the sample of children and adolescents, it was found that PA during childhood and adolescence has a significant impact on PA later in life, as well as indirectly on the overall health status of an individual. A significant PA decline was found according to educational level: less active university students compared to students in secondary schools (Grunbaum, 2002, Stone et al, 2002), as well as PA decline of MS university students compared to BS students (Ćurković, 2010, Pedišić, 2011). The role of PE in the promotion of PA has been confirmed in many studies, especially in the study aimed at determining students' attitudes towards PE in primary schools (Tomac et al., 2013), as well as in Croatian secondary schools (Bratanić & Maršić, 2004., Markuš & Vukmir, 2012). Male students had more sympathy and positive attitude towards PE than female students in Croatian primary and secondary schools. Older students in secondary schools had less sympathy for PE than younger ones. Markuš & Vukmir (2012) found that students in secondary schools like to be active in sports, but they do not like exercise in PE classes because of the prescribed activities they have to do according to the PE curriculum. Unlike secondary schools, students in the PE curriculum at the University of Zagreb have the opportunity to choose sports activities at the beginning of each semester. The aim of this study was to determine the experiences of first-year students on PE before joining the faculty. Sub-objectives are to determine: 1. differences in the experience of first-year students in relation to the type of secondary schools; 2. current involvement in sports or recreation and differences according to gender; 3. the opinion of first-year students about the quality of PE in previous education; and 4. their expectations from PE in the faculty.

## Methods

This experimental study was part of the action of the Department of Physical Education in the Faculty of Agriculture. It was conducted as part of PE (freshmen) at the beginning of the winter semester 2019/2020. The study involved a total of 168 (67.2%) first year students of the faculty (122 female and 46 male students) who completed the anonymous questionnaire. The questionnaire consists of eight different types of questions: two nominal qualifications: type of secondary schools and gender, two questions with offered answers (current involvement in sports and assessment of PE in previous education). Opinion in relation to the organization of PE is estimated by seven variables on a four-point scale: 'definitely not', 'mostly not', 'mostly yes' and 'completely yes', while the quality of PE was estimated by Linkert's five-point scale: 'never', 'rarely', 'sometimes', 'often' and 'always'. The last two questions were open-ended for freshmen's opinions regarding their expectations of faculty and suggestions for their preferred athletic activities. Data were analyzed using SAS 9.4. Statistical techniques included frequencies and percentages. The chi-square test and Fisher's test (for examples where cells have an expected count of less than 5) were used to determine the differences between the variables analyzed. In all statistical analyses, significance (p-value 0.05) was considered statistically significant.

## Results and discussion

Out of a total of 250 first year students, 168 students: 88 students (66 female and 22 male students from gymnasiums, 74 students (51 female and 23 male students) from vocational high schools and 6 students (5 female and 1 male student) from art schools. Majority of the students 77 (45.83%), except PE, did not regularly participate in any recreational exercises. 44 (26.9%) freshmen are active in sports but did not participate in competitions, 39 (23.21%) exercise 2-3 times per week. Only 6 freshmen are active athletes, while 2 (1.19%) freshmen have serious health problems and do not participate in sports.

Table 1. Relative frequency (%) about previous experience in PE (n=168)

Choose the option that prescribed your opinion	Definitely not	Mostly Not	Mostly Yes	Completely Yes	total
I like PE	2,38	22,62	<b>54,17</b>	20,83	100
I am satisfied with the PE organization in elementary schools	8,93	20,83	<b>51,79</b>	18,45	100
I am satisfied with the PE organization in secondary schools	7,14	25,60	<b>47,02</b>	20,24	100
PE was very interesting in secondary school	4,76	30,95	<b>46,43</b>	17,86	100
I have successfully done all task on the PE classes	1,20	3,57	<b>58,93</b>	36,31	100
PE teacher has motivated me to exercise in free time	19,05	29,17	<b>37,50</b>	14,29	100
I was member of sports school association and I participated in schools' sport competition	<b>70,24</b>	11,31	10,71	7,74	100

Majority of the freshmen (51.79% in primary and 47.2% in secondary) had positive experiences and were satisfied PE during their previous education. The curriculum PE was adapted to their abilities: 58.93% of the freshmen learned most of the motor tasks and 36.31% learned all of them. 70.24% of the freshmen were not members of the school athletic club, which contributed to the data from Croatian School Sports Association. In its program and activities, 120,000 (24.90%) students participated out of all 481,760 in the Republic of Croatia (Croatian Central Bureau of Statistics, 2017).

Table 2. Relative frequency (%) about quality of PE in previous education (n=168)

Choose the option that describe your answer	never	rarely	sometimes	often	always	total
In previous education the PE was well organized	1,19	16,07	<b>36,90</b>	<b>33,93</b>	11,90	100
PE professors have used different methods in their work	7,14	14,88	22,62	<b>41,67</b>	13,69	100
Exercises in PE classes were varied	2,38	13,10	25,00	<b>34,52</b>	25,00	100
PE professor has explained and demonstrated motor task in classes	1,79	12,50	20,83	23,21	<b>41,67</b>	<b>100</b>
PE professor has motivated students to take part in extracurricular sport activities	8,93	21,43	<b>30,95</b>	28,57	10,12	100

The analysis of the answers related to the quality of PE showed that the majority of the freshmen "often" (33.93 - 41.67%) participated in PE classes with different methods and different motor tasks and where PE professors explained and demonstrated motor tasks (41.67%). The data presented in Tables: 1 and 2 are consistent with the final evaluation of freshmen PE in the previous education: 44.05% has evaluated with rating: very good (4); 32.14% as good (3) and 16.7%

with grade: excellent (5).

Table 3. Frequency, relative frequency (%) and results of Fisher exact test related to engagement in sport according to type of secondary school

Type of school/engagement in PA	gymnasium	vocational	art	total	
Student – athlete	3 (3,41%)	3 (4,05%)	0	6 (3,57)	$\chi^2=4,8059$ df=8 p=0,6894 Fisher's test
Former athlete still active on recreational level (<3x per week)	21 (23,86%)	23 (31,08%)	0	44 (26,19)	
Recreational activity 2-3 time per week	19 (21,59%)	18 (24,32%)	2 (33,33%)	39 (23,21)	
Only in PE classes	<b>44 (50,00%)</b>	<b>29 (39,19%)</b>	4 (66,67%)	<b>77 (45,83)</b>	
Health problem - no engagement	1 (1,14%)	1 (1,35%)	0	2 (1,19)	
<b>Ukupno</b>	<b>88 (52,38)</b>	<b>74 (44,05)</b>	<b>6 (3,57)</b>	<b>168 (100)</b>	

The results of this experimental study contribute to previous studies in which the majority of students participated only in PE (45.83%). No significant statistical differences in terms of involvement in sports and type of secondary school.

Table 4. Frequency, relative frequency (%) and results of Fisher exact test about current engagement in sport according to gender

Engagement in sport	female	male	total	
Student athletes	5 (4,10%)	1 (2,17%)	6 (3,57%)	$\chi^2=23,2897$ df=4 p=0,0001 Fisher's test
Former athletes – recreational level (<3x per week)	20 (16,39%)	<b>24 (52,17%)</b>	44 (26,19%)	
Recreational level 2x3x per week	33 (27,05%)	6 (13,04%)	39 (23,21%)	
Only in PE classes	<b>63 (51,64%)</b>	14 (30,43%)	<b>77 (45,83%)</b>	
Health problem - no engagement	1 (0,82%)	1 (2,17%)	2 (1,19%)	
<b>Ukupno</b>	<b>122(72,62%)</b>	<b>46 (27,38%)</b>	<b>168 (100%)</b>	

Regarding gender and differences in current engagement in PA, we confirmed the results of previous studies on the sample of students of the Faculty of Agriculture (Ćurković et al, 2008; Pažanin, 2017), where male first-year students are more active than female (Table 4). PA of the majority of female first-year students (63, 51.64%) is only participation in PE classes. In the sample, most freshmen are former athletes who have maintained their habits of being active and they continue to be active recreationally, with a frequency of more than 3 times per week.

Table 5. Frequency, relative frequency (%) and results of Fisher exact test related to PE assessment about PE quality and type of school

Type of school/PE quality assessment	gymnasium	vocational	art	Total	
unsatisfactory	1 (1,14)	1 (1,35)	-	2 (1,19)	$\chi^2=3,8328$ df=8 p=0,8153 Fisher's test
satisfactory	7 (7,95)	4 (5,41)	-	11 (6,55)	
well	31 (35,23)	21 (28,38)	2 (33,33)	54 (31,14)	
very well	<b>33 (37,50)</b>	<b>38 (51,35)</b>	<b>3 (50,00)</b>	74 (44,05)	
excellent	16 (18,18)	10 (13,51)	1(16,67)	27 (16,07)	
Total	<b>88 (52,38)</b>	<b>74 (44,05)</b>	<b>6 (3,57)</b>	<b>168 (100)</b>	

Differences in first-grade PA scores by school type are not confirmed. PE in secondary schools, the majority of freshmen rated very good (37.50 - 51.35%) rather than good (28.38 - 35.23%). We have no significant statistical differences between the variables: evaluation of the quality of PE and type of school. Using the data in Table 6 (commonality, Kaiser's Measure of Sampling Adequacy (MSA) and SMC), we can conclude that two variables most determine the quality of PE in previous education: PE organization (0.67) and student evaluation (0.63), which is also confirmed by the extrapolation of the first factor (Table 7).



Table 6. Community ( $h^2$ ), Kaiser's Measure of Sampling Adequacy (MSA) and determination coefficient (SMC) for quality of PE

Quality of PE	$h^2$	MSA	SMC
Quality of PE organisation	<b>0,67</b>	0,81	<b>0,63</b>
Implementation of different type of teaching methods	0,48	<b>0,88</b>	0,44
Implementation of different type of motor tasks	0,45	<b>0,85</b>	0,43
Explanation and demonstration of motor tasks	0,52	<b>0,89</b>	0,46
Encourage for participation in extracurricular sport activities	0,38	<b>0,92</b>	0,34
Evaluation of PE classes in previous education	<b>0,63</b>	0,80	<b>0,61</b>
Kaiser's Measure of Sampling Adequacy: overall MSA		0,85	

Table 7. PE quality variables' proportion of variance explained by first factor (F1)

Variables	F1
PE organisation	,81
Evaluation of PE quality in previous education	,79
Explanation and demonstration of motor tasks	,71
Implementation of different teaching methods in PE	,68
Implementation of different motor tasks	,67
Encourage for participation in extracurricular sport activities	,61
Eigenvalues	3,124

The last two questions were open for freshmen to comment on their expectations and preferred sports activities. The most common expectations of freshmen were "better organization than in previous education" (16x); "acquire new knowledge and motor skills" (7x); "encourage more participation in PA" (6x); "PE classes adapted to students' abilities and knowledge" (4x); "PE attractive and useful" (5x) and "better understanding between professors and students" (3x). The majority of students expressed interest in participating in some of the following outdoor activities (running, walking, climbing, and cycling), then in various group fitness programs and sports games. Apart from these, PE curriculum in the Faculty of Agriculture should include the following: badminton, dance, table tennis and tennis. All the above activities have already been implemented in the PE curriculum since the academic year 2000/2001 except cycling.

## Conclusion

Physical education at the University of Zagreb is a unique subject that promotes students PA and the importance of taking care of their health. According to the results of PA studies conducted at the Faculty of Agriculture in Zagreb, the PE has an important role for the majority of students who have not adopted habits of regular participation in some sports: Ćurković et al (2008) found in the sample of 382 students that 78% of female and 53.12% of male students did not participate in sports activities in their free time, and almost ten years later Pažanin (2017) found the same in the sample of 368 students, where 40.21% participated only in PE. In addition to these data, we would like to point out the role and importance of quality PE (QPE) at university level through the data of studies that indicate a significant decrease of PA in the age group of 18-24 years old (Jeffrey, 2010; Gomez-Lopez, 2010); a critical point for the decrease of PA rates seems to be when young people transition from high school (adolescence) to university (young adults) (Bray, 2007, Ćurković, 2010; Kwan and Faulkner, 2011). Considering that "QPE is the foundation for lifelong engagement in PA and sports" (UNESCO, 2015), we conducted the experimental study with the aim of determining the experiences of first-year students in PE before joining the faculty in the 2019/2020 academic year and their expectations regarding PE in the faculty, as well as their preferences for some sports activities. The analysis of freshmen's previous experiences in PE and their expectations require the PE professors and faculty administration to ensure and provide a high quality PE curriculum that meets the students' interests, skills, and knowledge and fulfils their expectations. To encourage as many students as possible to be active in their free time, more effort should be made to make them aware of the importance of regular PA and the impact on their health and academic success.

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## THE EFFECTS OF TAEKWONDO PHYSICAL EDUCATION COURSE ON MUSCULOSKELETAL FITNESS OF MALE UNIVERSITY STUDENTS: A CONTROLLED STUDY

**Jun Choi Hong, Mohammed Hamdan Hashem Mohammed**

*King Fahd University of Petroleum & Minerals, Saudi Arabia*

### Purpose

Martial arts has been recommended as an exciting sport for Physical Education (PE) curricula (Winkle & Ozmun, 2003). This study aimed to determine if Taekwondo in a PE setting could improve the musculoskeletal fitness of university students.

### Methods

Thirty-nine students enrolled in the Taekwondo course. The duration of the course was eight weeks, twice a week with 50 minutes per session. The course included training for muscular fitness, flexibility, explosive strength, and cardiovascular fitness. The course also included sparring matches and sport-specific training. The following musculoskeletal fitness parameters were measured before and after eight weeks: muscular endurance using 60 seconds curl-up test, trunk flexibility using the sit-and-reach test, and explosive leg strength using the standing long jump test. Parametric tests were used to compare the students to a control group (N=32) to detect any effect of the course on the students. Differences with  $p \leq 0.05$  and Vargha-Delaney effect size (VD)  $\leq 42\%$  or  $\geq 58\%$  were considered evidence for any improvements in these fitness parameters.

### Results

All of the tested parameters improved except muscular flexibility, while those of the control group dropped ( $p \leq 0.05$  and  $VD \leq 42\%$  or  $\geq 58\%$ ). The improvements in these parameters of the Taekwondo students differed significantly from the decline experienced by the control group ( $p \leq 0.05$  and  $VD \leq 42\%$  or  $\geq 58\%$ ).

### Conclusions

Eight weeks of Taekwondo in a PE context improved the musculoskeletal fitness of male university students. Taekwondo is not only an exciting addition to a PE curriculum, but can be used to improve musculoskeletal fitness in a PE context.

*Key words: Taekwondo; health-related fitness; physical education; university*

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## ADOPTION OF MAJORETTE DANCE STRUCTURES IN PRESCHOOL CHILDREN

Josip Cvenić<sup>1</sup>, Iva Macan<sup>1</sup>, Magdalena Šipušić<sup>2</sup>

<sup>1</sup>University of Osijek J.J. Strossmayer, Faculty of Kinesiology, Croatia

<sup>2</sup>Kindergarten «Čarobna šuma», Križevci, Croatia

### Abstract

The main goal of the conducted research is the importance of kinesiological activity of a child at an early stage of development that can influence the development of basic biotic motor skills for manipulation of objects through the performance of dance majorette structures. The development of these skills is most intense in childhood, so it is recommended to use such activities as often as possible in working with children. Through the work, all the benefits of dance for the child, family, but also the whole environment and community are described. Majorette is a social dance with special elements and steps in which props such as batons and pom poms are used. Each majorette team is recognizable for their special uniforms consisting of a hat, jacket, skirt and boots. It is often said that they are „only living souvenir of the city“ because of their uniqueness and beauty. The basic aim of the study was to determine are there statistically significant differences from initial to final measurements in simple tests of motor skills in majorette dance, performed by children of younger preschool age. The research was conducted in the kindergarten “Križevci” on a sample of 15 children (9 girls and 6 boys) aged 3.8 to 4.5 years. Two examiners evaluated the five basic elements of the majorette dance at the beginning and end of the six-day dance program, children were rated with grades from one to five. A t-test for dependent samples was used to determine the difference. The results show that after a six-day of majorette program, there were statistically significant differences in the performance of majorette elements in all five tests ( $p < 0.00$ ).

*Key words: majorette sport, dance choreography, preschool children*

### Introduction

Majorette sport has a long tradition in Europe since the 18th century when the first majorettes led the movements of the orchestra with batons as a replacement for the conductor. The majorette appeared in Croatia at the end of the last century, but in a very short time Croatian majorettes became one of the most successful teams in Europe. It is not only a sport and dance, but it is also a symbol and pride of every Croatian city. Children can start training in preschool from the age of 4 to 7, which certainly has a positive effect on the child's proper growth and development. The long-standing stereotype that only girls can train, is slowly changing by the Association of Majorettes and Pom pom Teams of Croatia, which has been including boys for many years. Dancing has a very stimulating effect on preschool children and has a positive effect on the development of a sense of beauty and harmony of movement and proper posture (Findak and Delija, 2001). A new curriculum was introduced in Australia in 1998, according to which dance, music, drama, visual arts and media culture are an integral part of the art education field. According to Cvjetičanin and Kurjan (2002) project of education and theater has been launched in Greece with the aim of including drama education in the educational system. Music in children evokes positive emotions and cheerful mood, performing various movements with music contributes to the development of coordination. Dance has influence on national, social, aesthetic and health education. Dance provides regular physical activity necessary for the proper growth and development of the organism, and it has great influence on the development of anthropological characteristics. The educator is crucial in the appropriate selection of content and their integration with other contents of the preschool program. It is easy to encourage children to participate because the dance structures include a pleasant atmosphere, music, movement and dynamics that interest and delight children. Dance begins with learning and improving the structures of basic movements, after which it is necessary to process and improve musical expression. Steps express the values of notes, and hand movements express accentuated and unaccentuated parts of the beat. (Šumanović et al., 2005). Therefore, the aim of this research was to determine whether there is progress in the adoption of a proper motor structure from majorette dance, after a six-day program in which preschool children practiced majorette choreography.

## Methods

### Participants

The sample consisted of 15 participants (3.8-4.5 years old). The participants were children of the kindergarten “Križevci” in Križevci. They were tested between March 1<sup>th</sup> and 8<sup>th</sup>, 2019. Measurement of these participants was conducted over a period of 6 days, 15 children participated (6 boys and 9 girls).

### Sample of variables

For early and preschool children, motor achievements are usually based on biotic motor knowledge. For the estimation of motor achievements it can be used various batteries of tests which including elements in the domain of mastering of space, obstacles, resistance and handling of objects (Petrić, 2019). The most usual elements of biotic motor knowledge are crawling, walking, running, jumping, crawling through, climbing, pushing, lifting, carrying, catching, throwing and leading (Petrić, 2019). In this study tests aims to estimate motor achievement in the domain of mastering the manipulation of objects, i.e. catching and throwing. The sample of variables was conducted of five tests composed of the basic structures of majorette dance for preschool children, three tests were performed with a majorette baton and two with a pom-pom:

1. Throwing pom pom with the right hand and catching with the right hand,
2. Throwing pom pom with the left hand and catching with the left hand,
3. Throwing pom pom with the right hand and catching with the right hand with a 360° orbit,
4. Throwing the baton with the right hand and catching with the right hand,
5. Throwing the baton with the left hand and catching with the left hand

The initial testing was performed on the first day, while the final testing was performed on the sixth day. Scoring of each test was performed in such a way that each subject performed a test in 5 repetitions, and as a result the number of successfully performed attempts was entered. Between the initial and final testing, dance choreography of seven steps was performed every day. Each class consisted of 10 repetitions of dance choreography in duration of 20 minutes. The choreography was performed on the Pikachu song, and it consists of the following elements:

1. March with pom poms, hands on chest
2. March with pom poms, arm overhead
3. March with pom poms, arms on side
4. March with pom poms, arms on side, 360° orbit
5. March with pom poms, hands on chest
6. Kneel on right leg
7. Squat jump with forehead circle with arms

### Data analyses

The data obtained were analyzed by standard statistical methods package Statistica (ver.13.0). The first step in data processing was to determine the basic statistical parameters and distribution of variables. All data were presented using arithmetic mean (AM), standard deviation (SD), minimal (MIN) and maximal (MAX) results, kurtosis (KURT) and skewness (SKEW). Normality of distribution was tested with the use of the Kolmogorov-Smirnov test. Statistically significant differences between initial and final measurements of motor skills majorette dance measurements was calculated used T-test for dependent samples and p-level ( $p < .00$ ).

## Results and discussion

In the obtained test results from Figure 1, evident progress can be observed after six days of practicing dance choreography of majorette dance. Children achieved better average results in the final measurement compared to the initial measurement in all tests. In some results in tests where children initially had no successful attempts (0), and in just one week in the same test they recorded the result of 4 successful attempts.

The most significant progress was in the test throwing pom poms with the left hand and catching with the left hand (LHPP), and it can be seen in the final test result (2.87), difference between initial and final measurement was 1.80. If we look at the initial values in all measured tests, it can be seen that the average results are around 1.00. In the final measurement, all tests achieved average values greater than 2.20, which confirms that this dance program has improved biotic knowledge by manipulating objects, in this case a pom-pom and a majorette baton. Unexpectedly, the best result was achieved by the boy M.Ž with a total of 17 points out of a possible 25 in the final measurement, while the two girls have same score with a maximum of 14 points.

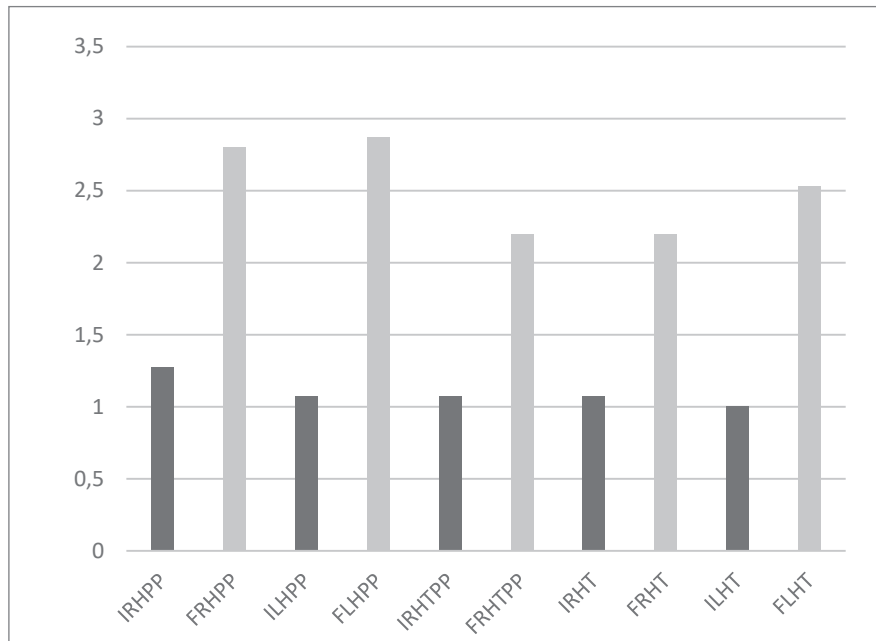


Figure 1. Results of initial and final measurement in variables: IRHPP - Initial throwing of pom poms in the air with the right hand and catching, FRHPP - Final throwing of pom poms in the air with the right hand and catching, ILHPP - Initial throwing of pom poms in the air with the left hand and catching, FLHPP - Final throwing of pom poms in the air with the left hand and catching, IRHTPP- Initial throwing of pom poms in the air with the right hand and catching with 360° twist, FRHTPP - Final throwing of pom poms in the air with the right hand and catching with 360° twist, IRHT - Initial throwing the baton with the right hand and catching with the right hand, FRHT - Final throwing the baton with the right hand and catching with the right hand, ILHT - Initial throwing the baton with the left hand and catching with the left hand, FLHT - Final throwing the baton with the right hand and catching with the right hand.

Table 2 shows the descriptive data of the test. It can be observed that the participants caught the majorette baton better with their left hand (2,53), than with their right hand (2,20), which is surprising because most of them are right-handed. However, the differences are not large, so the ability to perform good motor skills on the left and right side of the body can be a good representative factor of successful performance in aesthetic sports (Miletić et al., 2009). The opinion that left-handers are more successful athletes in many sports due to innate neurophysiologic advantage and tactical and strategic aspects in team sports is supported in sports circles and also by scientific research (Cavill et al., 2003; Barenett and Corballis, 2002). Left-handers are more successful athletes in a number of sports because of their innate neurophysiologic advantage and tactical and strategic aspects in team sports (Miletić et al., 2004.) Furthermore, from the results it can be concluded that it is more difficult for children to master throwing pom-pom with the right hand with a turn (2.20) than just throwing with the right hand without a turn (2.80). This is to be expected, considering that performing a motor task with a turn requires a higher level of motor skills, primarily coordination. The best results in final measurement are 4 successfully performed attempts, and there were no tests with maximum number of attempts recorded. If initial measurements are observed in all tests, then it can be observed that there were children who could not make any successful attempts at the beginning of the program.

Table 2. Basic descriptive statistic and t-test for all variables in initial and final measurement

	Valid N	M	Min	Max	SD	Skew	Kurt	max D	t	df	p
IRHPP	15	1,27	0	3	1,03	0,28	-0,92	0,20			
FRHPP	15	2,80	2	4	0,77	0,38	-1,12	0,25	-5,28	14	0,00*
ILHPP	15	1,07	0	3	0,96	0,41	-0,75	0,20			
FLHPP	15	2,87	2	4	0,74	0,23	-0,97	0,24	-6,87	14	0,00*
IRHTPP	15	1,07	0	2	0,80	-0,13	-1,35	0,21			
FRHTPP	15	2,20	1	4	0,94	0,14	-0,85	0,20	-4,79	14	0,00*
IRHT	15	1,07	0	2	0,80	-0,13	-1,35	0,21			
FRHT	15	2,20	0	4	1,01	-0,46	0,40	0,22	-3,70	14	0,00*
ILHT	15	1,00	0	2	0,93	0,00	-1,97	0,26			
FLHT	15	2,53	1	4	1,06	-0,10	-1,07	0,20	-4,56	14	0,00*

Legend: Valid N - number of entities, M - arithmetic mean, Min - minimal result, Max - maximal result, SD - standard deviation, Skew - skewness, Kurt - kurtosis, max D - Kolmogorov-Smirnov test, t-test, df-degrees of freedom, p - level of significance, \* - statistically significant difference



From Table 2. based on the obtained values, it is evident that throwing a baton was harder for children to adopt than throwing pom poms. The result was expected, since the pom poms are larger and less weight to fly, so it is easier to catch them, while throwing the majorette baton requires better precision, due to the structure of the baton. At the end of the analysis, it can be concluded that there is a statistically significant difference in all tests between the initial and final measurement ( $p = 0.00$ ). In just six days of practicing dance choreography from a majorette dance, the children improved their manipulative skills of handling pom poms and majorette batons, which was confirmed in the better performance of all motor tests. The limitation of this study are lack of control group and the small amount of similar researches which these results could be compared with, as well, the lack of research on the younger preschool population in this specific dance area.

## Conclusion

Kindergarten kinesiological activities are carried out daily in order to improve the child's health and proper growth and development. More dance structures that have a positive effect on the improvement of large biotic motor skills should be introduced into the curriculum of physical education and health in preschool age. Dance is a social phenomenon and every human being has a need to dance, which is why children enjoy dance structures. A dance structure affects the child's relaxation and reduction of tension, the development of motor skills, proper posture, encourages musical expression and most importantly develops teamwork child-child and educator-child. Majorette dance consists of complex dance structures and therefore it is not easy to perform them in kindergartens. However, because of their uniqueness, uniforms, batons and pom poms, they are interesting to children and easily accepted. In their curriculum, each educator can use at least the basic elements of majorette dance presented in this paper. The aim of this study was to examine the level of adoption of basic majorette dance structures and choreography in preschool children which last six days. Using a t-test for dependent samples, the study discovered a statistically significant improvement in a sample of 15 children aged 4 years in all tests designed to assess the majorette dance structure.

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## ABSOLUTE AND RELATIVE RELIABILITY OF THE MODIFIED SHUTTLE RUN TEST IN YOUTH FEMALE VOLLEYBALL PLAYERS

Karla Đolo<sup>1,2</sup>, Zoran Grgantov<sup>1</sup>

<sup>1</sup>University of Split, Faculty of Kinesiology, Croatia

<sup>2</sup>University of Mostar, The Faculty of Science and Education, Bosnia and Herzegovina

### Abstract

The aim of this study was to determine the absolute and relative reliability of the modified Shuttle run test for assessing reactive agility in youth female volleyball players. A sample of 32 volleyball players was recruited from 3 volleyball clubs in Herzegovina. Participants were aged  $11.23 \pm 0.67$  years and had practiced volleyball between 6 to 48 months. The test-retest reliability of the test was high ( $ICC=0.91$ ), with no detecting changes in the test-retest analysis ( $p=0.75$ ) using a *t*-test. Besides, the standard error of measurement was minimal ( $SEM=0.01$ ) as well as the smallest detectable change ( $SDC=0.02$ ). ANOVA showed no significant changes between items ( $p=0.16$ ). To test the absolute reliability of the test, the agreement between repeated measurements (test-retest) was quantified using the 95% limit of agreement ( $95\%LoA=0.047 \pm 0.042$ ). These results indicate that the Modified Shuttle run test is a reliable test to assess reactive agility in youth female volleyball players.

**Key words:** Reactive agility, test-retest reliability, standard error of measurement, smallest detectable change, intraclass correlation

### Introduction

Agility is the ability to change the direction and/or speed of movement efficiently (Sekulić et al., 2007). In many sports games, athletes should acquire a high level of agility (Bloomfield et al., 2007), because the majority of the sports, such as volleyball, require athletes to move efficiently and quickly while changing speed and movement direction. Agility as a coordination ability is especially important in the initial stage of the development of the sport (Raczek et al., 1989). Although agility is viewed separately from coordination abilities, it is well integrated with other coordination abilities (Sekulić et al., 2007). Therefore, it helps in faster learning and achieving a high-performance level (Sadri, 1993). Recent studies relate elite and sub-elite athletes with the level of agility they possess (Brughelli et al., 2008). During volleyball matches, players are involved in diverse situations such as defensive and offensive activities where power, strength, agility, and speed are required and are related to each other (Sekulić et al., 2013).

Most agility tests are based on the change of direction (speed), (COD/S) such as T-test, Illinois Agility test, L-run test, Zig-zag test (Haj-Sassi et al., 2011; Šimonek et al., 2017; Polman et al., 2004; Little et al., 2005). Some of these tests are not specific to volleyball because they cover much larger space and distance which players don't use during the match (Gabbett et al., 2007). To demonstrate a need for a more specific agility test for volleyball players Šimonek (2006) constructed the most suitable Shuttle run test since his test structure obtains pre-planned (athletes know changes in direction of movement) and reactive agility component (athletes direction is determined by reacting on acoustic stimuli).

In volleyball, the balls are sent from the opponents' field so the movements in our field (field defense or serve reception) are also mostly performed forward and slantwise forward. Therefore, this study aimed to analyse the reliability of the modified Shuttle run test in which more diagonal forward motions are expressed instead of lateral ones.

### Methods

The samples of 32 youth female volleyball players were recruited from 3 clubs in Herzegovina. Participants were aged  $11.23 \pm 0.67$  years and had practiced volleyball between 6 to 48 months. At the moment of testing, their training regime was 2-3 hours per week. The evaluation of the agility Shuttle run test (Šimonek, 2006) was modified. The test was conducted on an indoor floor surface to control environmental conditions such as temperature, wind, and ground conditions. Children were tested in the afternoon between 1 to 4 pm in two sessions with a 14-day interval between the sessions to assess test-retest reliability. A warm-up was conducted before the testing, which included 10 minutes of jogging and mobility exercises. In the modified version of the Shuttle run test 6 balls are arranged in the following way: one is in the center, and in front of it is standing tested person, the others are arranged behind the tested person in a semicircle,

and they all have a number on them (1-5). All balls are 3m away from the ball in the center (No. 0) and there is a 2.4m long distance between the first and last ball. After each of the measurements was taken, the positions of the balls were changed. The tested person starts from the standing position with his back to the balls. Having called one number out of 5 the tested person runs to the ball with the called number, touches it, and returns to touch the ball No. 0. At the moment of touching the 0 balls, the administrator calls another number of the ball (1 to 5). The same is repeated with the third number of a ball. The test finishes with the touching of the ball in the center after the return from the third ball. There were one preparatory attempt and three measured ones.

All the data were analyzed using SPSS version 24 for Windows statistical program. Descriptive statistics including the mean, standard deviation (SD), and range value were calculated. The reliability of this test between the first and the second measurement was assessed using a two-way mixed-effects Alpha model of intraclass correlation coefficient (ICC). The standard error of measurement (SEM) was also calculated to give an indication of the precision of individual scores over repeated administrations ( $SEM = SD \times \sqrt{1 - ICC}$ ), and the smallest detectable change (SDC) for the interpretation of changes in scores which is outside an error and which is due to a real change in score and not due to the measurement error. To test the absolute reliability of the modified Shuttle run test, the agreement between repeated measurements (test-retest) was quantified using the 95% limit of agreement (LoA) method originally described by Bland and Altman (1986). To investigate systematic bias, a t-test was conducted to test the hypothesis of no difference between the sample mean score for the test versus the sample means score for the retest. Since heteroscedasticity was found in the present data, a logarithmic transformation was applied giving values that can be interpreted concerning the original scale (Nevill and Atkinson, 1997). A repeated measure ANOVA was used to assess systematic bias between tests (Vincent and Weir, 2012).

## Results

To determine the reliability, the results of the mean scores in seconds (s), SD values, and ranges of the Shuttle run test were analyzed (Table 1).

Table 1. Descriptive statistics Shuttle run test

Test	MEAN	SD	MIN	MAX
SR1	8,99	0,91	6,84	10,66
SR2	8,82	0,85	6,68	10,14
SR3	8,84	0,83	7,13	10,64

The sensitivity of the tests was monitored through the Kolmogorov-Smirnov test which shows that the obtained result distribution was not significantly different from normal distribution as  $p$  was not less than 0,05 ( $p > 0,20$ ). The Shuttle run test had  $skw$  0,56 and  $kur$  0,37.

The results of ANOVA showed no statistically significant changes between items of measurements using Greenhouse-Geisser's estimation of sphericity to detect any systematic changes between items under the influence of fatigue, learning, or changes in motivation. Thus, no further analysis with posthoc tests is needed (Table 2).

Table 2. Results of analysis of variance

Test	F	p
SR	1,89	0,16

Mean scores, SD values, and ranges for the Shuttle run test (SR) obtained during the first and second test sessions are presented in Table 3.

Table 3. Descriptive statistics mean scores Shuttle run test (SR)

Test	MEAN	SD	MIN	MAX
SR(1)	0,96	0,04	0,84	1,01
SR(2)	0,94	0,04	0,84	1,02

There were no major differences between test session scores. The test-retest reliability analyses are shown in Table 4.

Table 4. Test-retest reliability of the Shuttle run test(SR), with standard error of measurement (SEM), smallest detectable change (SDC) and t-test

Test	ICC	SEM	SDC	t-value	p
SR	0,91	0,01	0,02	-0,32	0,75

It indicates excellent interrater reliability ICC (alpha) = 0,91 for the modified SR test. The standard error of measurement (SEM) indicates that the measurement error was minimal as well as the smallest detectable change (SDC). T-test was used to detect changes between test and retest, which yielded no significant difference between measurements ( $p_{SR}=0,75$ ). Bland-Altman plot illustrates the difference scores between measurements against the mean score for each subject (Figure 1).

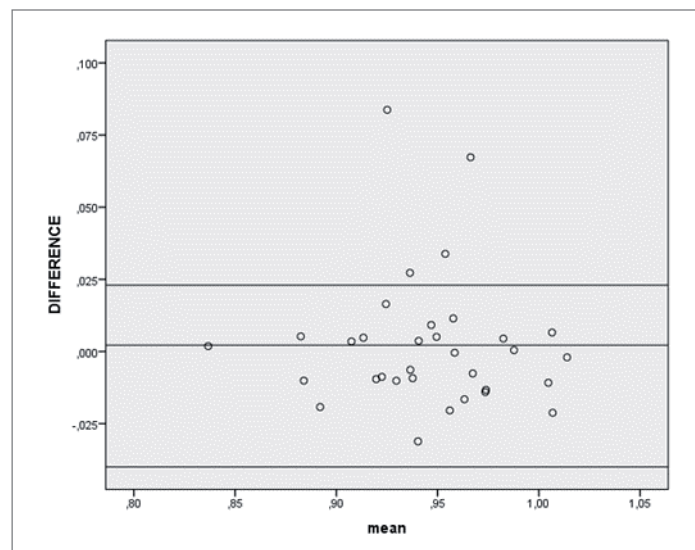


Figure 1. Bland and Altman plots with an upper and lower limit of agreement (LoA) of test-retest of the modified Shuttle run test. Mean-of-test and retest score, difference-between test, and retest score.

The mean difference (bias)±the 95% LoA of the logarithmically transformed data were of 0,047±0,042 seconds.

## Discussion

This study examined and tested the reliability of the modified reactive agility Shuttle run test. There are different categories of agreement of intraclass correlation coefficient with calculation ranging from questionable (0,70 to 0,80) to high (>0,90) explained by Vincent and Weir (2012).

Excellent test-retest reliability was demonstrated after the analysis of the modified Shuttle run test after logarithmic transformations data reducing heteroscedasticity. The reliability was high because the age of 11 years is the highest share showed time parameters estimation (Brodani et al., 2010).

The SEM values, as an estimate of measurement error, are important to establish the usefulness of the test and using SDC so one can determine if a change has occurred in subsequent testing periods (Portney et al., 1992). In these analyses random error was found to be low, resulting in excellent reliability.

To identify the stability reliability of the modified shuttle run test, absolute reliability is evaluated by calculating the 95% LOA (Bland and Altman, 1986). From Figure 1 it can be seen that there is not much change in the difference. The mean difference is near zero and positively biased what means that the values of retest were slightly larger than in the first trial.

As with the t-test, ANOVA is useful for detecting large systematic errors. In this case, repeated measures ANOVA revealed no statistical differences ( $p>0,05$ ) between the test items because factors such as fatigue, learning, changes in motivation probably did not affect the results.

## Conclusion

Modified shuttle run test is reliable and applicable for defining reactive agility which helps athletes not only to orientate but also quickly react to visual or acoustic stimuli in any game situation. Changing directions is very important in team sports because it improves overall performance, prevents injuries and raises performance in offensive and defensive circumstances. This modified Shuttle run test has good metric characteristics and can therefore be used to assess the reactive agility of young volleyball players.

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## SECULAR CHANGES IN MOTOR ABILITIES OF PRESCHOOL CHILDREN FROM CITY OF ZAGREB IN PERIOD FROM 2009-2019

Marijana Hraski, Vatroslav Horvat, Snježana Mraković

University of Zagreb, Faculty of Teacher Education, Croatia

### Abstract

The aim of this study is to establish the secular changes in motor abilities of preschool children from city of Zagreb in period from 2009-2019. The sample consisted of 132 children aged six years. 64 children were measured in 2009, while 68 preschool children were measured 2019. The battery of tests for assessing motor abilities consisted of a polygon backward for assessing coordination (PBW), sit and reach for assessing flexibility (SAR), standing long jump to assess explosive power (SLJ), arm plate tapping to evaluate speed (APT), and standing on one leg to assess balance (SOL). Basic descriptive parameters were calculated for all variables. ANOVA was used to determine differences in motor abilities of the measured groups of participants for a period of ten years. The results of the ANOVA indicate that there is a statistically significant difference in the motor abilities of preschool children according to the year of measurement. The children measured in 2019 in contrast to the children measured in 2009 achieved a statistically better results in the test for the evaluation of coordination, speed of movement and balance. Based on the obtained results it can be concluded that there is a positive secular trend in the development of motor abilities in preschool children from city of Zagreb for the period from 2009 to 2019. The results indicate that environmental awareness was raised about the need for daily physical activity and the involvement of children in organized forms of physical exercise.

*Key words: trends, physical fitness, 6-year-olds, one decade*

### Introduction

Secular changes relate to the development trend of some human characteristics and abilities for a period of one or more decades. Secular trends are a subject of study and are of particular interest in various field such as human biology, auxology, as well in kinesiology (Borms, 2003). Considering the modern way of life, the innovation in technological development and changes of lifestyle in early 21<sup>st</sup> century, a lot of research has been carried out to identify secular trends in the morphological characteristics of children (Zimmermann et al., 2004; Wang and Lobstein, 2006.) The general conclusion of those conducted studies is that today, due to sedentary lifestyles, inactivity and generally poor life habits such as bad diet and lack of movement, there is an increasing percentage of overweight and even obese children which become a global health problem (Christoforidis et al., 2011; Denisova, Scherbakova and Berezovikova, 2019). Correspondingly, the results of studies that monitor motor abilities of children for the period between the end of the 20<sup>th</sup> century and beginning of the 21<sup>st</sup> century, as well shows a negative secular trend (Nishijima, Kokudo and Ohsawa, 2003). The reasons for decline in motor abilities also are attributed to insufficient physical activity of children who spend their free time sedentary in front of screens and not active outside on playgrounds or in organized physical activities (Ignasiak, Sławińska and Malina, 2016). For that cause, over the last 20 years, experts have been largely concerned with identifying negative effects on growth and development that are affected by children's inactivity, and highlighting the unique benefits of movement and physical activity on overall health and development of youth (Onis and Blössner, 2000; Lobstein and Frelut, 2003). Professionals worldwide are trying to make the public aware of the need to bring about changes in society and children's lifestyles (Chin and Edginton, 2014). Accent is placed on motivating and involving children in organized forms of physical activity from an early age and increase number of physical education classes in schools (Dollman, Norton and Norton, 2005). Over the past decades many international conventions were held such as World Summits on Physical Education organized by the International Council of Sport Science and Physical Education, and World Conferences of Ministers and Senior Officials Responsible for Physical Education and Sport held under the auspices of UNESCO. The general consensus was that, in the service of children's health, the quantity and quality of physical education programs must be increased, and the practice of a physically active way of life in arrangement with healthy diet needs to be taking place from an early age (Chin and Edginton, 2014). Based on scientific and professional reports, worldwide projects, strategies and conventions there is evident more and more recent research of secular trends of physical fitness in preschool children who found positive changes and attribute those optimistic results to lifestyle changes and incising in daily physical activity of children (Rethorst, 2003; Roth et al., 2010; Ignasiak et al., 2016; Spengler et al., 2017). According to those findings,



the aim of this study is to establish the secular changes in motor abilities of preschool children from city of Zagreb in period from 2009-2019.

## Methods

The sample of participants in this study consisted of 132 children aged six years (+ -6 months). 64 children were measured in 2009, while in 2019, ten years later, 68 preschool children were measured. Both measurements were carried out in three same kindergartens in the city of Zagreb: DV Potočnica, DV Iskrice and DV Vrbik. Parental approvals were collected for all children who were tested. Measurements were carried out in the same conditions in the morning by the same experts, professors of kinesiology from the Faculty of Teacher Education, University of Zagreb. The battery of tests for assessing motor abilities consisted of a polygon backward for assessing coordination (PBW), sit and reach for assessing flexibility (SAR), standing long jump to assess explosive power (SLJ), arm plate tapping to evaluate speed (APT), and standing on one leg to assess balance (SOL). The data collected were processed with the statistical package Statistica 13. Basic descriptive parameters were calculated for all variables. ANOVA was used to determine differences in motor abilities of the measured groups of participants for a period of ten years.

## Results

The results of the descriptive statistical parameters obtained from the data collected in this study are shown in Table 1. It is evident from the table that the measurement of motor abilities was performed at two time points. The first measurement was carried out in 2009 on a sample of 64 preschool children. The second measurement was carried out ten years later, which means in 2019 on a sample of 68 six-year-old children. An insight into arithmetic means shows that the results in all tests for the assessment of motor abilities of preschool children are better in 2019 compared to the measurement in 2009.

Table 1. Descriptive statistics of motor abilities for preschool children measured in 2009 and 2019

	N 2009	N 2019	AM 2009	AM 2019	SD 2009	SD 2019
PBW	64	68	16,36	14,41	4,94	4,40
SAR	64	68	3,57	4,75	6,19	5,66
SLJ	64	68	90,55	96,01	18,19	19,95
APT	64	68	12,96	16,88	2,11	3,62
SOL	64	68	10,10	14,11	8,51	9,31

Legend: N-number of participants; AM-arithmetic mean; SD-standard deviation

In accordance with the aim of this study, where an attempt was made to determine whether there was a secular trend in the development of motor skills in preschool children for a period of one decade, an ANOVA was conducted. The results of the univariate analysis of variance indicate that there is a statistically significant difference in the motor abilities of preschool children according to the year of measurement (Table 2).

Table 2. Results of ANOVA in motor abilities of preschool children according to year

	Wilks' lambda	F-value	Effect df	Error df	p-level
2009-2019	0,66	12,91	5,00	126,00	0,00*

From the univariate results from individual tests for the assessment of motor abilities of preschool children, it can be seen that in three tests a statistically significant difference was obtained in the measurements taken at intervals of one decade. In table 3. it is showed that the children measured in 2019 in contrast to the children measured in 2009 achieved a statistically better results in the test for the evaluation of coordination (PBW), speed of movement (APT) and balance (SOL).

Table 3. Results of ANOVA in motor abilities of preschool children measured in 2009 and 2019

	Sum of squares	df	Mean square	F-value	p-level
PBW	125,53	1,00	125,53	5,76	0,02*
SAR	45,91	1,00	45,91	1,31	0,25
SLJ	983,82	1,00	983,82	2,69	0,10
APT	506,32	1,00	506,32	56,84	0,00*
SOL	530,63	1,00	530,63	6,66	0,01*

Based on the obtained results, and in accordance with the aim of this research, it can be established that there is a positive secular trend in the development of motor abilities in preschool children from city of Zagreb for the period from 2009 to 2019.

## Discussion

The secular changes in the motor abilities of children have been the subject of research by many authors around the world in recent decades. It has been shown that the motor efficiency is closely related to the level of physical activity (Kambas et al., 2004). Children who are involved in organized forms of physical exercise have better developed motor skills than children who are not physically active (Rethorst, 2003). Based on the scientific and professional reports, a Croatian National Curriculum Framework was adopted 2011, also since 2014 the National Curriculum for Early Childhood and Preschool Education is effective. The basic attention is on encouraging the overall and healthy growth and development of the child (Petrović-Sočo, 2013). Specifically, the curriculum enrich the content of teaching in the field of physical education in regular kindergarten program, and enrich the offer of shorter sport programs. Given the awareness of parents, local community and educational institutions on the need for changing lifestyles and increasing physical activity of children, there is a high percentage of children who participate in organized preschool sport programs in the past decade (Vidić et al., 2018). This study found that there were positive secular changes in the motor abilities of preschool children between 2009 and 2019 in the city of Zagreb. From the results obtained in this research it is evident that in the last ten years, through various national documents, strategies and projects, there has been a significant public awareness of the need for increased daily physical activity of children, and there is evident positive effects of changed lifestyles on child development. Also, the positive trend of performance of today's kindergarten children in several motor tasks with that of children some 20–30 years ago found Roth et al. (2010). In their study the contemporary sample performed equally well or even better than the children tested in 1973 and 1989 in standing long jump and obstacle course, tests for assessing explosive strength and agility. Rethorst (2003) establish a superior balancing performance of 3.5–7-year-old German children assessed in 2000 comparative to children tested 13 years earlier. Eggert et al. (2000) also tested balancing skills in 7-year-old children in 1995 and compared the sample with the one assessed in 1985. The authors did not find a significant decline in balancing skills over the 10-year period. The secular gains in physical fitness of Polish youth 7–15 years of age was considered across two surveys, 2001–2002 and 2010–2011 by Ignasiak et al. (2016). They concluded that physical fitness items changed variably over the decade but positive trends are confirmed. Static strength and agility improved significantly between surveys in all age groups, while explosive power showed negligible changes. Furthermore, Spengler et al. (2017) examine trends in motor performance of first grade students during a period of 10 years (2006–2015). In their study strength remained stable while speed and balance even increased in both sexes. The authors concluded that different lifestyles might be a substantial cause of such positive trends.

## Conclusion

The aim of this study was to establish the secular trends in motor abilities of preschool children from city of Zagreb in period from 2009-2019. The outcomes of provided statistical analyses point to that there is a significant difference in the motor efficiency of 6-year-old children given the year of assessing. The children measured in 2019 in contrast to the children measured in 2009 accomplished a statistically better results in polygon backward for the evaluation of coordination, arm plate taping for assessing speed of movement and standing on one leg for estimate balance. This study found that there were positive secular changes in the motor abilities of preschool children between 2009 and 2019 in the city of Zagreb. The results indicate that in the last ten years, the parents, local community and education institutions are aware about the need and importance for daily physical activity and the involvement of children in organized forms of physical exercise. Also, is it can be concluded that changes in lifestyles and daily life habits effects positive of on child development.

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## DYNAMICS OF LEARNING THE OVERHEAD SERVE IN VOLLEYBALL SCHOOL BY APPLYING THREE DIFFERENT METHODS

Marija Ivanković<sup>1</sup>, Zoran Čuljak<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>University of Mostar, Faculty of Science and Education, Bosnia and Herzegovina

### Abstract

The aim of this study was to determine if there were significant differences between methods of learning the overhead serve in volleyball. Three learning methods (synthetic, analytic, and combined method) were analyzed on a sample of 20 girls, members of the Croatian volleyball club "Smeč", through four phases of learning: initial, transitive, final, and retention. Based on the obtained results, it can be concluded that significant improvement occurred in learning the volleyball skill of overhead serve in all three groups, in which the skill was learned by different methods. Furthermore, the results indicate that there were no significant differences between the subjects regarding the method of learning – it made no difference if the new volleyball motor skill, the overhead serve, was learned by analytic, synthetic, or combined method. Moreover, it should be emphasized that there were some unexpected results in the retention measurement. The result in this point were higher than the results in the final measurement. This actually indicates that the subjects' motor skill progressed even after they had stopped learning it. The reason for this may lie in the fact that the training itself contains movement structures similar to the overhead serve (spike) performed by the subjects.

**Key words:** Motor learning, younger age groups, Student's *t*-test,

### Introduction

Learning is part of everyday life. It is defined as a relatively permanent change in behavior that occurs as a result of exercise or experience (Petz, 2006). Every day we learn many different patterns of behavior and action, and major part of learning certainly includes learning new movement structures and motor reactions. From the kinesiological viewpoint, motor learning implies a permanent change of a person's ability to perform some motor task as a result of exercise or motor experience (Miletić, 2012). In the background of motor learning are the changes related to exercise or experience, which determines a person's ability of performing motor skills (Schmidt & Wrisberg, 2000). Those changes are relatively stable and retained in procedural memory in the part of long-term memory responsible for storing skills, whereas adaptation, changes and upgrading of the existing movement structures is possible only as a result of new experience, exercise and training. Scientific research has shown that it is extremely important to coordinate developmental factors with the process of motor learning, considering only appropriate motor knowledge can be acquired, i.e., become an effective and appropriate kinesiological stimulus (Miletić & Čular, 2004). The same authors state that specific motor skills in the function of sport are increasing in number and the age at which skill acquisition in sports activities starts is lowered constantly. It is emphasized that the most important task of kinesiology is primarily to adjust the process of learning and acquisition of motor information to participants' age, especially because performance of movements is a complex process which requires precise and harmonious operation of numerous muscles, nerves and bones. It is precisely the possibility of adaptation and broad application of what is learned that is usually the aim of motor learning (Kezić, Erceg & Miletić, 2013). On the other hand, specific motor skills are considered a combination of fundamental skills applied in performance of specific sports activity. Studies have shown that successful mastering of fundamental skills is a precondition for successful introduction of specific sports and disciplines, but with exercise as a necessary factor of their development and perfection (Gallahue & Ozmun, 1998). By measuring the advancement in skills, the efficiency of the motor learning process can be verified. Influential theoreticians in the area of motor learning (Adams, 1987; Rudisill & Jekson, 1992; Edwards, 2010; Schmidt, & Wrisberg, 2008) define the existence of models of motor performance curves, which are of particular significance for the scientific approach to studying the phenomenon of motor learning. Motor performance curve is a graphical representation made in a certain time span as a result of frequent measurements of motor performance.

Volleyball is a sport with complex polystructural movements which includes a series of different movements, throws and falls, sprints, static holds, hits, jumps (spike, block, serve, etc.) (Janković, Marelić, 2003). The most complex elements of volleyball game are certainly spike and serve, which are characterized by explosive reaction (timely quick hit on the ball), movement coordination (throwing the ball, hitting the ball), flexibility-movability (shoulders, elbow, wrist). Taking

into account the diversity and complexity of volleyball elements, there are different methods for teaching a new motor task adapted for younger age categories.

The analysis of current status, i.e., measurement of different dimensions of anthropological status, is surely one of the most important elements of transformation procedures in motor learning and sport in general. By regularly monitoring the level of motor skills, it is possible to diagnose, and therefore program, correct and control the motor learning process. Only the results of repeated measurements can be the basis for getting a realistic picture of how successful the transformation process actually is, and then make the necessary corrections in the plan and program (Sattler et al. 2012). Considering the complexity of movement structures in volleyball, objective assessment of motor skills is an important scientific and practical problem.

By reviewing previous studies, it can be noticed that there is an evident deficit of scientific research investigating the methods of assessment and analysis of progress in motor skill learning in volleyball, especially for younger age categories. In reference to this, previous studies that are related to some other sports and sports games, but are closely connected to methods of motor learning, will be mentioned. It is believed that the area of motor learning in younger age categories is a conflicted area (Findak, 1999). This is confirmed by the fact that the synthetic method is more suitable for working with students in lower classes of elementary school, as students at this age observe all phenomena as a whole, with modest ability of analytic thinking. In their study, Tomljenovic et al. (2001) revealed that the subjects in the analytic group had learned new motor tasks more quickly and achieved a better level of skill as they were more thorough and paid more attention to detail, whereas the subjects who had learned new motor tasks by synthetic learning method, performed the task quickly without emphasizing certain parts, and repeated the same performance errors. Factors of conflict in other studies are usually sex, age, and complexity of the motor task being taught.

Considering all of the abovementioned, the main aim of this study is to determine the possible differences in acquisition and retention of the learned volleyball motor skill of overhead serve by applying three different methods of learning (synthetic method, analytic method and combined method) in children of younger school age.

## Methods

The subject sample included 20 girls, members of the Croatian Volleyball club "Smeč" from Široki Brijeg, Bosnia and Herzegovina. Chronological age of participants was  $9.00 \pm 0.9$  years. Children without health problems and motor impairment participated in the study. Before the study, all participants and their parents were asked about their willingness to participate in the study and necessary authorizations were obtained.

For the purposes of this study, a test was created to assess the motor skill *overhead serve* for beginners in volleyball. In doing so, a model was applied assessing errors in motor performance across the phases of performance of the given motor task. The main objective of such assessment is to decompose motor movement into simpler movement structures, which allows simpler assessment of the acquisition level of the task.

The motor task was assessed on a 1-5 scale, with the grades denoting the following: 1-motor task was not or cannot be performed, 2-major errors in performance with recognizable movement structure, 3-major errors in motor task performance, 4-small errors in motor task performance, 5-motor task was performed correctly.

To obtain the most precise information possible, the subjects were divided into three experimental groups: 1. Synthetic group – in which in the learning process the subjects were given information on the overall task performance; 2. Analytic group – in which in the learning process the subjects were given information on how to learn the task from the parts, i.e., they practices all phases of overhead serve separately; 3. Combined group – in which in the learning process the subjects learned the first two phases as a whole, and the other phases separately. The assessment of acquisition level of the motor task was conducted four times in the time period of four months, i.e., three times in the period when the learning itself was done and another additional retention measurement conducted after a one-month period of not practicing. To avoid subjective assessment of a single evaluator, each subject's performance was evaluated by three highly-educated coaches with many years of coaching experience via video recordings.

The performance of the given motor task, i.e., serve, was executed in conditions adapted to children of all age groups. The serve zone was placed behind the 6-m line, and the serve was performed with a 230-250g ball (Mikasa Mva123L, Foam, 230-250 G, Size 5), with the net set at 210cm without volleyball antennas. During all four measurements, the subjects were recorded by video camera (Sony HDR SR10), after which the evaluators independently assessed performance of all subjects. Finally, the data were entered into the Statistica 7 software (StatSoft, Inc.7) and analyzed. Descriptive statistics were used to obtain basic data as all descriptive statistical parameters for synthetic, analytic and combined method in all points of measurement were calculated: arithmetic mean (AM), minimum result (Min), maximum result (Max), standard deviation (SD), and MaxD value for determining significant deviation from normal distribution of variables by Kolmogorov-Smirnov test (KS test). To prove objectivity and degree of agreement between the evaluators in assessing the mutual object of measurement, Cronbach's alpha coefficient ( $C\alpha$ ) and interitem correlation (Iir) were calculated. To determine if there were statistically significant differences (p values) between the points of measurement for each method,



the dependent samples T-test was used. To determine if there were statistically significant differences (p values) between the learning methods in all points of measurement, the independent samples T-test was used.

## Results

Basic descriptive indicators, indicators of objectivity, degree of agreement between evaluators (Cronbach's alpha coefficient ( $C\alpha$ ) and inte-ritem correlation (Ilr) in assessing the mutual object of measurement) are presented in Table 1.

Table 1. Objectivity of expert evaluation of the volleyball motor skill level and sensitivity of results in all points of measurement

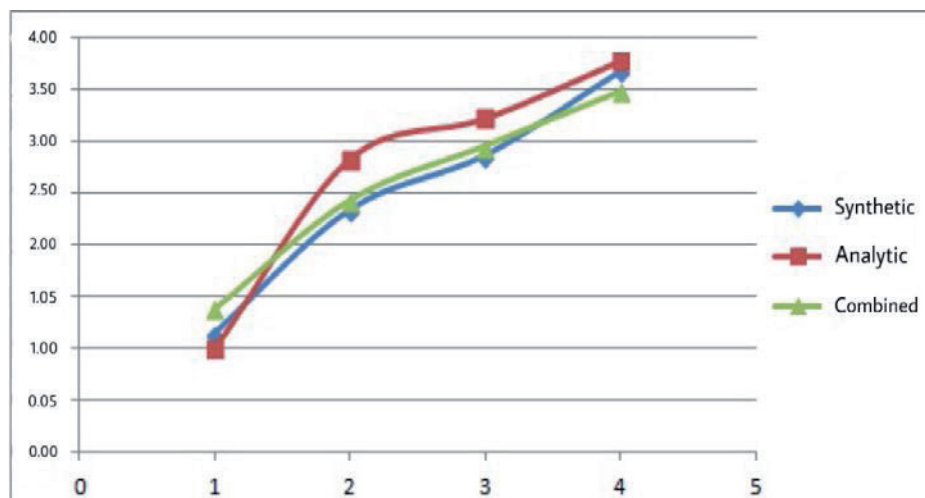
	IN1	IN2	IN3	AM	SD	K-S	Ilr	$C\alpha$
IN1	1.00	1.00	0.84	1.20	0.41			
IN2	1.00	1.00	0.84	1.20	0.41	0.28	0.99	0.96
IN3	0.84	0.84	1.00	1.15	0.37			
	TR1	TR2	TR3	AM	SD	K-S	Ilr	$C\alpha$
TR1	1.00	0.69	0.73	2.55	0.76			
TR2	0.69	1.00	0.82	2.45	0.51	0.24	0.75	0.87
TR3	0.73	0.82	1.00	2.55	0.76			
	FI1	FI2	FI3	AM	SD	K-S	Ilr	$C\alpha$
FI1	1.00	0.72	0.79	2.80	0.77			
FI2	0.72	1.00	0.91	3.05	0.69	0.15	0.82	0.92
FI3	0.79	0.91	1.00	3.15	0.75			
	RE1	RE2	RE3	AM	SD	K-S	Ilr	$C\alpha$
RE1	1.00	0.74	0.84	3.45	0.76			
RE2	0.74	1.00	0.84	3.65	0.67	0.15	0.81	0.92
RE3	0.84	0.84	1.00	3.80	0.89			

$d=0.29$  for  $N=20$  ( $p<0.05$ )

Legend: IN - initial measurement, TR - transitive measurement, FI - final measurement, RE - retention measurement, AM – arithmetic mean, SD – standard deviation, K-S Kolmogorov-Smirnov test of normality of distribution, 1-3 – inter correlations between evaluators, Ilr – Inter-item correlation,  $C\alpha$  – Cronbach's alpha coefficient.

Analysis of the results presented in Table 1 shows very high reliability of the measuring instrument identified through a high coefficient of inter-item correlation (IIR: 0.75–0.99). The Cronbach's alpha varies in range ( $C\alpha$ : 0.87-0.96), which shows reliability of the measuring instruments.

Graph no. 1. Presents arithmetic means of the observed motor skill (overhead serve) for three groups of subjects (synthetic, analytic and combined group) in all points of measurement.



Graph 1. Curves of motor performance for synthetic, analytic and combined method.



Arithmetic means of the observed motor skill (overhead serve) for three groups of subjects (synthetic, analytic and combined group) in all points of measurement are presented in Graph 1 to analyze the progress of the motor skill for each of the observed groups and to analyze the differences between the observed groups in different points of measurement.

The results of an independent samples T-test which was used to determine whether there were statistically significant differences (*p* values) between the learning methods in all points of measurement are presented in Table 2.

Table 2. Statistically significant differences (*p* values) between methods of learning in all points of measurement, independent samples *T* – test

<b>INITIAL MEASUREMENT</b>	<b>Synthetic learning method</b>	<b>Analytic learning method</b>	<b>Combined learning method</b>
<b>Synthetic learning method</b>		0.38	0.33
<b>Analytic learning method</b>	0.38		0.08
<b>Combined learning method</b>	0.33	0.08	
<b>TRANSITIVE MEASUREMENT</b>	<b>Synth</b>	<b>Analy</b>	<b>Combi</b>
<b>Synthetic learning method</b>		0.13	0.79
<b>Analytic learning method</b>	0.13		0.27
<b>Combined learning method</b>	0.79	0.27	
<b>FINAL MEASUREMENT</b>	<b>Synth</b>	<b>Analy</b>	<b>Combi</b>
<b>Synthetic learning method</b>		0.40	0.82
<b>Analytic learning method</b>	0.40		0.41
<b>Combined learning method</b>	0.82	0.41	
<b>RETENTION MEASUREMENT</b>	<b>Synth</b>	<b>Analy</b>	<b>Combi</b>
<b>Synthetic learning method</b>		0.74	0.68
<b>Analytic learning method</b>	0.74		0.50
<b>Combined learning method</b>	0.68	0.50	

The analysis of the results in Table 4 shows that there are no statistically significant differences between the groups in the initial point of measurement, as all the obtained values exceed the cutoff *p* value of 0.05. Thus, it can be concluded that the initial overhead serve skills do not differ within the groups.

## Discussion

By testing the normality of distribution of variables by Kolmogorov-Smirnov test, it can be observed that in all points of measurement except in the initial one the obtained coefficients do not exceed the critical value. In the initial point *K-S* is 0.28, whereas in other points of measurement it ranges from 0.15 to 0.25. From this it can be concluded that all results, in transitive, final and retention measurement, do not deviate significantly from normal distribution.

Significant progress was probably easier to accomplish considering their poor initial motor skill in the tested task. Furthermore, the graph shows that in the synthetic group, learning follows a so-called S curve, which is a combination of a negatively and a positively accelerated curve, defined by slow progress in the beginning of the learning process and again after a phase of linear progress. The combined group has the best initial scores and their curve is linear, which means it had weak initial progress, but the progress improved in the further learning process. As opposed to the combined group, the analytic group has the lowest scores in the initial measurement, but in the second measurement point the growth of results is much higher in relation to the other two groups and the initial point of measurement. The curve of the analytic group can be defined as negative as it indicates rapid progress in the beginning of the learning process, whereas in the further period the progress is not as prominent. In this case the negative curve can be explained by the complexity of the motor task itself. The subjects in this group achieved the best results in the transitive point of measurement because at the very beginning they understood and learned all the phases of the motor task well only because they had learned it in parts.

It can also be seen from the table 2 that within all three groups there are no significant differences in neither of the further points of measurement. Thus, there are no significant differences between the groups using synthetic, analytic and combined learning method in neither transitive, final nor retention measurement. Based on this, it can be concluded that it made no difference whether the subjects learned the new motor skill (overhead serve) as a whole, in phases or as a combination. What is particularly interesting is that even after a period of not practicing, there were no differences in the skill level of this element between the groups. Therefore, neither method stands out significantly.

## Conclusion

Motor learning as part of everyday life of young athletes is defined as a relatively permanent change in behavior with the purpose of improving all current and future performances. Therefore, the choice of teaching methods is very important in order to achieve as best results as possible. The main aim of this study was to analyze the efficiency and the differences between the learning methods (synthetic method, analytic method, combined method) in mastering a new motor task. Furthermore, respecting the motor learning theories on the importance of motor skill retention, a retention test was also conducted.

Based on the obtained results, it can be concluded that significant progress occurred in learning the motor skill (overhead serve) in all three groups, in which subjects learned by different methods. Moreover, the results prove that there were no significant differences between learning the new motor skill (overhead serve) by analytic, synthetic or combined method. However, it should be emphasized that the best results were recorded in the group learning by analytic method. In the initial measurement for their group the lowest results were recorded, but in the transitive measurement they already had the best results, maintaining the best results right until the retention measurement. This phenomenon can be explained by the complexity of the motor task itself. It should also be emphasized that some unexpected results were recorded in the retention measurement. It appears that the results in this point were higher than the results in the final measurement. This actually indicates that the subjects made a progress in this motor skill even when they stopped learning it. The reason for this may be that the training itself includes movement structures similar to the overhead serve (spike) performed by the subjects. Furthermore, considering that training sessions have not been supervised by the researchers, there is a possibility that the subjects themselves practices the new motor skill during the retention period, even though they had been warned about it. This points to certain weaknesses of this study, first of all to the lacked control of the experimental process. Furthermore, this study would gain on seriousness and significance if it was done on a larger subject sample, with a smaller span of chronological age.

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## RECREATIONAL KINESIOLOGICAL ENGAGEMENT AND SELF-RESPECT IN STUDENTS OF DIFFERENT AGES

Tomislav Jelić<sup>1</sup>, Željko Kovačević<sup>2</sup>, Nenad Rogulj<sup>3</sup>, Marijana Čavala<sup>3</sup>, Josefina Đuzel<sup>3</sup>

<sup>1</sup>Elementary School "Ivan Duknović" Marina, Croatia

<sup>2</sup>University of Split, Department of Health Studies, Croatia

<sup>3</sup>University of Split, Faculty of Kinesiology, Croatia

### Abstract

The purpose of this research was to establish the level of recreational kinesiological engagement and the level of self-respect of the students at the University of Split, to detect the differences in the recreational kinesiological engagement and self-respect among the students of different ages, as well as in self-respect among students kinesiologicaly engaged in different recreational ways. The research was done on the sample of 1243 full-time students at the University of Split, aged 19-25, of 22.5 average age. Recreational kinesiological engagement was defined on four different extensity levels of engagement in free recreational activities. For self-respect assessment, we used standard ten-item Rosenberg's scale of self-respect. Data collecting on kinesiological engagement and self-respect of the students was done by the mediation of the county's Institute for Public Health with the approval, written authorisation and immediate participation of the authorising doctors and the Institute services. The results of research show that there is no statistically significant difference in the engagement in recreational kinesiological activities among the students of different ages, while there is in self-respect among the students of different ages. Furthermore, the research results reveal the existence of statistically significant differences in self-respect among the students engaged in different ways in recreational kinesiological activities, since the students with the higher level of kinesiological engagement also have a higher level of self-respect.

**Key words:** activities, kinesiological recreation, self-respect

### Introduction

Moving, in addition to other recreational kinesiological activities, is one of the biotic human necessities supporting living (Malina et al. 2004; Abernethy, 2005). Contemporary humans (homo sedens) are marked by hypokinesy, unbalanced diet and stress, thus moving, sport and recreational kinesiological activities are imposed as actual necessities (Warburton et al., 2006). Unquestionably, the lack of moving is harmful to biological growth and development in children, and to health in adults, while inactivity can frequently be fatal in the elderly (Gallahue and Donnelly, 2003). Moving and recreational kinesiological activities substantially and integrally influence the anthropological status and living quality in humans. There are no medical conditions or any anthropological features such as morphological characteristics, psychological and sociological features, cognitive, motor and functional abilities, without a strong positive influence of moving and kinesiological activity (Beedie et al., 2000; Rowland, 1990). It is known for a fact that the muscle activity itself, being the basis for all recreational kinesiological activities, integrally engages all organism systems and activates physiological processes in the aspect of the natural response of organism to kinesiological stimulus.

The main tasks of the kinesiological recreation are to use moving to contribute to the universal development and to maintain the necessary level of the anthropological features with the purpose of achieving a quality living in addition to maintain the necessary level of working competence (Cools et al, 2008), and, primarily, health. Therefore, in 2004, WHO adopted a document titled Global Strategy on Diet, Physical Activity and Health, emphasizing the importance of acquiring regular physical activity starting in childhood.

A large amount of physical activity research has dealt with student population (Benitez & Martinez, 2020; Osipov, A. Y. et al., 2020; Simonton, 2020). Moving, sport and recreational kinesiological activities have an enormous importance and make a positive impact on various psychological characteristics and mental health. By involving into kinesiological activities, one significantly raises the level of frustration tolerance, improves psychological stability and adaption to stressful and emotionally demanding situations, stimulates motivation, self-motivation, positive emotions and cheerful mood, improves self-control, motivates extroversion and significantly reduces anxiety (Kouli et al., 2007; Hagtvat and Hanin, 2007; Harbichová, Komarc & Scheier, 2019).

Recreational kinesiological engagement of college students in the Republic of Croatia is not on the necessary level which is indicated by a large number of studies (Pejić, 2008; Fučkar et al., 2008; Božić-Fuštar et al., 2009; Rogulj et al., 2011). A research led by Čurković et al. (2009) on the sample of 397 students from different parts of the Republic of Croatia revealed that only 2% of the respondents are involved in organised sport kinesiological activities, and as few as 31.16% are engaged in recreational kinesiological activities.

Thus, based on the previous scientific knowledge which unquestionably reveals a positive influence of sport engagement, primarily recreational kinesiological activities on health and all the anthropological as well as psychological features, the main intention of this study is to establish the level and the differences of recreational kinesiological engagement of the students of different ages at the University of Split, the level and the differences in self-esteem in students of different ages, as well as the relations between the level of recreational kinesiological engagement and self-esteem.

## Methods

### The sample of entities

The research has been conducted on the sample of 1243 full-time students at the University of Split, aged 19-25, of an average age 22.5. It was a representative sample including a large part of the student population of the University of Split and involving students from all the faculties in Split. The sample did not include the students at the Faculty of Kinesiology in Split due to obvious reasons since their kinesiological engagement at the classes, but also outside the classes is disproportionately greater in relation to other students.

### The sample of variables

The sample of variables has been defined by three variables:

#### 1. *The students' age*

The students' age has been defined by five age categories as it follows: students aged 19-20, students aged 21-22, students aged 23-24, students aged 25-26 and students aged 27 and older.

#### 2. *Recreational kinesiological engagement*

Recreational kinesiological engagement involves the quantity of practising leisure recreational activities such as swimming, playing futsal, basketball, fitness, aerobics, cycling, dancing, pilates, tennis and further on, and it has been defined on four levels: no recreational activity whatsoever, recreational activity with the extensity of 1 to 2 hours a week, recreational activity with the extensity of 3 to 4 hours a week, recreational activity with the extensity of 5 or more hours a week.

#### 3. *Self-esteem*

To assess self-esteem, we used standard 10-item Rosenberg self-esteem scale which represents the self-assessment of the general self-esteem in the aspect of the respondents' general assessment of their own value as a human being (Pullman and Alik, 2000). It consists of ten answer choices with a given four-degree scale: I agree thoroughly, I agree, I don't agree, I completely disagree. The example of the answer choice is "*I am capable of performing tasks as efficient as most of the others*". This scale is the most frequently used self-esteem scale, and its good metric characteristics have been confirmed by numerous previous researches (Pullman and Alik, 2000; Robins et al, 2001).

### Data processing methods

In all the category variables we established the presence of frequencies and the percent calculation. In accordance with the partial aims of the study, the differences between single variables have been established by a non-parametrical HI-square test. The differences in certain answer choices of self-esteem among the students of different ages have been established by the univariant variance analysis. Hypothesis testing has been done on the level of the statistical significance of  $p < 0.01$ . Data processing has been done by *Statistica for "Windows Ver.7.0."* statistical package.

## Results and discussion

Table 1. Frequencies, percentages and the results of Hi-square test between the frequency of recreational activities engagement and students' ages

RECREATIONAL ENGAGEMENT	AGED					TOTAL
	19-20	21-22	23-24	25-26	27+	
never	16 (21,62%)	89 (13,99%)	73 (18,16%)	18 (19,57%)	9 (23,08%)	205 (16,49%)
1-2 hours	32 (43,24%)	271 (42,61%)	177 (44,03%)	38 (41,30%)	16 (41,03%)	534 (42,96%)
3-4 hours	18 (24,32%)	171 (26,89%)	88 (21,89%)	22 (23,91%)	10 (25,64%)	309 (24,86%)
5 hours and more	8 (-10,81%)	105 (16,51%)	64 (15,92%)	14 (15,22%)	4 (10,26%)	195 (15,69%)
Hi-square				p		
10,72				0,55		

Table 1 presents frequencies and results of Hi-square test between the frequency of recreational activities engagement and the students' ages. It is evident from the table that out of the total number of respondents as much as 16.49% is never engaged in any recreational activities, and most of them (42.96%) is engaged in recreational activities as little as 1-2 hours a week. Least students, only 15.69% are more extensively engaged in kinesiological recreation for 5 hours a week or more. Evidently, male students from Split have a relatively low level of kinesiological engagement. The reasons may be found in insufficiently developed exercising routines.

This low level of recreational kinesiological engagement might also be determined by various psychological and sociological factors. By starting university studying, students clearly have other priorities than being engaged in recreational activities. They tend to change their residence quite frequently (students coming from smaller places or other towns), thus they need a certain period to socialise and adapt to a new environment. During the period when their natural growth and development finishes, some professional and existential motives appear, more time, concentration and energy is spent on lessons and learning, a young individual is becoming independent, and a need for assertion appears in different areas, not only in the kinesiological one, which significantly reduces the recreation percentage in the structure of spare time. One should also consider the fact that kinesiological infrastructure at the University of Split is at a relatively low level and does not fulfil the necessary organization, material, technical and personnel conditions to realize sport and recreation kinesiological activities in students. We may also assume that the current financial crisis and the existing student standards limit the kinesiological engagement of the students, since a monthly fee for a gym or a tennis court is quite substantial. However, the basic reason for the insufficient recreational kinesiological engagement in general may be a low level of kinesiological culture and undeveloped awareness of the importance of kinesiological activities for health and quality of human living, and primarily the undeveloped exercising routine. A basic precondition for creating this routine, in addition to the need for recreational kinesiological activities, is for an individual to experience a positive kinesiological transformation of the anthropological status, so this must be the primary aim in physical education lessons at universities as well.

The results of HI-square test ( $p=0.55$ ) evidently show there is no statistically significant interdependence between the level of recreational kinesiological engagement and the students' ages. Not even with a more detailed inspection of the frequency percentages in table 1 may we observe more significant numerical differences which confirms the results of the HI-square test.

Table 2. Frequencies, percentages and the results of Hi-square test between the self-esteem level and students' ages

SELF-ESTEEM	AGED					TOTAL
	19-20	21-22	23-24	25-26g.	27+	
BELOW AVERAGE	47 (64%)	297 (47%)	226 (56%)	46 (50%)	18 (46%)	634 (51%)
ABOVE AVERAGE	27 (36%)	339 (53%)	176 (44%)	46 (50%)	21 (54%)	609 (49%)
Chi-square				p		
14,13				0,01		

Table 2 presents frequencies, frequency percentages and Hi-square test results between the self-esteem level and the students' ages. By studying the Hi-square test results, it is evident that there is a statistically significant interdependence between the students' ages and self-esteem level on the statistical significance level of  $p=0.01$ . By a closer inspection in table 3, it is evident that younger students mostly have a below average self-esteem level (64%), while among the oldest students prevail those with higher, i.e. above average self-esteem level (54%). It is evident there are more students with



below average than above average self-esteem level, which leads to a conclusion that the level of self-esteem in this population of students is slightly closer to lower levels. A higher self-esteem level among the oldest students may be explained by different sociological factors, primarily by the fact that these are generally undergraduates with greater life and professional experience, who have most probably reached the final phase as far as their existential matters are concerned. On the other hand, first year students are influenced by numerous complicating factors, from not acclimatizing themselves easily in a new situation at the beginning, over unfavourable material conditions and the dependence on their parents, to the unresolved housing problems, which may also reflect on their self-esteem level.

Table 3. Univariate analysis variance results for self-esteem variable among the students of different ages

VARIABLE	AM					F	p
	19-20	21-22	23-24	25-26	27-		
I am mostly satisfied with myself	3,35	3,6	3,52	3,59	3,59	3,75	0
I sometimes think I do not worth at all	3,3	3,43	3,35	3,39	3,26	1,55	0,18
I think I have a lot of good characteristics	3,31	3,45	3,38	3,41	3,41	1,72	0,14
I am capable of performing tasks as well as most of the others	3,47	3,62	3,55	3,53	3,64	2,1	0,08
I don't have much to be proud of	3,32	3,38	3,37	3,49	3,33	0,8	0,52
I sometimes feel completely useless	3,24	3,29	3,21	3,15	3,18	1,19	0,32
I feel at least as much worth as the others	3,42	3,48	3,44	3,41	3,51	0,57	0,69
I would like to appreciate myself more	2,76	2,83	2,81	2,8	2,85	0,15	0,96
on the whole, I am prone to believe I am a failure	3,57	3,74	3,68	3,71	3,59	2,36	0,05
I think of me with a positive attitude	3,41	3,55	3,48	3,52	3,59	1,84	0,12

By inspecting table 3 it is evident the older students in all the answer choices with positive tendencies (answer choice 1, 3, 4, 7 and 10) have higher average grades in their self-esteem levels, and in most of the inverse answer choices with negative orientation (answer choices 2, 5, 6, 8 and 9) they have lower average grades which is mostly in accordance with HI-square test results. The greatest and statistically most significant differences were found in the first answer choice - I am mostly satisfied with myself ( $p=,00$ ) and in the tenth answer choice - I think of me with a positive attitude ( $p=,05$ ). In the stated answer choices, older students have statistically significant higher level of self-esteem compared to younger students.

The absence of significant differences in a large number of answer choices may primarily be explained by the sample characteristics including students aged 18-27, i.e. in the period generally marked by a higher and more stable level of self-esteem than in younger individuals. Namely, unlike adults, children create their inner image of themselves and their own values based on the relations with their family, friends, teachers and others in their lives, as well as from their growing ability to view the world in more relative terms. The growing differentiation of self - concept leads to conflicts among certain dimensions which is mostly emphasized in mid-adolescence period. These conflicts are the most important source of identity crisis, and because of the need to find a balanced self-image and due to the demands of their social environment, the usual self-concept becomes lower and raises only in late adolescence period, at the end of the secondary school education.

Table 4. Frequencies, percentages and Hi-square test results between the kinesiological recreation engagement level and the self-esteem level

RECREATION ENGAGEMENT	AM LESS SELF-ESTEEM	AM MORE SELF-ESTEEM	TOTAL
never	127	78	205 (16,49%)
	(20,03% -61,95%)	(12,81% -38,05%)	
1-2 hours	296	238	534 (42,96%)
	(46,69% -55,43%)	(39,08% - 44,57%)	
3-4 hours	133	176	309 (24,86%)
	(20,98% - 43,04%)	(28,90% -56,96%)	
5 hours or more	78	117	195 (15,69%)
	(12,30% -40,00%)	(19,21% -60,00%)	
Chi-square		p	
31,3		0	



Table 4 presents frequencies, percentages and Hi-square test results between the kinesiological recreation engagement level and the self-esteem level. By inspecting table 4, it is evident that among students with low or no recreational kinesiological engagement prevail those with lower level of self-esteem (61.95/55.43%), while among those kinesiological engaged for 3 or more hours per week prevail students with a higher level of self-esteem (56,96/60,00%). Unquestionably, we established the interdependence between the self-esteem level and the extensity of recreational kinesiological activities engagement. This has additionally been confirmed by a high value of HI-square test (31.30) which is statistically significant on  $p=.00$  level. Therefore, based on research results, we may conclude there are some statistically significant differences in self-esteem among the students with different engagement in recreational kinesiological activities, since the students with a higher level of recreational kinesiological engagement have a higher level of self-esteem as well.

By using this methodological approach, we could detect the existence of the statistically significant interdependence of the self-esteem level and the recreational kinesiological engagement, i.e. we could only assume that kinesiological engagement has a positive influence on the self-esteem level, or that a higher self-esteem level motivates students to engage into kinesiological recreation more frequently. It is known for a fact that recreation engagement improves sociological adaptation, emotional and functional relations among the participants in recreational activities, competition, it reduces anxiety, raises self-confidence and self-actualisation, which is most probably reflected in self-esteem as well. However, one may also assume that individuals with a higher level of self-esteem are more inclined to kinesiological recreation which is a specific public activity, since they more easily publicly expose and are not concerned with the public opinion. Students with a low level of self-esteem hardly ever decide to participate in “disclosed” recreational kinesiological activities such as playing futsal or tennis, particularly if their low level of motor knowledge or motor abilities reduces a possibility of a “dignified” engagement into these activities.

## Conclusion

A necessity for recreational kinesiological engagement has been actualised in contemporary society characterised by hypokinesy, unbalanced and unhealthy diet and stress which has an extremely negative influence on human medical conditions. Unfortunately, inactivity in contemporary society is evident in younger population as well, which is clearly indicated by the results of this study conducted on a sample of students. Insufficient involvement of the students at the University of Split into recreational kinesiological activities is probably the consequence of the low level of kinesiological infrastructure at the University of Split which does not offer minimal organization, material and technical as well as personnel conditions in order to perform sport and recreational kinesiological activities, but is also the consequence of the low kinesiological culture and undeveloped awareness of the importance of kinesiological activities with regard to health and the quality of living, and primarily the consequence of undeveloped routine of physical exercising. Furthermore, study results reveal that the level of recreational kinesiological engagement decreases with students' ages, i.e. younger students have the highest, and the oldest students the lowest level of recreational kinesiological engagement. Younger students also have a lower level of self-esteem, compared to older students. What is essential from the point of view of kinesiology as a science is that results of this study unquestionably confirm that students with high kinesiological engagement additionally have a higher level of self-esteem which is in accordance with previous knowledge. However, the assumptions that recreational kinesiological activities may substantially influence the raising of the self-esteem level or that a higher level of self-esteem motivates students to engage into kinesiological recreation more frequently may be confirmed only by future longitudinal research procedures.

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## IMPACT OF SPECIFIC WATER COMPETENCIES ON THE KNOWLEDGE OF SWIMMING IN FIRST AND SECOND-GRADE ELEMENTARY SCHOOL CHILDREN IN THE DUBROVNIK COUNTY

Dajana Karaula<sup>1</sup>, Dean Kontić<sup>2</sup>, Klara Šiljeg<sup>1</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>University of Dubrovnik, Croatia

### Abstract

Swimming is a dynamic ability because it requires the process of adoption through exercise and experience, which we build in previous autonomy, confidence, and satisfaction in the aquatic environment. The study aimed to determine the impact of individual water movement competences on the knowledge of swimming measured by the 3x5 m test around pool-set buoys. The sample consisted of 300 children between 6 and 8 years of age. All of them were first- and second-grade pupils from five elementary schools in Dubrovnik, Croatia. A variable sample included six tests for the assessment of specific motor skills that measured swimming skills or water competencies such as jumping into the water (dive on a leg), breathing on the edge of the pool, swimming with stopping and raising a hand, backstroke swimming, 3x5 m swimming around buoys and 2.5 m length dive. The results indicate that between the predictor set and the criterion variable, a multiple correlation of .84 was achieved at .00 level of significance, and that about 71% of the total variance of change in the direction of movement, i.e., 3x5 m swimming, can be explained. Based on the results, it can be concluded that, all too often, the knowledge of swimming is considered to be only the proper “performance” of a swimming movement, whereas the actual ability to swim is much more than that.

**Key words:** *swimming competence, water competence, drowning prevention*

### Introduction

Prevention of drowning among children is essential in order to improve and protect their life and health (Šiljeg & Sindik, 2015). Yearly, around half a million people drown worldwide. Mortality from drowning in children is in second place. The number of drowning deaths in open water is higher in adolescents, while it is higher among children in indoor facilities (European Child Safety Alliance - ECSA, 2012). The percentage of deaths among boys is higher than in girls (Dimitrić & Batez, 2013).

It is difficult to estimate the swimming skills properly. Estimation is in significant correlation with the water environment (water facilities: swimming pool or open water, water and air temperature, water depths, water condition such as waves or calm water). There are many cases where swimmers can swim in a controlled environment (swimming pool), while waves or deeper water may cause problems for them. It is essential to estimate how well children perform swimming skills in different weather or environmental conditions. Swimming skills refer to the ability and techniques to dive safely, swim underwater, breathe correctly, and float on water (Šiljeg & Sindik, 2015). Kjendlie et al. (2013) claimed that introducing waves in calm water decreases floating in the water in 11-year-olds by 24%. According to Andersson (2016), the immediate stress, shock factor when forced to swim in unsteady water seems to lead to a higher performance decrease. Junge et al. (2010) showed on a sample of 70 children, who were declared as swimmers and swam 25 meters, that 94% of them could not stop swimming and float on the water; they could not control their breathing and buoyancy forces, so they failed to take up a floating position on their back. Today, researchers are attempting to uncover what it means to be able to swim appropriately in order to reduce risks of drowning as well as to reduce the degree of drowning in the population (Moran et al., 2012; Petrass, Blitvich, McElroy, 2012; Kjendlie et al., 2013). Moran (2013) considers the term “concept of water competence” to be more appropriate than “swimming ability” or “swimming skill” with regards to drowning prevention. The development of a comprehensive swimming ability should be a goal for coaches, with an emphasis on drowning prevention (Karaula et al., 2019). In this paper, we adopt “water competency” as a more appropriate term than swimming skills and research specific movements in the water, their correlation, and impact on swimming.

## Methods

### Participants

The sample consisted of 300 children between 6 and 8 years of age. All of them were first- and second-grade pupils from five elementary schools in Dubrovnik, Croatia. The research was conducted following the Code of Ethics for Research with Children, a document compiled by the Council for Children, an advisory body of the Government of Croatia. Signed parental consent for participation in the research was obtained for each participant. The procedure was verbally explained to each participant before the beginning of the research.

### Procedure

The measurements were carried out at the “Gruž” swimming pool in Dubrovnik. The testing procedure was standardized for all children. The measurements were carried out during June and July of 2018, and five experts carried out the testing. The grades were in the range of 1 to 3. The variable sample included six tests for the assessment of specific motor skills that measured swimming skills or water competencies such as jumping into the water (dive on a leg), breathing on the edge of the pool, swimming with stopping and raising a hand, backstroke swimming, 3x5 m swimming around buoys, and 2.5 m length dive (Ninčević, 2019).

### Statistical analysis

Statistic for Windows, version 13.0, was used for the statistical analysis of specific motor skills. The following was computed: basic statistical parameters (mean, minimum and maximum results, standard deviation). The normality of distribution was tested with the Kolmogorov-Smirnov test, which established that there was no normal distribution for all variables; we, therefore, used the Kendall Tau correlation coefficient (nonparametric statistics). The Kendall Tau correlation coefficient was used because, according to, it shows more accurate results than the Spearman correlation coefficient in nonparametric statistics.

The impact of the predictor system of variables on the criterion of this research, as well as its statistical significance, were proved with the regression analysis.

## Results and discussion

Table 1. Descriptive indicators

VARIABLES	N	Mean	Min	Max	S.D
JUMPING INTO THE WATER	300	2.77	1.00	3.00	0.55
BREATHING ON THE EDGE OF THE POOL	300	2.41	1.00	3.00	0.70
SWIMMING + RAISING HAND	300	2.26	1.00	3.00	0.79
BACKSTROKE SWIMMING	300	2.13	1.00	3.00	0.84
3X5 M SWIMMING	298	2.31	1.00	3.00	0.86
DIVING	299	1.70	1.00	3.00	0.71

N-number of participants; Mean-arithmetic mean; Min-minimum value; Max-maximum value; S.D.-standard deviation

Table 2. Correlation matrices of all variables. The table shows the Kendall Tau \* correlation coefficients ( $p < 0.05$ )

VARIABLES	JUMPING INTO THE WATER	BREATHING ON THE EDGE OF THE POOL	SWIMMING + RAISING HAND	BACKSTROKE SWIMMING	3X5 M SWIMMING
JUMPING INTO THE WATER	1.00				
BREATHING ON THE EDGE OF THE POOL	0.43	1.00			
SWIMMING + RAISING HAND	0.40	0.46	1.00		
BACKSTROKE SWIMMING	0.38	0.50	0.71	1.00	
3X5 M SWIMMING	0.40	0.45	0.76	0.68	1.00
DIVING	0.35	0.46	0.59	0.58	0.55

Table 3. Regression analysis for the dependent variable SWIMMING 3X5 M

N=298	Overview of regression for dependent variable: variable Swimming 3x5 m r=0.84 r <sup>2</sup> = 0.71 p<0.0000					
	b*	Standard error	b	Standard error	t(292)	p-value
Intercept			-0.02	0.14	-0.14	0.89
JUMPING INTO THE WATER	0.06	0.04	0.10	0.06	1.63	0.10
BREATHING ON THE EDGE OF THE POOL	0.00	0.04	0.01	0.05	0.10	0.92
SWIMMING + RAISING HAND	0.56	0.05	0.61	0.06	10.56	0.00
BACKSTROKE SWIMMING	0.27	0.05	0.27	0.05	5.03	0.00
3X5 M SWIMMING	0.05	0.04	0.06	0.05	1.07	0.29

Descriptive statistics show the lowest mean score in the diving test (mean=1.70) and the highest mean score (2.77) in the jumping into the water test (Table 1). This can be explained by the fact that the children did not experience the fear of jumping into the water but rather the fear of diving. As they live on the mainland, they have probably learned how to jump into the water while playing at the beach. The fear of diving may be correlated with a complicated motor structure: how to put the whole body under the water, how to move through water while holding the head under the surface, how to control breathing while under the surface, and how to move with default aim to pass to the other side under the swimming lane. A huge problem for children is how to keep their eyes open underwater. All of the aforementioned may pose a problem for children if they suddenly come across waves in open water or if they experience fatigue, which may subsequently lead to drowning. Šiljeg et al. (2016) cited in their research that children tend to overestimate their swimming knowledge. Comparing the mean score in the swimming on the back (mean 2.13) with the swimming on the breast (mean 2.31; 2.26) (Table 1), the lowest score of swimming on the back can be explained by the complexity of backstroke swimming (Bravi, 2011; Šiljeg, 2018). This complexity can be conditioned in the following cases: visual control is reduced during the forward movement, stroke is done on the side, not under the body, the rotation has to be from one side to the other throughout the entire cycle. Gonjo et al. (2014) highlighted in their research that the backstroke is more energetically demanding than the freestyle during swimming. All described correlations between the tests are statistically significant ( $p < 0.05$ ) (Table 2). The values of correlation coefficients vary from low to high values ( $r = 0.35-0.76$ ). The lowest correlation is between the 2.5 m length dive and jumping into the water ( $r = 0.35$ ), which can be explained by the entirely different motor structure, different body position in the water, and different duration of the task. A low correlation is also found between jumping into the water and backstroke swimming ( $r = 0.38$ ), which had been expected because in backstroke swimming, there is no breathing in the water as in jumping, and the body position is quite different (horizontal in backstroke vs. vertical in jumping). The most significant correlation is between swimming around buoys and swimming with stopping and raising a hand, which had been expected because both tests represent swimming on the breast as a skill.

Table 3 shows a multiple correlation of .84 at the .00 significance level between the predictor set and the criterion variable, and that it is possible to explain about 71% of the total variance of the change in the direction of movement, i.e., 3x5 m swimming. Of all the five predictor indicators, only the indicator of swimming with stopping and raising a hand and the backstroke have contributed to an explanation of the criterion ( $BETA = .56$  and  $BETA = .27$ ) because its regression coefficient of significance ( $P = .00$ ) is significant. The results obtained in this research can serve as significant prognostic factors that carry the same impact information in the 3x5 m variable. What is interesting about this research is that the 2.5 m length diving and the breathing at the edge of the pool variables do not show any correlation with the criterion variable. The biggest problem when testing children's or adult's knowledge of swimming is the very swimming from point A to point B in any body position in the water with the head out.

Based on the swim 25 m or 50 m section, an individual receives a diploma for the BEGINNER SWIMMER (25 m) or SWIMMERS (50m). In the study carried out by Karaula et al. (2019), only 34.92% of the Faculty of Kinesiology students agreed with the statement, "It is not necessary to be able to swim a certain length (25 m or 50 m) for the knowledge of swimming." In a study involving 200 school children (Junge, 1984, according to Stallman, Junge, Blixt, 2008), all children were able to swim 25 meters (but only to swim straight ahead) and were declared swimmers. What is of great importance in that research is that only 5% were able to satisfactorily complete the combined test (consisting of a jump, dive, 12.5 m breaststroke, turn, reel, stop and rest for 30 seconds, and swim 12.5 m backstroke).

Langendorfer and Bruya (1995) state that the term water movement competence is more comprehensive than swimming competence, and that it better describes the range of water skills and knowledge associated with aquatic activities. In the study of Karaula et al. (2019), only 72.22% of students rated the statement "Breathing, breath-holding, and respiratory control are essential components of water movement "competences" with the highest grade, i.e., they completely agreed with it. The control of breathing in the aquatic environment is of utmost importance because it is associated with mental adaptation to water, balance control, i.e., buoyancy, relaxation in water, and certainly control of movement. In the research



carried out by Rocha (2016), 86% of swimming teachers always conduct breathing control exercises during the swimming lesson. According to Lanoue (1963), people do not usually drown because they do not know how to swim, but because they cannot get air. Closely related to the breathing control and breath retention is mastering the control and regulation of buoyancy (Stallman, Junge, & Blixt, 2008). Also, the test of jumping into deep water has no relation to the criterion variable of swimming knowledge. Jumping, exhaling, and diving tests are considered skills or competencies that are important aspects of aquatic ability and are particularly related to survival skills. These competencies are used to test the coping with the unexpected immersion of the face into the water, and lack of knowledge of these skills can lead to drowning. It is important when a person falls into the water to control their fear by breathing and turn on their back with the help of different rotations and float.

## Conclusion

Too often, the proper “performance” of a swimming movement is considered as the knowledge of swimming, while the true ability to swim is actually more than that. What is of the utmost importance is for an individual to master different competences in the water, such as exhaling into the water, jumping into the water, diving, looking underwater, rotating the body around different axes, and based on this avoid death by drowning in many cases. Based on the results of this research, awareness should be raised about the different competencies of swimming and survival, as well as the possibility of creating new methods of teaching swimming and designing new courses for teaching children and adult non-swimmers in different natural conditions (controlled and uncontrolled conditions).

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## RELATIONSHIP OF STUDENTS' AGE, GENDER AND INITIAL STATUS WITH PROGRESS IN CARDIORESPIRATORY FITNESS ASSESSED BY TWO FIELD TESTS

Ivana Klaričić<sup>1</sup>, Tihomir Vidranski<sup>2</sup>, Mirela Šunda<sup>3</sup>

<sup>1</sup>Faculty of Kinesiology, University of Osijek, Croatia

<sup>2</sup>University of Slavonski Brod, Croatia

<sup>3</sup>High School Antun Gustav Matoš, Đakovo, Croatia

### Abstract

The purpose of this research was to determine differences in the relationship of students' age, gender and initial status with progress in cardiorespiratory fitness (CRF) between two field tests. The sample consisted of 145 high school students, 98 girls and 47 boys. The average students' age was 16.6 years. Students' CRF was assessed at the beginning and at the end of the school year by two field tests and the progress was calculated. The results showed significant differences in the relationship of students' age and initial score with the progress in CRF between two field tests. The differences related to gender have not been determined. Age has a greater relationship with the progress in 20m shuttle run ( $R^2_{\text{part}} = 8,0\% : 1,4\%$ ) and the initial score in 600m run ( $R^2_{\text{part}} = 22,2\% : 0,8\%$ ). The conclusion was when interpreting the results of the status and the progress of CRF assessed by 20m shuttle run test, the possibility of limited progress should be considered so the false conclusions about the success of transformation processes could be avoided.

**Key words:** cardiorespiratory fitness, youth, 20m shuttle run, 600m run

### Introduction

Cardiorespiratory fitness (CRF) is a measure that refers to the ability of the body's large muscle groups to perform continuous, rhythmic and dynamic physical activity and exercise (Tomkinson et al., 2019). Maximum oxygen uptake ( $VO_{2\text{max}}$ ) is a directly measured indicator of CFR, which is also registered as relative  $VO_{2\text{max}}$  ( $\text{ml} / \text{min}^{-1} / \text{kg}^{-1}$ ) when needed. Researches have shown that CFR indicators are highly correlated with health indicators such as obesity, high blood pressure and blood fat, and increased cardiometabolic risk (Pillsbury, Oria, & Pate, 2013). Measurement of  $VO_{2\text{max}}$  is conducted in laboratory and is mostly resource overdemanding for use in a large set of examinees. In such cases, field tests are used for assessing CFR.

But when it comes to youth, the interpretation of  $VO_{2\text{max}}$  in relation to growth, maturation and health is unclear (Armstrong, 2017).  $VO_{2\text{max}}$  levels rise with age and maturation, males achieves higher values than females (Armstrong, Tomkinson, & Ekelund, 2011). On the other hand, field tests results are decreasing with growth and maturation (Armstrong et al., 2011). Thus, Saint-Maurice, Welk, Finn, and Kaj (2015) determined only 13% (male) and 18% (female) of common variance of  $VO_{2\text{max}}$  and the 20m shuttle run score in youth. Also, genderspecific analyses by Von Haaren and Hartel (2011) determined significantly lower correlations of the 20m shuttle run and  $VO_{2\text{max}}$  for the boys ( $r = 0,29$ ) compared to the girls ( $r = 0,58$ ). Pillsbury et al. (2013) claim that direct correlation of  $VO_{2\text{max}}$  with health indicators hasn't been identified in youth as it has in adults, thus confirming the mentioned obscurity. Also, Kristensen et al. (2010) determined only a weak to moderate association between CRF and physical activity in adolescents.

Given the unclear role of  $VO_{2\text{max}}$  levels in interpretation and resource overdemanding, field tests are becoming a better choice for assessing CRF in young people. Field tests are generally divided into tests with a specified running time or those with a specified running distance (Pillsbury, et al., 2013). The specified time ranges from 6 to 15 minutes and distances from 400 to 5000m. However, different tests have different metric characteristics and are not equally adequate for use in all populations. It is very important to differentiate the school population from one who is actively engaged in some of the sports activities. In addition, the simplicity of use should be considered when selecting the appropriate test. Mayorga-Vega, Bocanegra-Parrilla, Ornelas, and Viciano (2016), after extensive research review, recommend 1,5 mile and 12 minute tests as tests of high and stable relationship with  $VO_{2\text{max}}$  level. Nonetheless, Pillsbury et al. (2013) believe that examinees' motivation should also be considered and recommend tests of shorter duration.

The 20m shuttle run is a specific field test, it does not belong to groups of tests with a specified running time distance, but the intensity (running speed) increases progressively. Castro-Pinero et al. (2010) after extensive review of research

recommend it as a highly valid test for assessing CRF. Domone, Mann, Sandercock, Wade, and Beedie (2016) also recommend it as a test of high scalability (simple to use, economical) for large groups of examinees such as the school population. Scott, Thompson, and Coe (2013) determined that subjects between 10 and 15 years of age, while performing a shuttle run test, achieve the same maximum heart rate (197 bpm) and relative oxygen uptake ( $45 \text{ ml} / \text{min}^{-1} / \text{kg}^{-1}$ ) as the ones in the laboratory.

Given the constant offer of newly constructed or customized tests, there may be confusion in the selection and thus interpretation of the results obtained. Age and gender are recognized as factors that significantly differentiated subjects in CRF field tests. So they also have influence on the score of the tests, the progress and the dynamics of the results. The purpose of CRF assessment is not the score itself, but the insight in the individual's health. This data is often basis for decision that could have significant consequences in young peoples' lives, such as selection in sport. Therefore, it is necessary to use field tests appropriately so false conclusions could be avoided.

20m shuttle run and 600m run are tests that are often used to assess CRF. 600m run is conducted in such a way that it is necessary to run the specified distance in the shortest possible time, that is, the examinee determines the running pace and its dynamics. The 20m shuttle run test is conducted in such a way that the running pace is set and it increases progressively in set periods of time. Given that both tests assess CRF, there should be no difference between the tests. But when the activity differences are observed, the assumption is that certain differences could exist. The aim of this study is to determine the differences in the relationship between age, gender and initial status with progress between two different CRF field tests.

## Methods

*Sample.* The sample consisted of 145 students from 1st to 4th grade of general education high school Antun Gustav Matoš in Đakovo, Croatia. Out of a total of 145 pupils, 98 were girls and 47 boys. The average age of the examinees was 16.6 years.

*Variables.* The set of variables was the initial assessment in two CRF field tests, 600m run and 20m shuttle run, progress between initial and final assessments (9/2018, 6/2019) in both tests, and gender and age of the student. Higher score and progress are referring to better result and progress in 20m shuttle run, but in 600m run are referring to worse result. Both tests have sufficient validity (Mayorga-Vega, et al., 2016; Castro-Pinero, et al., 2010) to be used as CRF field tests.

In Republic of Croatia Curriculum of Physical Education enacts compulsory assessments of students' cardiorespiratory fitness and motor abilities at the beginning and the end of every school year as a forms of tracking students' health.

*Data analysis.* Arithmetic mean and standard deviation are calculated for all variables. The relationship of age, gender and initial score with the progress in the tests will be analyzed by regression analysis, separately for each test. The male gender will be coded 1 and the female one 0. If the mentioned relationship was statistically significant, a joint regression analysis with the interactions will be conducted to determine the statistical significance of the differences between two tests. In a joint regression analysis, the variables will be standardized to have a common measurement unit.

## Results

Boys, compared to girls (table 1), have higher average initial score in both field tests. They also have higher average progress in 20m shuttle run than girls, and slightly lower in 600m run.

Table 1. Descriptive parameters of age, initial assessment and progress

		AS	SD	Min	Max	
Girls (n=98)	Age	16,5	1,2	14,3	18,5	
	Shuttle (x 20m)	Initial assessment	38,6	14,4	15	97
		Progress	3,0	9,9	-28	41
	600m (s)	Initial assessment	175,0	26,8	122,9	266,7
		Progress	-9,2	13,0	-45,1	25,1
	Boys (n=47)	Age	16,6	1,1	14,5	18,4
Shuttle (x 20m)		Initial assessment	58,7	24,4	20	114
		Progress	5,6	10,2	-16	33
600m (s)		Initial assessment	137,2	23,6	103,4	197,7
		Progress	-7,8	15,2	-52,5	24,9

AS – arithmetic mean, SD – standard deviation, Min – minimal result, Max - maximal result.

Age and gender have statistically significant relationship with the progress in both tests (table 2). Both age and gender have a greater relationship with the progress in 20m shuttle run ( $R^2_{part} = 8,0\%$ ; 1,6%) compared to 600m run ( $R^2_{part} = 1,4\%$ ; 0,6%). But, the initial assessment score in 600m run, in contrary to 20m shuttle run, has a significant relationship with progress. Initial score in 600m run explains 22,2% of progress in a way, the lower the initial score, the higher the progress.

A joint regression analysis has to be conducted to determine statistical significance of differences in the relationship of age, gender and initial assessment score with the progress between the two tests.

Tablica 2. Regression analysis results for 20m shuttle run test and 600m run

		20m shuttle run	$\beta$	st.err. $\beta$	b	st.err.b	$R^2_{part}$	p
R	0,31	Intercept			47,86	12,10		
$R^2$	10,00%	Initial assessment	-0,13	0,09	-0,07	0,05	0,8 %	0,15
$F_{3,143}$	5,16	Age	-0,29	0,08	-2,44	0,70	8,0 %	0,00
p	0,00	Gender	-0,20	0,09	-2,11	0,97	1,6%	0,03
600m run								
R	0,49	Intercept			-1,25	14,55		0,93
$R^2$	23,72%	Initial assessment	-0,60	0,09	-0,26	0,04	22,2%	0,00
$F_{3,143}$	14,62	Age	0,18	0,08	2,04	0,09	1,4%	0,02
p	0,00	Gender	0,30	0,09	4,39	1,32	0,6%	0,00

R – multiple correlation,  $R^2$  – coefficient of determination, F – Fisher's test,  $\beta$  – standardised regression coefficient, st.err. $\beta$  – standardised error of regression coefficient  $\beta$ , b – unstandardised regression coefficient, st.err.b – standardised error of regression coefficient b,  $R^2_{part}$  – partial coefficient of determination, p – level of significance.

Statistically significant interactions (table 3), age and initial score, justify the comparison of regression parameters from two separate regression analyzes (table 2).

Table 3. Regression analysis results (20 m shuttle run test and 600m run test)

		$\beta$	st.err. $\beta$	b	st.err.b	p
R	0,59	Intercept		1,62	0,61	0,01
$R^2$	34,88%	Test	-1,69	0,68	-1,52	0,61
$F_{5,143}$	30,43	Initial assessment	-0,38	0,05	-0,37	0,05
p	0,00	Age	-0,13	0,05	-0,10	0,04
		Test x initial ass.	-0,36	0,05	-0,35	0,05
		Test x age	1,66	0,68	0,09	0,04

R – multiple correlation,  $R^2$  – coefficient of determination, F – Fisher's test,  $\beta$  – standardised regression coefficient, st.err. $\beta$  – standardised error of regression coefficient  $\beta$ , b – unstandardised regression coefficient, st.err.b – standardised error of regression coefficient b,  $R^2_{part}$  – partial coefficient of determination, p – level of significance.

Statistically significant differences are: the initial score explains 22.2% of the progress in 600m run test, as opposed to 0.8% in the 20 m shuttle run test. Conversely, age explains only 1.4% of progress in 600m run, as opposed to 8% in the 20m shuttle run test. Differences between progress explained by gender, 1,6% in 20 m shuttle run and 0.6% in 600m run, are not significant.

## Discussion

As mentioned above, boys compared to girls, have a better average initial assessment score in both tests (table 1). Boys also have higher average progress in the 20 m shuttle run, but their average progress of 600 m run is lower than girls'. Many previous studies show gender differences in various motor skills and CRF, in a way that males achieve higher scores (Armstrong, et al., 2011). These gender differences are minimal in children and then increase from childhood to adulthood due to the positive effect of male sex hormones on muscle mass and subcutaneous fat (Ramos, Frontera, Llopart, & Feliciano, 1998).

However, the subject of this research is the relationship of age, gender and initial score with the progress in two tests. Due to the adaptation processes of the organism, participants' progress in tests should, as much as possible, depend on the transformation processes and should not dependent on their gender and age. Given the complexity of the functioning of the human body, total independence is neither possible nor expected. Both gender and age had a significantly higher

relationship with progress in the 20m shuttle run compared to 600m run. Boys compared to the girls with the same initial score have lower progress. Likewise, older students have lower progress compared to younger students with the same initial score. This incidence is similar in both tests, but is statistically significant only in 20 m shuttle run. Age explains 8,0% and gender 1,6% of the variance of progress in the 20m shuttle run compared to 1,4 and 0,6% in 600m run. This incidence is even more unusual in interpretation because the same initial score in boys and girls is not equal in terms of gender differences.

The practical significance of these results is that an adequate test should be selected to assess CRF. If conditions allow, two tests will give better insight into the CRF. For example, the correlation between initial scores from the two tests in this research is  $r = -0.77$  ( $R^2 = 59.3\%$ ), which shows that scores of both tests contain only 60% of CRF, but also 40% of some other construct. Previous studies recommend shuttle run as a test with high and stable validity across different populations (Castro-Pinero, et al., 2010; Tomkinson, Lang, Blanchard, Leger, & Tremblay, 2019). This research places some caution when interpreting progress in this test.

Some students (table 1) have negative progress in one of the tests. Also, according to 20m shuttle run (PACER) goal table (California Department of Education) 38% boys and 35% girls didn't achieve Healthy Fitness Zone. It is important to determine the causes of such a condition. Assessing CRF in the school population just makes sense to recognize individuals whose condition has deteriorated significantly in order to respond. Possible causes may be current conditions such as illnesses, low levels of motivation, and they do not represent an alarming situation. However, there can be significant increases in body mass, chronic illness, and some mental states related to the inability to overcome the daily challenges and problems of young people. In such individuals, it is recommended to repeat the test to determine whether the reduced ability level was merely a reflection of current disabilities or whether it was a realistic state of ability. According to Armstrong and Weisman (2019) age and maturity status-driven changes in fat free mass have been revealed as the most powerful morphological influences on the development of youth CRF. Responding to an established condition is the purpose of measuring the level of CRF in a school population.

In conclusion, it is necessary to know the limitations of the selected tests, but also of the participants. This allows proper interpretation of their scores and the progress and evaluation of the effects of the training process as reliably as possible so it could be appropriately intervened.

## Conclusion

The purpose of this study was to determine the difference in relationship between students' age, gender and initial status with their progress between two CRF tests. Only differences in age and initial score are statistically significant. Age was more related to progress in 20 m shuttle run. A possible cause to that may be the fact that the pace in the 20m shuttle run was progressive. It means that higher progress in the test can also be linked to the students' anaerobic capacity. The conclusion is when interpreting the results of the state and the progress in CRF with 20m shuttle run, limiting progress is possible due to age and gender. In that way false conclusions about the success of the transformation processes of its participants would be eliminated.

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## EVALUATION OF THE DANCE SPORT PROGRAMME FOR PRESCHOOL CHILDREN: EFFECT ON THE LEVEL OF MOTOR ACHIEVEMENTS

Lucija Konstantin<sup>1</sup>, Ema Ištuk<sup>2</sup>, Vilko Petrić<sup>3</sup>

<sup>1</sup>University of Zagreb, Faculty of Teacher Education, Croatia

<sup>2</sup>K2K Dance Centre, Rijeka, Croatia

<sup>3</sup>University of Rijeka, Faculty of Teacher Education, Croatia

### Abstract

The aim of the present research is to determine the effect of the dance sport programme on the level of motor achievements in preschool children. The sample of participants consists of a total of 44 girls aged 4.5 to 6. The experimental group consists of 22 girls attending dance lessons in the K2K Dance Centre, while the control group consists of 22 randomly chosen participants attending the Rijeka Kindergarten. The variables were created after the Childfit tests used to measure early and preschool children's motor achievements. The basic descriptive parameters were calculated for both groups, while differences among them were tested by the independent variable Student's t-test. The experimental group shows a statistically significant difference ( $p=0.00$ ) in motor achievements in the domain mastering space and obstacles, which indicates a partial motor development of children attending the dance programme. An early and preschool child needs an integral motor development in order to acquire general motor literacy. In the realisation of specialised sport programmes such as dancing, attention should be paid to the motor knowledge belonging to domains which are not dominantly represented in a certain sport. It is always necessary to ensure children's integral motor development for them to equally advance in all domains of biotic motor knowledge.

**Key words:** *sport programmes, preschool child, motor achievement, dance*

### Introduction

To ensure a child's wellbeing is one of the basic tasks of the National Curriculum of Early and Preschool Education, and it considers the personal, emotional, educational, social and physical wellbeing of a child. When it comes to ensuring the physical wellbeing, what is important is the development of motor skills, acquisition of the habit to move which is by itself the precondition for the acquisition of hygiene and nutrition habits, and consequently the precondition for health. Moreover, the National Curriculum strives to ensure successful functioning and development of personal potentials, whether cognitive, artistic, motor, etc. That means that it is necessary to satisfy a child's initiative, curiosity and wish for learning in various areas (The National Curriculum of Education, 2015). Since there are many areas of interest, besides the integrated sport programme of an early and preschool education institution, specialised sport programmes are also conducted.

The fundamental principle of an integrated sport programme is the correlation between contents of a sport and regular preschool programme. This programme aims are regular growth and development of a child and his/her motor abilities through daily exercises and an individualised approach to the child. The integration of motor skills and knowledge with other constituents of a child's integral knowledge is highlighted. The application of early, but to children adequate kinesiological programmes, can be an efficient way for them to start developing habits for a healthy living as early as at the preschool age. On the other hand, specialised sport programmes are sport trainings conducted after the regular programme of an early and preschool education institution. Such programmes are led by persons trained to work in a certain sport and their programme has to be adapted to children's age and possibilities. It has been established that sport programmes influence children's motor achievements, when motor achievements are defined as a conjunction of motor knowledge and motor skills, and they can be expressed through the possibility of a certain child to connect and make the best use of his/her knowledge and skills in a concrete motor situation, in order to achieve the best possible result (Novak et al., 2014).

Former research has suggested that a sport programme improves children's motor abilities, has a positive impact on engaging in physical activities from the earliest age, and affects the physical literacy of preschool children (Domika et al., 2018; Caput-Joginica et al., 2009; De Privitello et al., 2007). It is thus known today that sport programmes usually have a positive influence on the development of children's kinanthropological characteristics and the acquisition of motor knowledge. What has not been sufficiently studied is how they affect children's motor achievements, i.e. if children know

how to link the acquired knowledge and abilities in certain situations, and use them in order to achieve the best possible result. The motor knowledge which is at the base of organised physical exercising with early and preschool children is called biotic motor knowledge (Petrić, 2019). It enables the child's basic movements in a space, such as mastering space, obstacles, resistance, and objects manipulation, so it can be considered as basic motor literacy.

Therefore, the aim of this research is to determine the effect of a dance sport programme on the level of preschool children's motor achievements.

## Methods

The sample of participants consists of a total of 44 girls aged 4.5 to 6. The experimental group consists of 22 girls attending dance lessons in the K2K Dance Centre, while the control group consists of 22 randomly chosen participants attending the Rijeka Kindergarten.

The variables were created after the Childfit tests used to measure early and preschool children's motor achievements (Petrić, 2019), more precisely the test for the assessment of motor achievements in the domain of mastering space (space), the test for the assessment of motor achievements in the domain of mastering obstacles (obstacles), the test for the assessment of motor achievements in the domain of mastering resistance (resistance) and the test for the assessment of motor achievements in the domain of mastering objects manipulation (manipulation).

The research was co-funded by the University of Rijeka as part of the project uniri-drustv-18-268. Before the sole research was conducted, an agreement had been reached with the K2K Dance Centre leader and the main trainer of the dance group in which the research would be conducted about the way in which the necessary data would be collected. Next, children's parents were informed about the intended research and its aims and their consents for the conduction of the research were collected. The same procedure was applied in the Rijeka Kindergarten. The research was conducted during June 2019, based on four tests carried out during regular dance trainings. The same procedure was carried out with the control group. The dance sport programme is based on a child's need for movement, play and amusement. All is conducted by respecting children's developmental characteristics. A specialised dance sport programme is conducted after the regular programme of the early and preschool education institution. The content of the aforementioned sport programme regards the acquisition of certain dance structures, as well as dance elements and techniques which are part of that structure. The introductory, preparatory part of the class regards the preparation of children and their bodies for the main part of the class when the choreography is usually acquired. To acquire the choreography, which consists of stylized and alternated dance elements and techniques, during the introductory and preparatory part of the class children acquire the basic elements of the dance technique. The final part of the class consists of light movements and games which pacify children and bring their bodies to a relaxed and rested condition. Everyday movements and concepts are usually used to explain a certain step more easily. Except acquiring the dance technique, special attention is paid to rhythm, movement dynamics, space and cooperation.

All the measured data were processed and analysed in the programme STATISTIKA 12.5 (StatSoft, Inc., Tulsa, OK, USA). Results are presented in the form of tables and charts. The basic descriptive parameters were calculated for both groups, while the difference between the control and experimental group was tested by the independent variable Student's t-test. The statistical level of significance was tested with an error of  $p=0.05\%$ .

## Results

Table 1 shows the experimental and control group results. The obtained results show that the average values of all variables are better within the experimental group which can lead to the conclusion that the experimental group examinees are more homogeneous than the control group examinees.

Table 1. Descriptive parameters (mean  $\pm$  standard deviation) for the experimental and control group

Variables	M $\pm$ SD eksperimental	M $\pm$ SD control
Space	4.34 $\pm$ 0.29	7.43 $\pm$ 2.41
Obstacles	6.97 $\pm$ 1.63	9.21 $\pm$ 2.91
Resistance	8.69 $\pm$ 2.06	11.44 $\pm$ 4.34
Manipulation	12.55 $\pm$ 3.00	17.11 $\pm$ 13.71

Chart 1 presents the average values obtained in four motor achievement tests in the domain mastering space, mastering obstacles, mastering resistance and in the domain object manipulation. It can be observed that the experimental group has better average values than the control group in all domains. The greatest difference in average values can be seen in the domain object manipulation where it equals 4.56 seconds in favour of the experimental group. In the domain mastering

space the average value of the experimental group is better for 3.09 seconds, in the domain mastering obstacles it is better for 2.24 seconds while in the domain mastering resistance it is better for 2.75 seconds.

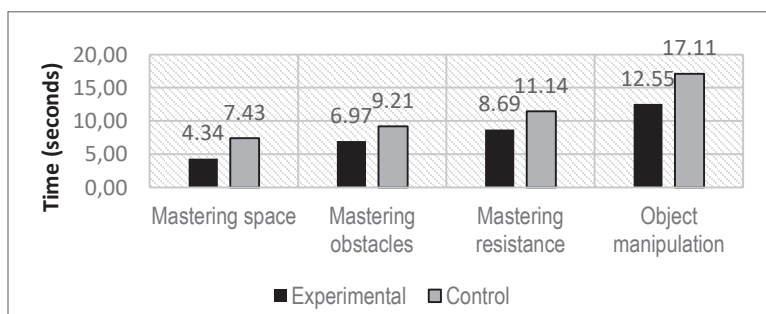


Chart 1. Comparison of average values within the experimental and control group

Although the experimental group achieved better results than the control group in all domains, a statistically significant difference appears only in the domains mastering space and mastering obstacles. Table 2 presents the statistically significant difference in the two domains and, although there is an improvement with regard to the descriptive indicators, the statistical difference is not significant in the domains mastering resistance and object manipulation.

Table 2. Results of differences between ( $M - \text{mean}$ ) the experimental and control group

VARIABLES	M - dance	M - kindergarden	t	p
Space	4.34	7.43	4.19	0.00
Obstacles	6.97	9.21	2.35	0.03
Resistance	8.69	11.44	1.97	0.06
Manipulation	12.55	17.11	1.13	0.27

The analysis of overall results has led to the conclusion that the experimental group is more advanced than the control group in all variables. What is more, there is a statistically significant difference in the domains mastering space and obstacles, which indicates the primary areas stimulated by dance.

## Discussion

The results obtained in this research show that the specialised dance sport programme achieves excellent results in the advancement of motor achievements. Every form of physical activity with early and preschool children has an exceptional significance on their growth and development, on the removal of negative consequences caused by contemporary life, and on a child's integral health (Milosavljević et al., 2018). The experimental group achieved generally better results in all biotic motor knowledge domains which is in line with former research about sport programmes which positively influence the development of children's kinanthropological characteristics and the acquisition of motor knowledge (Domika et al., 2018).

The dance programme primarily develops children's motor abilities in the domains mastering space and mastering obstacles. As a result, the experimental group achieved better results in all motor achievement domains, but a statistically significant difference is only visible in the domains mastering space and mastering obstacles. This can be attributed to the specificities of dance as a sport. The motor contents mostly represented in dance belong almost completely to the two mentioned domains, for instance, walking, running or jumping (Šumanović et al., 2005). The sport programmes contents are specific and based on elements belonging to exactly a specific sport being carried out. While dancing, children constantly use the knowledge in the domains mastering space and obstacles because it is imposed by its standard environment and spatial environment. On the other hand, to master resistance and manipulate objects it is necessary to adapt the space and stimulate children for such movements which is, unfortunately, a rare case. To enable a better improvement of children in these domains of their motor development, it is necessary to include the contents of domains mastering resistance and objects manipulation into the dance curriculum, in line with children's interests and developmental possibilities.

Former research has confirmed the fact that integrated and specialised programmes have a different impact on early and preschool children (Petrić et al., 2018). Integrated sport programmes, contrary to specialised ones, significantly influence the overall motor development, which means that they equally develop all children's biotic motor knowledge domains (Petrić, 2019). This research results indicate possible unwanted consequences of directing a child toward a specific sport too early. To encourage children athletes to develop in only one sport, before being physically and psychologically ready, can lead to negative consequences, for instance, an isolated development of a muscle group and organ function, disruption of the harmonious physical development and biological balance, etc.

## Conclusion

The conducted research has established that the acquisition of dance structures and dance techniques has a significant influence on the motor achievements in the domain mastering space and obstacles. An early and preschool child needs integral motor development in order to acquire the general motor literacy. In the realisation of specialised sport programmes it is necessary to pay attention to the motor knowledge belonging to domains which are not predominant in a certain sport in order to ensure a child's integral motor development and equal growth in all biotic motor knowledge domains.

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## THE INFLUENCE OF ANXIETY ON LEARNING A TUCK JUMP (ON A HORSE VAULT) WITH STUDENTS OF CLASS TEACHER STUDIES

Jurica Lovrinčević, Petar Otković, Tihomir Vidranski

Faculty of Education, Osijek, Croatia

### Abstract

Learning new elements in students can cause different feelings of fear and anxiety. Study was conducted to investigate the extent in which anxiety is present in students of teacher studies prior to the first lesson of learning new gymnastic element, and whether the level of anxiety in students before the first hour and third hour of learning element is different. In this research we also wanted to determine the level of motor skill of the gymnastic element at the end of each class, after the methodical procedure of learning for that class was complete. Results shows that students have physical and cognitive symptoms of anxiety shortly before conducting the first class. Level of anxiety decreases while going through methodical procedure. Assessment of gymnastic element a tuck jump ( on a horse vault) after each lesson has shown that students improve their technique of performing the element with each subsequent hour.

*Key words:* Physical education, Anxiety, motor skills

### Introduction

Jumping is a gymnastics discipline that involves jumping over a fixture, a take off with both legs, and a persistence of hands on the fixture (Živčić - Marković, Stibilj – Batinić, & Badić, 2010). In elementary school, easier and safer types of jumps are performed, such as a tuck jump (on a horse vault) which begins in grade 5 (Živčić - Marković, Stibilj – Batinić, & Badić, 2010). Successful performance of the jump depends on the correctness of the performance of all stages, and is described according to the key positions of the body (Živčić Marković & Krističević, 2016). Through the Teacher studies such as University integrated undergraduate and graduate Teacher study at the Faculty of Education in Osijek, various jumping elements are learned (Fakultet za odgojne i obrazovne znanosti, 2020). Humanistic theory states that anxiety is the result of an experience that does not fit into one's self-image (Larsen & Buss, 2008). Anxiety disorder is the most common childhood disorder, with 6.8% of children and adolescents (Lebedina Manzoni, 2007). According to (Woolfolk, 2016) anxiety can occur whenever there are performance pressures, when failure has serious consequences, and when there is competition and comparison among students. Robins et al. 2004, according to (Vizek Vidović, Rijavec, Vlahović-Štetić, & Miljković, 2014) have shown that emotional stability is related to self-efficacy and, therefore, to school achievement. Exercise, as an additional therapy, may be recommended as a therapy for depressive and anxiety disorders (Mišigoj-Duraković & sur., 2018). A 2004 study by Bobetić (according to (Lebedina Manzoni, 2007) showed worrying results regarding the incidence of anxiety in students (N = 165) at school. Students expressed fear of questioning and concern as a characteristic of the classroom environment, all of which were accompanied by physiological reactions in half of the subjects such as stomach pain, insomnia and increased heart rate. The literature review found a large number of anxiety studies in elementary and adolescent students, and a relatively small number of anxiety studies in university students and physical education in higher education. The aim of the research is to examine the extent in which anxiety is present with students of the University Teacher Studies just before the lesson of acquiring new motor skill with the purpose of confirming the existence of anxiety. Also, it will be examined whether there is a statistically significant difference in anxiety before the first lesson and after two lessons of learning the same motor skill. Furthermore, the association between the level of motor skill and anxiety level will be examined and analyzed, with the assumption of determining the reduction of anxiety level with increasing motor skill level.

### Methods

The sample for the research consists of 96 students (10 male) of the Faculty of Education in Osijek. The average age of the participants is 20. The average students' height is 168.4 cm and the average weight is 60 kg. The measuring instrument used in the conducted research is a questionnaire (Competitive State Anxiety Inventory - 2, CSAI - 2; Martens et al., 1990) that contains 15 items for determining physiological and cognitive symptoms of anxiety. We focused on three physical symptoms of anxiety: tension in the body, increase in heart rate and abdomen pain. Cognitive symptoms were concern of their own performance and calmness. The participants completed the same questionnaire before the first and

the third lesson of tuck jump learning. Also, the questionnaire contained an item that examined students' initial knowledge of performing a tuck jump. The participants responded with yes or no to the statement 'I know how to perform a tuck jump'. Based on previously made criteria, the students received grades at the end of the first, second and third lesson of a tuck jump learning for determining level of motor skill for each student. Data processing was performed by using the computer program Statistica 10.

## Results

The reliability of the applied anxiety symptom scale shortly before the first lesson of tuck jump learning turned out to be excellent and is Cronbach's Alpha = 0.956, and shortly before the third class is Cronbach's Alpha = 0.947.

Table 1. Average values of students' anxiety shortly before the first and last, third lesson of tuck jump learning

	AS (M)	N	Sd.	SEM
Pair 1a	2,2597	96	,78712	,08033
A_after	1,8292	96	,68281	,06969

a - Students' anxiety shortly before the first lesson of tuck jump learning

A\_after - students' anxiety shortly before the third lesson of tuck jump learning

Table 2. T-test for dependent samples on differences in student anxiety levels shortly before the first and third lesson of the tuck jump learning

	Differences a and A_after				t	df	Sig. (2-tailed)	
	AS (M)	Sd.	SEM	95% Confidence Interval of the Difference				
	AS (M)	Sd.	SEM	Lower	Upper			
a - A_after	,43056	,52786	,05387	,32360	,53751	7,992	95	,000

We tested and analyzed three physical and two cognitive symptoms of anxiety. Results are following: before the first lesson of learning a tuck jump (on a horse vault), 36 students (38%) feel a great deal of tension in the body, of which 15 (16%) feel very intense tension in the body, 21 students (22%) have intense tension in the body. 35 students (36%) feel low body tension and 25 students (26%) do not feel any body tension. Before taking third lesson, 51 student (53%) feel no tension in the body, and only 11 students (11%) feel very intense tension in the body, 34 students (35%) feel a slight tension in the body. When heart rate tested before first class, 44 students (46%) does not feel their heart rate increasing while 52 students (54%) feel increase in heart rate. Before third class, 68 (71%) does not feel any increase in heart rate, and 29% of students feel increase in heart rate. Results from abdomen pain before first class says that 52 students (54%) does not feel abdomen pain, 24 students feel small abdomen pain, 14 students (15%) big abdomen pain and 6 students (6%) very big abdomen pain. Before third class results are 74 students (77%) doesn't feel abdomen pain, 14 students small abdomen pain, 5 students big abdomen pain and 3 students very big abdomen pain. Answering the question about the concern of their own performance (cognitive symptoms) before first class 21 students (22%) were not concerned about their own performance, 29 students (30%) expressed less concern, 27 students (28%) were rather concerned, and 19 students were very concerned. The results before third class show that 45 students (47%) are not concerned at all, 31 students (32%) are less concerned, 17 students (18%) are quite concerned, and only 3 students (3%) are very concerned. Results from cognitive symptom calmness imagining achieving their own goal in the performance of a tuck jump are following: 33 students (34%) are not at all calm and cannot imagine achieving their own goal in the performance of a tuck jump, 23 students (24%) find it less calm, 27 students (28%) are quite calm, and 13 of students (14%) shows a very strong composure and before third class: 17 students (18%) who are not calm at all, 27 students (28%) find it less calm, 23 (24%) are quite calm, and 29 of (30%) shows a very strong composure.



Table 3. Non-parametric test of the correlation between the total assessment of tuck jump motor skills in the second and third lesson and the level of anxiety (Spearman's Rho correlation test)

			2.	3.	a	A_after
Spearman's rho	2.	Correlation coefficient	1,000	,897**	-,434**	-,653**
		Sig. (2-tailed)		,000	,000	,000
		N	96	96	96	96
	3.	Correlation coefficient	,897**	1,000	-,464**	-,653**
		Sig. (2-tailed)	,000		,000	,000
		N	96	96	96	96
	a	Correlation coefficient	-,434**	-,464**	1,000	,731**
		Sig. (2-tailed)	,000	,000		,000
		N	96	96	96	96
	A_after	Correlation coefficient	-,653**	-,653**	,731**	1,000
		Sig. (2-tailed)	,000	,000	,000	
		N	96	96	96	96

#### Legend

\*\* - The correlation is significant at the  $p < 0.01$  level

2. - Students' grades at the end of the second lesson of tuck jump learning

3. Student' grades at the end of the third lesson of tuck jump learning

a - Students' anxiety shortly before the first lesson of tuck jump learning

A\_after - students' anxiety shortly before the third lesson of tuck jump learning

67 students (70%) stated that they did not know how to perform a tuck jump and received a grade of 0. The average grade of the students who performed a tuck jump after first class is 1.70.

In the second lesson, 29 students (30%) failed to perform a tuck jump, and were given a grade of insufficient (1). Students' average grade for performance of a tuck jump in the second lesson is 2.75. In the third lesson, 28 students (29%) failed to perform a tuck jump and were given a grade of insufficient (1). Students' average grade for performance of a tuck jump in the third lesson is 3.23.

## Discussion

The results show that the tension in the body decreased before the third lesson of learning the cramp. Before taking third lesson, 51 student (53%) feel no tension in the body in compared with 26% before first class, and only 11 students (11%) feel very intense tension in the body compared to 38% before first class. In regards to conclusions from (Lebedina Manzoni, 2007) of around 6,8% children and adolescents having anxiety disorders, we can see much greater percentage of students having symptoms of anxiety when performing this element. When looking at the results of the variable heart rate, they increase from 46% to 71% in favor of those who do not feel increasing of the heartbeat. According to that, we can conclude that, before first class, students feel a greater level of anxiety about performing the element compared to the anxiety level on before third lesson. By increasing the level of motor skill, the heart rate variable, ie the degree of anxiety, decreases. Results show difference in the Abdomen pain variable. Before taking the first class, 52 students (54%) did not feel abdomen pain, while analyzing results before taking the third class says number increased to 74 students (77%). Before taking third class of learning a tuck jump (on a horse vault), there is a significant decrease in abdomen pain. These variables are considered as physical symptoms of anxiety. The study showed that students achieved the above mentioned physical symptoms of anxiety on higher level before taking the first class compared to the levels of anxiety before taking third class of learning a tuck jump (on a horse vault). This results agree with the conclusions of (Woolfolk, 2016). Most of the students had some symptoms of anxiety because of the pressure of performing the element. Answering the question about the concern of their own performance, results from third class improved compared to results before first class. This can be attributed to the lack of skills in technique of performing the jump and the complexity of the gymnastic element itself. Before taking third class, there is less concern about the performance of a tuck jump (on a horse vault). It can be concluded that the majority of students (78%) are concerned about the performance before the first class, and the concern is reduced before the third class (47%). Also, one more cognitive symptom achieve improvement through the methodological process of learning a tuck jump. We can see reduction of students who are not calm at all before taking the first class of learning (33% to 18%) and in the group of students who shows a very strong coposure (14% to 30). The results obtained in this statement relate to the students' perceived self-efficacy, which is the perceived ability to cope with specific situations, that is, the perception of one's own abilities for activities in future situations, in this case performing a gymnastic element a tuck jump (on a horse vault). The perception of self-efficacy influences many different types of behaviors that are necessary for human achievement. People with low feelings of self-efficacy show a

tendency for anxiety during the task, restlessness, quitting, and re-examining their abilities (Pervin, D., & John, 2008). This statement confirms that students with higher level of anxiety achieve lower grades which later leads to quitting and re-examining their own abilities. It can be concluded that the calmness of the students increases before the third hour of learning a tuck jump (on a horse vault). The average grade of all students before first class is 1.70. By examining the initial condition and level of motor skill of students it can be concluded that the majority of students (70%) do not know how to perform a tuck jump (on a horse vault). Students' average grade for a second-class performance is 2.75. The students' average grade after a third lesson of learning the element 3.23. It can be concluded that, after each lesson the technique of performing a tuck jump (on a horse vault) is improved in students, and thus the average grade is increased. Like in the research from (Vizek Vidović, Rijavec, Vlahović-Štetić, & Miljković, 2014) when level of anxiety and emotional stability are related to academic achievements.

All three hypotheses proposed prior to the study were confirmed by analyzing the students' responses to the statements in the anxiety questionnaire, as well as the students' grades for the performance of the tuck jump. The students show physical and cognitive symptoms of anxiety before the first lesson of tuck jump learning, and the results of the t-test for dependent samples show that the students report, on average before the third lesson of tuck jump learning, statistically significant lower anxiety than before the first lesson of tuck jump learning,  $t(95) = 7.99$ ,  $p < .001$ . Likewise, students' grades are increasing with each lesson, and the technique of performing the tuck jump is improving.

## Conclusion

The study conducted on a sample of 96 students of the Faculty of Education identified physiological and cognitive symptoms of anxiety before the first lesson of tuck jump learning. Out of the 15 statements in the anxiety questionnaire, intensity of all of physical symptoms decreased in students shortly before the third lesson of tuck jump learning. Comparing the results from questioning cognitive symptoms before first and third lesson we can conclude that all cognitive symptoms decreased in the students shortly before the third lesson of tuck jump learning. Analyzing the grades after each new lesson, we can see that tuck jump technique was improving, as well as the grades. Furthermore, the results show a significant negative association between students' anxiety levels before the third lesson of tuck jump learning and anxiety levels ( $r = -0.653$ ,  $p < 0.01$ ). The higher the level of anxiety in the students, the lower were the results of their assessment of tuck jump motor skills performance. In this study there was a big difference in the ratio of men and women, so following researchers should focus on questioning levels of anxiety classified by gender and see if male and female students have different levels of anxiety while learning motor skills.

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## SELF-ESTEEM DIFFERENCES AMONG MEDICAL STUDENTS ACCORDING TO GENDER AND YEAR OF STUDY (GENERATION)

Tonći Mašina<sup>1</sup>, Milan Milošević<sup>1</sup>, Sanja Ćurković<sup>2</sup>

<sup>1</sup>University of Zagreb, School of Medicine, Croatia

<sup>2</sup>University of Zagreb, Faculty of Agriculture, Croatia

### Abstract

According to demanding long-term study, continuous improvement, academic stress, it is important for students to continuously apply a lifestyle that will support the preservation and development of a sense of self-esteem. Determine the level of self-esteem for medical students and examine whether there are differences in the level of self-esteem by gender and year (generation) of studies. The cross sectional study was conducted on a sample of 1197 students (36% male). Data were collected by self-administered anonymous questionnaire: Rosenberg Self-esteem scale (RSS) and analysed by descriptive statistics and non-parametrical tests. The 941 Rosenberg Self-esteem scale questionnaires were collected and analysed (response rate of 79%). In total Self-esteem score (male M=44,00; IQR=39,00-47,00 vs. female M=41,00; IQR=36,00-45,00) both genders showed high level. Significant differences between genders were observed in total Self-esteem score. Significantly higher score was observed among second-year students in; independent sample, group B2 vs A2, 41,00 (36,00-45,00) vs 44,00 (39,00-47,00),  $p < 0,001$  and group C1 vs A2, 42,00 (36,50-46,00) vs 44,00 (39,00-47,00),  $p = 0,029$  and dependent sample, A2 44,00 vs A1 41,50;  $p = 0,002$ . In order to adapt students more effectively to the challenges of academic education, it would be necessary to provide students with many different contents within the faculty, in addition to which the students would also meet the needs for exercise, socializing and the like.

**Key words:** Medical students, Self-esteem, Gender differences

### Introduction

The most dynamic development period of growing up happens during the transition between high school and college. It's a period determined by taking responsibility for oneself, one's own health and one's relationships, Mašina and Milošević (2012), and Ćurković (2010).

The college surroundings, because of its role in educating the young, represents an ideal medium for promoting a healthy lifestyle, Tsouros et al. (1998). In addition to that is a fact that the student lifestyle is under a massive impact by the students' surroundings, Peker and Bermek (2011).

Because of everything stated, changes in self-esteem of the young are possible and they can impact other parts of their lives. Coopersmith (1967.) determines self-esteem as an estimate of how much an individual accepts or discards themselves, and that evaluation indicates the level of belief in one's own abilities, importance, success and value.

Many researches analyse how demographic variables such as gender, race, etc. are connected with self-esteem. The goal is to determine which groups of people have a good level of self-esteem and which groups of people are more prone to develop low self-esteem levels. Gender is one of the more important traits of social identification and recent researches confirm that male adolescents have higher levels of self-esteem compared to their female peers, even though the difference is small, Feingol (1994) i Kling et al. (1999).

Among student population results show that male students have higher levels of self-esteem compared to female students. Furthermore, a significant correlation between happiness and self-esteem has been confirmed. That correlation was noticed among male students, Sadia Malik (2013).

Among higher-than-average physically active students a negative correlation between stress and self-esteem was noticed. At the same time, a correlation between physical activity and perceived stress. No correlation between physical activity and perceived stress as well as physical activity and self-esteem, Hubbs et al. (2012).

Self-esteem and intense physical activity represent the preventative factors for stress while moderate physical activity has shown positive correlation with self-esteem, Li et al. (2014.)

The programme of regular physical activity has been determined as an influential variable to better self-esteem and lower the feeling of hopelessness among female students in Turkey, De Sousa Fortes et al. (2014). The research results

indicate that self-esteem is influenced by dissatisfaction with one's own body. Negative self-esteem is under a bigger influence of dissatisfaction with one's own body compared to positive self-esteem and satisfaction with one's own body.

High level of self-esteem is desirable among students, especially medical students. Taking into consideration the intensity and length of the college programme, constant need for improvement and stress, it is desirable that the students continuously live a lifestyle that will support the already existing self-confidence. In that way, the students will be able to maturely deal and respond to the demands of a modern doctor's life. The main goal of this research is to determine the levels of self-esteem among male and female medical students and to examine if a differentiation between the levels of self-esteem exists according to gender and the year of study.

## Materials and methods

The sample in this research is made up of students in their 1<sup>st</sup> and 2<sup>nd</sup> year of Medical Faculty, University of Zagreb out of which:

- for the needs of the cross sectional study students in the 2<sup>nd</sup> year of study ( generation 2012/13) are incorporated in the measurement . 192 students were included in the sample (79 male and 113 female students – group B2) and students in the 1st year of study (generation 2014./2015.) in which 254 students were included (92 male and 162 female students – group C1)
- for the needs of cohort research, students in their 1<sup>st</sup> year of study were incorporated (generation 2013./2014). They were examined as freshmen in university (group A1) and in sophomore year (group A2). In the initial measuring 258 students were included (91 male and 167 female students). At the final measuring 237 students were included (83 male and 154 female)

The survey of examined groups was conducted during the summer semester, between March and May 2014. and 2015. Permission was granted by Ethical committee of Medical Faculty, University in Zagreb (Ur. Broj: 380-59-10106-16-20/159, Klasa: 641-01/16-02/01).

## Self - esteem

To determine self-esteem, Rosenberg's scale of self-esteem (RSS) was used, which is regularly used to track the self-esteem among medical students at the Medical faculty, University of Zagreb, Rosenberg (1965). It is a one-dimensional scale which consist of 10 items which measure the total self-esteem, including both positive and negative feelings towards oneself. The questionnaire is scaled on a five point Likert scale with answers ranging from "completely incorrect" (1) to "completely correct" (5). The results of the questionnaire are determined by adding the circled numbers that are attached to a certain answer. It is important to note that the answers to the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 9<sup>th</sup> answers are scored in the opposite way. Higher results indicate a higher level of self-esteem.

## Statistics

The data is shown graphically and in tables. Using Smirnov-Kalmogorovlj's test the distribution of continuous data. In further statistical breakdown non-parameter tests were used. With Kruskal-Wallis's test (analysis of more than 3 questioned groups) with post-hoc Mann-Whitney U test, the differences between continuous values between certain independent groups were analysed. Dependent differences were analysed with the Wilcoxon's test. All P values smaller than 0.05 are considered important. In this analysis, the programme support IBM SPSS Statistics version 25 was used ([www.ibm.com/analytics/data-science/predictive-analytics/spss-statistical-software](http://www.ibm.com/analytics/data-science/predictive-analytics/spss-statistical-software)).

## Results

The analysis of the research shows that three generations of male and female students are incorporated into this research. 1197 baccalaureates and medical students in their freshman and sophomore year of study were invited to participate in the research. In total, the data that was sampled and analysed comprised of 941 medical students. The total count of answers was 79% (male students 80%, female students 79%). The total percentage of men and women that participated is 1.73, with 37% men and 63% women (Table 1).

Table 1. Cohorts encompassed by the research, number and percentage of male and female students included in the research

Group	Year of study	Academic year	Planned	Comprised (males + females)	%
A1	1 <sup>st</sup> year	2013/2014	301	258 (91+167)	86
A2	2 <sup>nd</sup> year	2014/2015	298	237 (83 + 154)	92
B2	2 <sup>nd</sup> year	2012/2013	298	192 (79 + 113)	64
C1	1 <sup>st</sup> year	2014/2015	300	254 (92 + 162)	85

A, B, C – name of the group 1,2 – year of study (1-first year, 2-second year)

Descriptive indicators of self-esteem levels show that the highest values of self-esteem were achieved by the students in group C1, 45,00 (41,00–47,00), then students in group A2, 44,00 (39,00–48,00), A1 43,00 (37,00–46,00) and then B2, 42,00 (38,00–46,00).

Among female students the highest values in the research were noticed in group A2, 43,00 (38,00 – 47,00), then students in groups B2, 40,50 (35,25–44,00) A1 40,00 (36,00–44,00) and C1,40,00 (35,00–45,00).

Table 2. Descriptive indicators of the level of self-esteem for male and female students

Level of self-esteem	N	AS	SD	Min	Max	Centile			
						25.	Medijan	75.	
RSS male students	A1	91	41,13	7,05	19,00	50,00	37,00	43,00	46,00
	B2	79	41,58	5,56	26,00	50,00	38,00	42,00	46,00
	C1	91	43,10	6,02	24,00	50,00	41,00	45,00	47,00
	A2	83	41,48	7,70	18,00	50,00	39,00	44,00	48,00
RSS female students	A1	165	40,09	5,62	23,00	50,00	36,00	40,00	44,00
	B2	112	39,39	6,55	18,00	50,00	35,25	40,50	44,00
	C1	162	39,62	6,23	20,00	50,00	35,00	40,00	45,00
	A2	153	42,14	5,99	22,00	50,00	38,50	43,00	47,00

N-number of the examinees; AS-arithmetic mean; SD-standard deviation

### Differences in self-esteem by gender

A significant difference was noticed with male students scoring higher results on the scale in comparison to their female counterparts 44,00 (39,00 – 47,00) vs. 41,00 (36,00 – 45,00),  $p < 0,001$  (Table 3).

Table 3. The different indicators of self-esteem divided by gender

Level of self-esteem	N	AM	SD	Min	Max	Centile			P	
						25.	Median	75.		
RSS total	Male	253	42,09	6,51	18,00	50,00	39,00	44,00	47,00	0,001
	Female	427	40,47	6,34	18,00	50,00	36,00	41,00	45,00	

N- number of the examinees; AM- arithmetic mean; SD- standard deviation

### The differences in the „levels of self-esteem“(RSS) in regards to the year of study

Kruskal Wallis test was used to analyse differences according to the year of study in the area of self-esteem. A significant difference was noticed, Kruskal-Walis 13,759;  $df$  3;  $p = 0,003$ .

With additional analyses the significant differences between significant samples were noticed between:

- groups B2 and A2, 41,00 (36,00–45,00) in comparison to 44,00 (39,00–47,00),  $p < 0,001$  and
- groups C1 and A2, 42,00 (36,50–46,00) in comparison to 44,00 (39,00–47,00),  $p = 0,029$  (Table 4).

In dependent sample a significant difference in the amount of self-esteem was noticed, meaning that the students in the last measuring achieved higher results in comparison to the beginning measuring (A2 44,00 vs A1 41,50;  $p = 0,002$ ).



Table 4. Differences in the levels of self-esteem divided by year (generation) of study

Self esteem	N	AM	SD	Min	Max	Centile			Pa	Pb	Pc	Pd	Pe	Pf
						25.	Median	75.						
A1	256	40,46	6,17	19,00	50,00	37,00	41,50	45,00	0,231	0,001	0,744	0,33	0,029	0,002
B2	191	40,30	6,24	18,00	50,00	36,00	41,00	45,00						
C1	253	40,87	6,37	20,00	50,00	36,50	42,00	46,00						
A2	236	41,91	6,63	18,00	50,00	39,00	44,00	47,00						

N – number of the examinees; AS – arithmetic mean; SD – standard deviation; P<sub>a</sub> – level of significance between groups B2 and C1; P<sub>b</sub> – level of significance between groups B2 i A2; P<sub>c</sub> – level of significance between groups A1 and B2; P<sub>d</sub> level of significance between groups A1 i C1; P<sub>e</sub> level of significance between groups C1 and A2; P<sub>f</sub> – level of significance between groups A1 i A2

## Discussion

The achieved results in this research indicate to the fact that male and female students have a high level of self-esteem, however, the male students show higher levels of self-esteem in comparison to their female counterparts. Besides that, female and male students in their 2<sup>nd</sup> year of study (group A2) have significantly higher levels of self-esteem in comparison to the students in other examined groups (A1,B2,C1). Some previous researches and meta-analyses confirm the results of this research and state that male students have higher self-esteem levels in comparison to their female counterparts. However, the noticed difference is small. Bachman at al. (2011), Feingol (1994) and Abedalhafiz at al. (2012).

Lower self-esteem values among medical students were discovered by Amin at all(2018.) and in this research, while Naderi at al. (2009.) note results that show that female students have a higher level of self-esteem in comparison to male students. Their research shows that female students in Turkey have better self-esteem than their male colleagues. Possible reasons for male students having higher levels of self-esteem in comparison to their female counterparts indicated in this research could depend on the PA and stress levels. According to Li at al. (2014.), self-esteem positively correlates with the total and moderate levels of PA while body image is a significant determinant of self-esteem De Sousa at al. (2014.).

The researches of Mašina and Milošević (2012.), Peker and Bermek (2011.), and Senjam and Singh (2012.) indicate higher levels of PA among male medical students in comparison to female medical students. Therefore, it is safe to assume that the higher level of PA is the reason for the higher levels of self-esteem among male students in comparison to female students.

Stress on the other hand negatively correlates with self-esteem (Hubbs at al. 2012.) Medical students are exposed to high levels of stress because of the huge academic load, need to adjust to newly found life situations at the beginning of their student lives along with lifestyle changes, regardless of gender. Since male students have better developed stress coping mechanisms than their female counterparts, Mašina at al. (2017), Senjam and Singh (2011), we can conclude that is a likely reason for the higher levels of self-esteem.

Besides the differences between genders in the levels of self-esteem medical students are differentiated by the generation/year of study in this analyzed sample. Unfortunately, recent literature doesn't have any available researches that dealt with the differences in levels of self-esteem according to the year of study, so it is not possible to compare the achieved results with any relevant researches among other samples of student population. It is safe to assume that the male and female students comprising the cohort research had extra motivation to improve their lifestyle, which impacted the achieved levels of self-esteem in this research.

## Conclusion

To allow students a better adjustment to the demands of the academic education, it is necessary to enable them various programmes incorporated at their University. That way, students would be able to satisfy their need for movement, exercise and socialization, along with fulfilling their academic obligations. Physical activity and organized physical exercise positively impact the levels of self-esteem and those two components work preventatively in unison as protection for the students' mental health.

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# THE EFFECTS OF JUDO PHYSICAL EDUCATION COURSE ON MUSCULOSKELETAL FITNESS OF MALE UNIVERSITY STUDENTS: A CONTROLLED STUDY

Mohammed Hamdan Hashem Mohammed, Jun Choi Hong

*King Fahd University of Petroleum & Minerals, Saudi Arabia*

## Purpose

Martial arts has been recommended as an exciting sport for Physical Education (PE) curricula (Winkle & Ozmun, 2003). This study aimed to determine if Judo in a PE setting could improve the musculoskeletal fitness of university students.

## Methods

Twenty-seven students enrolled in the Judo course. The duration of the course was eight weeks, twice a week with 50 minutes per session. The course included training for muscular fitness, flexibility, explosive strength, and cardiovascular fitness. The course also included sparring matches and sport-specific training. The following musculoskeletal fitness parameters were measured before and after eight weeks: muscular endurance using 60 seconds curl-up test, trunk flexibility using the sit-and-reach test, and explosive leg strength using the standing long jump test. Parametric tests were used to compare the students to a control group (N=32) to detect any effect of the course on the students. Differences with  $p \leq 0.05$  and Vargha-Delaney effect size (VD)  $\leq 42\%$  or  $\geq 58\%$  were considered evidence for any improvements in these fitness parameters.

## Results

All of the tested parameters improved while those of the control group dropped ( $p \leq 0.05$  and  $VD \leq 42\%$  or  $\geq 58\%$ ). Moreover, the changes in the parameters of Judo students were significantly different from the decline in the control group ( $p \leq 0.05$  and  $VD \leq 42\%$  or  $\geq 58\%$ ).

## Conclusions

Eight weeks of Judo in a PE context improved the musculoskeletal fitness of male university students. Judo is not only an exciting addition to a PE curriculum, but can be used to improve musculoskeletal fitness in a PE context.

*Key words: Judo; health-related fitness; physical education; university*

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## RELATIONSHIP OF CARDIORESPIRATORY FITNESS AND PHYSICAL ACTIVITY LEVEL OF PUPILS

Ivana Nikolić, Snježana Mraković, Srna Jenko Miholić

University of Zagreb, Faculty of Teacher Education, Croatia

### Abstract

The aim of this study was to determine predictive values of body mass index, motor abilities, level of physical activity (PA) and sedentary behavior on cardiorespiratory fitness of pupils. The sample consisted of fourth grade pupils (N=74) of the city elementary school aged 10 to 11 years. The predictor set of variables consisted of body mass index, two motor tests for the assessment of agility and repetitive strength as also daily time spent in sedentary activities and high, medium and low intensities calculated on the basis of the Youth Physical Activity Questionnaire (YPAQ). The criterion variable was the result in 3 min running test. The relationship was calculated by the regression analysis. The results of this sample show a high percentage of physically active children, 60 (81%) who meet the WHO recommendations of  $\geq 60$  min/day of moderate to vigorous PA. The highest partial effect on cardiorespiratory fitness shows test for the assessment of coordination, agility and explosive strength (BETA=-.507;  $p=.000$ ) and body mass index (BETA=-.306;  $p=.000$ ), followed by high-intensity PA (BETA=.184;  $p=.004$ ), moderate (BETA=.132;  $p=.037$ ), and the negative impact of sedentary activities (BETA=-.136;  $p=.026$ ). The obtained results and the characteristics of this sample indicate that organized PA in school have an important role in promoting and increasing of a daily high to moderate intensity physical activity.

**Key words:** *physical activity, cardiorespiratory fitness, pupils*

### Introduction

Physical activity (PA) is associated with many health benefits in school-aged children and young people. Despite recommendations of the World Health Organization (WHO) that children and youngsters spend at least 60 min/day in some of the moderate intensity PA, the results show that the level of moderate and vigorous PA decrease by about the ninth year of age (Dalene et al., 2018), and from 9-12 years (Corder et al., 2015) vigorous PA decrease faster. Cardiorespiratory fitness (CRF) is an important indicator of health and can be improved by regular PA, that has a strong influence on health in childhood and adolescence.

Studies show that low level of CRF is a strong predictor for clustering of cardiovascular disease risk factors in children (Anderson et al., 2007), while adequate level of CRF contributes to improving and maintaining health status and is used as a prevention of obesity and related health conditions.

Previous research shows that intensification of PA level is necessary, because vigorous PA (Parikh & Stratton, 2011) and hard PA ( $\geq 9$  METs) (Denton et al., 2013) are more strongly associated with CRF in children compared to lower intensities, such as moderate.

The aim of this study was to determine predictive values of body mass index, motor abilities, level of physical activity and sedentary behavior on cardiorespiratory fitness of pupils.

### Methods

The sample of subjects consisted of 74 pupils (41 male and 33 female) of the First elementary school in Čakovec. With the prior consent of the parents, 4th grade pupils aged 10 to 11 years participated in the study.

The sample of variables for the assessment of physical fitness consisted of two anthropometric measures (body height and body weight), based on which the body mass index (BMI) was calculated, two standard motor tests for the assessment of coordination, agility and explosive strength - carrying over by running (COR) and repetitive strength - sit-up (MSU). Cardiorespiratory fitness was assessed by a 3-minute running test (F3).

A youth physical activity questionnaire (YPAQ) was used to assess PA and screen sedentary time in children. The questionnaire estimates physical activities in the last 7 days, and includes organized PA, PA in school, PA in leisure time and sedentary activities, and makes a list of physical activities energy consumption for the youngsters in which they most frequently participate (Ridley, Ainsworth & Olds, 2008). According to Ainsworth et al. (2000) activities were characterized

and scored according to metabolic equivalent intensity levels (METPA scores) as high-intensity PA (>6 METs), moderate intensity PA (3.0-6.0 METs), light intensity PA (1.6-3.0 METs) and sedentary activities (<1.6 MET). For example, the total time spent in moderate to high intensity activities (MVPA) in 7 days was calculated by summing all physical activities whose MET value was greater than 3 and the average values expressed in minutes per day. The questionnaire was translated into Croatian language, with some PA being replaced by culturally more appropriate activities for this region. Prior to the application of the questionnaire, a pilot study was carried out by random selection on the same sample of subjects (N=30) to determine the reliability of the questionnaire by test-retest method in a period of three weeks between the first and the final application. Reliability coefficients were ranged from 0.59 to 0.76 and illustrated acceptable reliability. The lowest coefficient ( $r_{tt}=0.59$ ) was obtained in the variable light activity (min/day) and the highest ( $r_{tt}=0.76$ ) in the variable vigorous activity (min/day). Children filled out the questionnaire in school together with the trained measurer. Basic descriptive statistic parameters were calculated. Regression analysis was used to determine the predictive value of BMI, motor abilities and level of PA on the criterion variable (F3). The obtained data were processed using the statistical data processing package «SPSS for Windows 17.0».

## Results and Discussion

Of the total sample of subjects (N=74), the majority are involved in organized sports activities, and only 7 (9.5%) are not involved. The majority, 31 of them (41%), are involved in football, basketball and volleyball. In dance activities are included 12 (16%) respondents, sports with racquet 7 (9%), martial arts 5 (6%) and individual sports such as gymnastics, athletics and swimming 12 (16%).

Table 1. Descriptive statistics of the variables

Variables	Min	Max	AM	SD	Skew	Kurt	KS-Z
BH (cm)	133.40	164.00	148.08	6.68	-.055	-.642	.701
BW (kg)	23.60	63.30	39.75	9.69	.829	.012	.253
BMI	12.80	30.30	18.15	3.80	1.184	.698	.042
COR (sec)	9.70	17.25	11.58	1.23	1.544	4.820	.480
MSU	14	38	22.39	3.63	.797	3.800	.459
F3	250	900	685.88	114.57	-.909	1.937	.563

Legend: BH-body height, BW-body weight, BMI-body mass index, COR- carrying over by running, MSU-sit-up, F3-3-minute running test

The average body mass index (BMI) is  $18.15 \pm 3.80$ , with a minimum score of 12.80, and maximum of 30.30. Higher values of asymmetry coefficients (Skew) in the variables BMI and carrying over by running (COR) indicate the grouping of subjects in the lower values zone with a few extremely high values.

Table 2. Descriptive statistisc of the physical activity

Variables	Min	Max	AS	SD	Skew	Kurt	KS-Z
VIGPA(min/day)	3.00	188.57	33.13	30.63	2.02	7.73	.071
MODPA(min/day)	4.00	195.71	72.61	45.54	.947	.025	.028
MVPA(min/day)	27.86	265.00	107.02	53.35	1.150	1.178	.071
LIGHPA (min/day)	2.14	192.86	43.98	40.07	1.446	2.215	.072
SST (min/day)	85.71	490.00	298.56	100.02	.020	-.739	.914

Legend: VIGPA-vigorous PA, MODPA-moderate PA, MVPA-moderate to vigorous PA, LIGHPA-light PA, SST-sedentary screen time

Table 2 shows that children spend daily in moderate to high/vigorous intensity PA (MVPA) from 27.86 min to 265 min ( $107 \pm 53.35$  min/day). Skew in the variables VIGPA, MODPA, MVPA indicates the grouping of subjects in the lower value zone with a few extremely high values. There is a high percentage of physically active children, 60 (81%) who meet the WHO recommendations of  $\geq 60$  min/day of moderate to vigorous PA, compared to the results (Inchley et al., 2016) of the PA of Croatian school children conducted in 2013./2014. year as part of the international HBSC project which shows that only 39% boys and 26% girls, aged 11 were in MVPA at least 60 min/day. One reason for this difference can be assumed to be the validity of the YPAQ questionnaire (McCrorie, Perez & Ellaway, 2016), which shows an average overestimation of MVPA for 25 min/day in relation to the direct method of measurement. Also, the characteristics of this sample show a high representation in organized leisure PA, as well as in school PA. Beside of the regular physical education classes, 50 children had extracurricular sports activities as part of their regular primary education, and 30 children attended

the universal sports school, twice a week for 45 min. Comparing the average values of time spent in MVPA to peers surveyed by the same questionnaire, respondents of this sample have higher values by 18 min (Raistenskis et al., 2015), by 7 min (Mc Crorie, Perez & Ellaway, 2016) and 32 minutes (Brooke et al., 2014). The high dispersion of results is in the sedentary activity variable and ranges from 85 to 490 min/day ( $298 \pm 100.02$  min/day). The respondents spent in sedentary activities average 5 hours/day and are similar to British peers (Klitsie et al., 2013), who spend 35 hours/week. Compared to Lithuanian peers who self-reported with the same questionnaire (Raistenskis et al., 2015), respondents in this sample spend 2.5 h more in sedentary activities per day.

Table 3. Regression analysis for cardiorespiratory fitness (F3)

R=0.88;R <sup>2</sup> =0.78;Adj.R=0,75 F(7.66)=33.69;p=0.00;SEE=56.34	B	SE	Beta	t	p
COR	-47.138	8.492	-.519	-5.725	.000
MSU	2.843	2.393	.090	1.317	.192
BMI	-9.214	2.290	-.306	-4.024	.000
VIGPA (min/day)	.687	.235	.184	3.010	.004
MODPA (min/day)	.332	.155	.132	2.133	.037
LIGHPA (min/day)	-.087	.189	-.030	-.462	.646
SST (min/day)	-.156	.061	-.136	-2.211	.026

Legend: COR-carrying over by running, MSU-sit-up, BMI-body mass index, VIGPA-vigorous PA, MODPA-moderate PA, MVPA-moderate to vigorous PA, LIGHPA-light PA, SST-sedentary screen time

According to the value of the coefficient of multiple correlation ( $R=0.88$ ), with a significance level of  $p=.00$  it can be established that there is a statistically significant correlation between the predictor and criterion variable CRF (Table 3). The value of the coefficient of determination shows that the set of predictors explained 78% of variance of the criterion variable, i.e. mostly according to corrected coefficient of determination, 75% of the criterion variance CRF. The highest partial influence ( $BETA=-.507$ ;  $p=.000$ ) is indicated by the test COR and BMI ( $BETA=-.306$ ;  $p=.000$ ). The predictive value of the PA variables on CRF showed the highest partial impact of high-intensity VIGPA ( $BETA=.184$ ;  $p=.004$ ), followed by moderate MODPA ( $BETA=.132$ ;  $p=.037$ ), and a negative impact of sedentary SST ( $BETA=-.136$ ;  $p=.026$ ) activities. Variables MSU and time spent in LIGHPA were not significantly related with the criterion variable. A negative correlation between BMI and CRF has been identified by other authors on a sample of peers (Hussey et al., 2007), showing that normal weight children have lower BMI and greater aerobic capacity in higher intensity activities than children who have higher BMI and lower aerobic capacity. Similar results are reported by Bonney et al. (2018) according to which overweight and obese children have reduced cardiorespiratory capacity compared to peers with normal weight. The negative correlation of BMI with aerobic capacity in a sample of subjects of the same age is cited by Gontarev and Ruzdi (2014) and Ceshia et al. (2016). Positive correlations between time spent in higher intensity PA and CRF are in accordance to research on children of similar age. Denton et al. (2013) found that for boys, vigorous and hard intensity PA ( $\geq 9$  METs) were significantly correlated to CRF. Gutin et al. (2005) in their research reports that adolescents who engaged in relatively large amounts of vigorous PA tended to have a better CRF and smaller, but significant proportion moderate PA of the variance in CRF. The importance of high intensity PA on CRF level (Ruiz et al., 2006) is shown in children who engaged  $>40$  min of vigorous PA/day had higher CRF than did those who accumulated  $<18$  min of vigorous PA/day. The correlation between variable light intensity PA and CRF is in accordance with studies (Aires et al., 2010; Yang et al., 2019) who found that light PA (1.5–2.9 METs) was not significant when associated with CRF. The negative significant correlation of sedentary activities with CRF indicates that children who spend more time in daily sedentary activities have significantly lower CRF. The results are not congruent with the study by Denton et al., (2013) in which no significant correlation was obtained.

## Conclusion

The results of this observational study may be useful in understanding the correlations between CRF and PA of different intensities in early school age children. Although the assessment of PA was performed by the indirect questionnaire method, the majority of subjects in this sample met the recommendation of daily PA, and the results confirm the previous understanding of the importance of intensifying high and moderate PA intensity in improving CRF. The lack of research is a small and convenient sample of a city school, so the obtained results cannot be generalized. However, the results and the characteristics of this sample also indicate that organized PA at school have an important role in promoting and increasing daily moderate to high intensity physical activity.

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## PHYSICAL ACTIVITY AND PHYSICAL EDUCATION CLASSES FOR STUDENTS DURING THE COVID - 19 PANDEMIC

Josipa Peršun<sup>1</sup>, Katarina Knjaz<sup>2</sup>, Srna Jenko Miholić<sup>3</sup>

<sup>1</sup>Faculty of Chemical Engineering and Technology, University of Zagreb

<sup>2</sup>Faculty of Graphic Arts, University of Zagreb

<sup>3</sup>Faculty of Teacher Education, University of Zagreb

### Abstract

In March 2020, regular contact classes in Physical Education at the University of Zagreb were interrupted and transferred to a virtual environment. It was one in a series of restrictive measures adopted to combat the Covid-19 pandemic caused by Coronavirus-2, which has greatly changed not only the usual way of life but also physical activity which is known to have numerous positive effects on individual health and society as a whole. Distance learning was conceived in such a way that students have partial freedom to create activities they need to perform using the information and tasks provided through a variety of online and digital tools. The aim of this study was to determine the existence of differences in physical activity before and during the pandemic and differences in physical activity with according to gender. The aim was also to determine students' attitudes towards the new form of (online) teaching. The research was conducted through an anonymous online questionnaire on 189 students of one of the faculties of the University of Zagreb, with an average age of  $19.98 \pm 0.84$  years. Significantly lower levels of physical activity were found in female students before the pandemic and there were differences in physical activity by gender before the pandemic, but not during. The level of physical activity during the pandemic increased compared to the level of physical activity before the pandemic, especially among female students. Most of the respondents have a positive attitude towards online teaching. This research has shown how teaching conceived in this way and the online and digital tools used can increase the level of physical activity and that in the future they should be incorporated into regular teaching.

**Key words:** Covid-19 pandemic, physical activity, students, Physical Education classes

### Introduction

In December 2019, a new severe acute corona virus (SARS-CoV-2) appeared in China, which quickly spread around the world (Zhou et al., 2020) and caused a global crisis. The virus causes a disease called COVID-19. In March 2020, the World Health Organization (WHO) declared a global pandemic, which, on May 2, 2021, numbered a total of 151 812 556 infected people, of which 3 186 817 died. In order to balance the curve of exponential growth of the spread of the virus and given the lack of adequate cure and vaccine, many countries around the world have introduced some form of blockade, i.e., restrictions on the current way of life. Croatia, similar to a large number of countries in Europe and the world, has taken certain anti-epidemic measures. Between March 19 and May 11, 2020, the Civil Protection Headquarters of the Republic of Croatia adopted a number of measures: social distancing, ban on gatherings in public places, restriction of movement between local and regional self-government units, suspension of public transport, closure of a number of institutions, cafes and restaurants; suspension of almost all service activities. Regular, i.e., contact teaching in schools and universities was suspended and transferred to a virtual environment ("remotely"). The number of people working from home was greatly increased. All organized sports activities were prohibited. Fitness centres, gyms, swimming pools and all sports facilities were closed. All of the above has greatly changed the everyday life of most people; their work, schooling, way of spending free time, and thus physical activity (Hossain, Sultana & Purohit, 2020).

Physical activity is a complex behaviour that occurs in a variety of forms and contexts. Free play, household chores, transportation, various types of recreation, activities within the education system (Physical Education) and organized sports are just some of the types of physical activities (Malina, Bouchard, & Bar-Or, 2004). The World Health Organization has defined physical activity as "all movements or activities in daily life, including activity at work or school, recreation or sports activity" (Pan American Health Organization, 2002). It is known that regular physical activity of the appropriate type, frequency, sufficient duration, and intensity, carried out by one's own choice such as recreation, or necessary and even mandatory physical activity has numerous positive effects on physical and mental health (Schuh et al, 2018, 2019) and that insufficient levels of physical activity are one of the four leading risk factors for mortality in the world. Specifically for Covid-19, physical activity has been shown to provide protective elements in the fight against the disease caused by

the virus (Jacob, Tully, & Barnett 2020; Schuch et al, 2020; Simpson and Katsanis 2020).

The recommendations of the World Health Organization (WHO, 2010) for people over the age of eighteen are a minimum of 150 minutes per week of moderate-intensity aerobic physical activity or a minimum of 75 minutes per week of high-intensity aerobic physical activity with daily minimum intervals of ten minutes. Additional health effects can be achieved by doubling the recommended values.

Physical Education (PE) at the University of Zagreb is mandatory in the first and second year of the undergraduate study and is actually the last step of systematic exercise during schooling. One of the most important goals of PE is to prevent premature reduction of ability levels due to insufficient physical activity and to train students for individual physical exercise and rational, meaningful use of their free time. It is performed during 30 classes per semester in the form of exercises.

Student age is a transitional period from adolescence to adulthood. Adolescence has been shown to be a key period in which previously acquired habits that persist into adulthood change or further reinforce (Hallal et al., 2006). Students who are more physically active and in better physical condition show better health-related quality of life, health parameters, and academic success (Ge et al, 2019; Gordon-Larsen et al, 2004; Hervás et al, 2018; Lipošek et al, 2018).

Much has been written about the possible negative health consequences of the pandemic, particularly due to insufficient physical activity as an indirect consequence of quarantine (Hall et al., 2020; Lippi et al., 2020). Special attention is paid to the fact that staying at home and limited movement and social interaction can lead to the appearance and increase of fear, depression, and anxiety (Hammami et al, 2020). Adapted physical activity programs can enhance the suppression of the negative physiological and psychological consequences of restrictions associated with the mentioned pandemic (Chen et al., 2020; Jiménez-Pavón et al., 2020).

The aim of this paper is to determine whether there is a difference in physical activity among students before and during the measures introduced during the Covid-19 pandemic, whether there are differences with regard to gender and what are the attitudes of students towards the introduced online teaching in which both students and professors have found themselves for the first time (and without any preparation).

## Methods

The research was conducted on 189 students of the Faculty of Chemical Engineering and Technology, University of Zagreb, with an average age of  $19.98 \pm 0.84$  years. During the twelfth week of distance learning, the respondents completed an anonymous questionnaire made for the purposes of this research. The questionnaire consists of questions about age, gender, and year of study on the basis of which grouping and analysis were performed, questions about physical activity before and during the Covid-19 pandemic as well as attitudes towards distance learning of Physical Education.

In accordance with the recommendations of the World Health Organization and the Croatian Institute of Public Health, and the previously mentioned restrictions, students were offered several activities to fulfil their obligations for the Physical Education course. In addition to the recommended walking, running, and cycling, they were also offered rollerblading and hiking, as well as independent exercise in their homes. Detailed exercise instructions as well as examples of exercises were available to all students through platforms on which all classes and mutual communication took place.

The obtained data were processed with the statistical software package Statistica - version 13.3 and Microsoft Excel 2016 licensed for the University of Zagreb. After basic descriptive statistics, nonparametric data analysis methods were used to determine differences (Wilcoxon rank test and Mann-Whitney U test). Response frequencies are shown for all variables. The level of statistical significance was set at  $p < 0.05$ .

## Results

The questionnaire was completed by a total of 189 respondents (153 female students - 81% of the total sample and 36 male students - 19%) with an average age of  $19.98 \pm 0.84$  years. The largest share of respondents (60%) is in the first year, 39% in the second year and 1% in the third year of the undergraduate study.

Table 1. Physical activity before and during a pandemic

		total sample		female students		male students	
		%	N	%	N	%	N
I spent all or most of my free time doing things that involve almost none physical activity	before	25,4	48	28,76	44	11,11	4
	during	7,94	15	6,54	10	13,89	5
Sometimes (1-2 times a week) I had physical activity in my free time	before	29,63	56	30,07	46	27,78	10
	during	22,75	43	26,14	40	8,33	3
Sometimes (3-4 times a week) I had physical activity in my free time	before	28,57	54	26,14	40	38,89	14
	during	38,62	73	37,91	58	41,67	15
I often (5-6 times a week) had physical activity in my free time	before	14,29	27	13,73	21	16,67	6
	during	25,93	49	25,49	39	27,78	10
Very often (7 or more times a week) I had physical activity in my free time	before	2,12	4	1,31	2	5,56	2
	during	4,76	9	3,92	6	8,33	3

Wilcoxon's rank test showed a statistically significant increase in physical activity in the entire sample at the time of the COVID-19 pandemic ( $z = 6.60$ ,  $p < 0.00$ ), as well as in the group of female students ( $z = 6.42$ ,  $p < 0, 00$ ). There was no statistically significant difference in physical activity between male students at the time of the pandemic ( $z = 1.76$ ,  $p < 0.08$ ).

Table 2. Differences in physical activity of respondents before and during the pandemic

	gender	Mann – Whitney U test				
		N	Sumrank	U	Z	p
Physical activity before the pandemic	F	153	13844,0	2063,0	-2,33819	0,02
	M	36	4111,0			
Physical activity during the pandemic	F	153	14264,0	2483,0	-0,92	0,36
	M	36	3691,0			

The Man - Whitney test showed a statistically significant difference between male and female students in physical activity before the pandemic, but not during the pandemic.

Table 3. Students' wishes for physical activity during the pandemic

During the pandemic, I want to be physically active	Gender		
	Female N (%)	Male N (%)	Total N (%)
Yes	149 (97,39)	33 (91,67)	182 (96,3)
No	4 (2,61)	3 (8,33)	7 (3,7)
Total	153 (100)	26 (100)	189 (100)

Table 4. Attitudes of female and male students towards PE distance learning

PE distance learning:	Gender		
	Female N (%)	Male N (%)	Total N (%)
I like it.	140 (91,5)	30 (83,33)	170 (89,95)
I do not like it.	13 (8,5)	6 (16,67)	19 (10,05)

Table 5. Attitudes of male and female students on the impact of PE distance learning on the level of physical activity

PE distance learning helps me to be physically active	Gender		Total N (%)
	Female N (%)	Male N (%)	
Yes	149 (97,39)	31 (86,11)	180 (95,24)
No	4 (2,61)	5 (13,89)	9 (4,76)

Male and female students do not differ statistically significantly in their attitudes in the last three mentioned variables.

## Discussion

The pandemic caused by Covid-19 disease is affecting the entire world population. Research shows that adolescence is a period in which acquired habits (and thus habits of engaging in physical activities) that extend throughout life are strengthened or possibly changed (Hallal et al., 2006; Keating et al., 2005) and that this is the last step on which we can systematically, within the education system, influence a considerable part of the population. Thus, the primary goals of this research were to determine the possible differences in the level of physical activity in students before and during restrictive measures and their attitudes towards PE distance learning.

The obtained results are in contrast to most studies in which a general decrease in physical activity was observed, especially in the male population (Ammar et al, 2020; Sekulić et al., 2020; Tison et al, 2020; Xiang et al., 2020), but they agree with several studies whose results have shown just the opposite. In a study in Belgium, in addition to the undesirable increase in sedentary time, the number of physically active persons also increased (Constandt et al., 2020). In general, the most physically active and active individuals decreased their physical activity, while those inactive, i.e., minimally active, increased their activity levels (Giustino et al, 2020; Lesser et al, 2020). The reason for the significant increase in physical activity levels in the examined sample during restrictive measures during the pandemic compared to the time before the pandemic can be found in the fact that the physically inactive in previous studies most often reported lack of time as the main reason for inactivity. (Rasbash et al, 2019). It is certainly necessary to mention that in this research, students were encouraged to engage in physical activity, in order to perform obligations for the course, or due to almost daily communication which was not present in the mentioned research. During distance learning students did not waste time on transportation to several different faculty locations and were able to choose the time and type of physical activity as part of the performance of obligations for the PE course. Very different examples of activities were available to them on several online platforms as well as the possibility of combining different activities (which is not possible when conducting regular contact classes due to space, time and organizational constraints). This form of teaching gave them a certain freedom to create and organize their own time and activities, which for the most part certainly increased the motivation to carry out physical activities. The views of the largest number of respondents speak in favour of that. Almost 98% of female students and 92% of male students showed a desire for physical activity during restrictive measures. Almost 90% of respondents have a positive attitude towards such conceived and conducted distance learning. Over 95% of them believe that distance learning classes conducted in this way help them to be physically active. Research by Feter et al. (2019) and Gal et al (2018) confirm the positive impact of wearable devices and smartphone applications on physical activity.

Viewed by gender, this study found significantly lower levels of physical activity among female students before the pandemic. Also, a significant increase in the levels of physical activity during restrictive measures was found among female students. This can be explained by the fact that girls are generally less active and that males are more involved in organized sports activities that were prohibited by the measures, while girls are more likely to exercise independently in nature or at home (van Uffelen et al., 2017). In a study by Rodriguez-Larrad et al. (2021) female students stated that during the pandemic they used social networks as a tool to increase levels of physical activity, just as they found new sources of physical activity. In this research, a larger number of female students (although not statistically significant) want to be physically active during the pandemic, they like the conceived and conducted PE distance learning and believe that it helps them in physical activity which also contributes to increased physical activity.

## Conclusion

Engaging in physical activity during a Covid-19 pandemic has been shown to be associated with reduced depression and anxiety as well as raising the body's immune system and resistance to infection (Wolf et al, 2021). Considering the above mentioned, and all the previously known positive effects of appropriate physical activity on physical health and the specifics of this transition period from adolescence to adulthood, special attention should be paid to this population, especially at the time of the pandemic.

In order to maintain or even increase levels of physical activity during the pandemic, specific circumstances are needed, as well as will and motivation. This research has shown how digital and web technologies can be one of the ways to have a positive effect on physical activity levels and how restrictive measures can even have a positive effect on certain segments of life. In the future (after the pandemic), the introduction of digital technologies in regular Physical Education classes or giving more space to them should certainly be considered. Given the established difference in the level of physical activity during restrictive measures by gender, all further actions should be adjusted to the specifics of each gender.

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## THE CORRELATION OF DIFFERENT PHYSICAL ENVIRONMENTS IN EARLY EDUCATION INSTITUTIONS WITH THE LEVEL OF CHILDREN'S MOTOR ACHIEVEMENT DEVELOPMENT

Vilko Petrić<sup>1</sup>, Lidija Vujičić<sup>1</sup>, Mirela Peić<sup>2</sup>

<sup>1</sup>University of Rijeka, Faculty of Teacher Education, Croatia

<sup>2</sup>Kindergarten Rijeka, Croatia

### Abstract

The aim of the present research is to determine the correlation of different physical environments in an early education institution with the level of motor achievement development with children of an early age. The research encompassed two mixed nursery groups of a total of 34 children attending the City of Rijeka kindergartens. The quantitative variables were formed based on the Childfit tests intended for the measurement of early and preschool children's motor achievement. The basic descriptive parameters were calculated, while to determine the statistical significance of differences between groups the independent sample Student's t-test was used. The research results indicate that the physical environment which stimulates movement can significantly ( $p=0.00$ ) influence the development of motor achievements in all biotic motor knowledge domains (mastering space, obstacles, resistance and object manipulation). The physical environment which stimulates movement is significantly correlated with the integral development of children's motor achievements. Such an approach enables children to satisfy their need for movement, but also to enjoy in the learning process which in fact stimulates them to further construct and co-construct knowledge. It is normal for a child to *seek* movement as an unavoidable part of integrated learning, so it has to be constantly stimulated by the physical environment. Children thus *live and learn by moving*.

**Key words:** children, early age, physical environment, motor achievement

### Introduction

Motor achievement is defined as the conjunction of motor knowledge and abilities, and are expressed by the child's readiness to link them in a concrete motor situation and make a maximum use of them in order to achieve the best possible result (Findak and Prskalo, 2004). The diagnosis of early and preschool children's motor achievement aims at actually establishing the level of potential possibilities, i.e. the current maximal achievement in domains mastering space, obstacles, resistance and object manipulation (Petrić, 2019a). Effort is put on establishing the level of the quality of perfection for motor knowledge and abilities belonging to a certain domain through their actual application in a certain time and in the most rational way. Children move less and less, and their motor development is more and more under risk. Early education institutions can have a significant role when it comes to increasing the level of children's motor development thanks to the fact that more and more children attend kindergartens from the earliest age. Scientists indicate that in working with children of an early or preschool age it is extremely significant to motivate them to move and stimulate their motor development (Novak et al., 2014).

The first organised motor experience of a child should be positive and encouraged by a stimulating physical environment. The lack of such experience in the early childhood can prevent and/or significantly aggravate a child's motor development which is almost impossible to make up for in later sensitive developmental phases. It is known today that the environment ensures a social context to children, it stimulates investigation and discovery, as well as learning and playing by doing (Došen Dobud, 2016). When the kindergarten environment is well designed, children can learn there for the whole duration of the eight or nine hours usually spent there (Vujičić et al., 2018). What has not been sufficiently studied is the effect of the environment on children's motor development.

Therefore, this research aims at determining the correlation of different physical environments in an early education institution with the level of motor achievement development with children of an early age.

## Method

### Sample of participants

The research comprises two mixed nursery groups of a total of 34 children attending the City of Rijeka kindergartens. The experimental group consists of 18 children in the day care programme whose average age is 3.4. The control group consists of 16 children, averagely 3.2 years old. Both kindergartens are of a modern construction and architecture, with large and spacious indoor and outdoor spaces. Both preschool teachers participate in the learning communities in their working teams. It can be concluded that they have the necessary competences for the organisation of the educational process based on early-aged children's integrated learning.

### Sample of variables

The quantitative variables were formed based on the Childfit tests intended for the measurement of early and preschool children's motor achievement (Petrić, 2019b). The first variable *SPACE* – by the test for the measurement of children's motor achievements in the domain of mastering space; the second variable *OBSTACLES* - by the test for the measurement of children's motor achievements in the domain of mastering obstacles; the third variable *RESISTANCE* – by the test for the measurement of children's motor achievements in the domain of mastering resistance; and the fourth variable *MANIPULATION* - by the test for the measurement of children's motor achievements in the domain of mastering objects manipulation.

### The measuring protocol and description of the research

The research has been full supported by the University of Rijeka under the project number *uniri-drustv-18-268* and approved by the kindergartens' expert panel. The preschool teachers participated in all the research phases, especially in the planning and designation of an integrated curriculum including all areas of a child's development in one unit and organisation of the educational process in which children, according to their own interests, needs and possibilities, could choose the content of their activities freely, and investigate and learn in a way which had a sense and purpose. Children's parents were informed about the research and gave their consent for their children to participate in the research which was conducted in June 2019 and which required four visits to each educational group.

The physical environment of the experimental group was formed to stimulate children to movement. Children had the possibility to use the different spaces of the kindergarten which were alternated to make them challenging for movement and various children's physical activities (the living room, gym, hall, anteroom, atrium and courtyard). The stimuli and props were always accessible, they were used in different parts of the day considering children's needs and interests. Motor activity was highly represented in all children's activities (visual art, research, music, imitation, drama and scene, on-desk manipulation, pre-reading and pre-mathematical...). Each activity centre ensured stimuli including movement and motivation for children to perform motor tasks, which enabled them to learn by moving.

### Data processing

The measured data was processed in the program SPSS Statistics 2.1. The basic descriptive parameters were calculated: arithmetic mean and standard deviation. To determine the statistical significance of differences among groups, the independent sample Student's t-test was used. Results are presented in the form of tables and charts. The statistical significance was tested on the level of  $p < 0.05\%$ .

## Results

It can be observed (Table 1) that experimental group children have a lower deviation from average results than control group children, i.e. they are more homogenised in their motor achievements in all variables.

Table 1. Descriptive parameters ( $AS \pm SD$ ) of the experimental and control group motor achievements

Variables	Experimental	Control
SPACE	3.39 ± 0.33	8.41 ± 1.37
OBSTACLES	4.81 ± 1.07	10.22 ± 2.16
RESISTANCE	5.71 ± 0.82	13.05 ± 3.61
MANIPULATION	10.03 ± 0.88	19.08 ± 14.25

The chart shows that both groups achieved the best results in the domain mastering space, then in domains mastering obstacles and resistance, while the poorest results were obtained in the domain object manipulation.

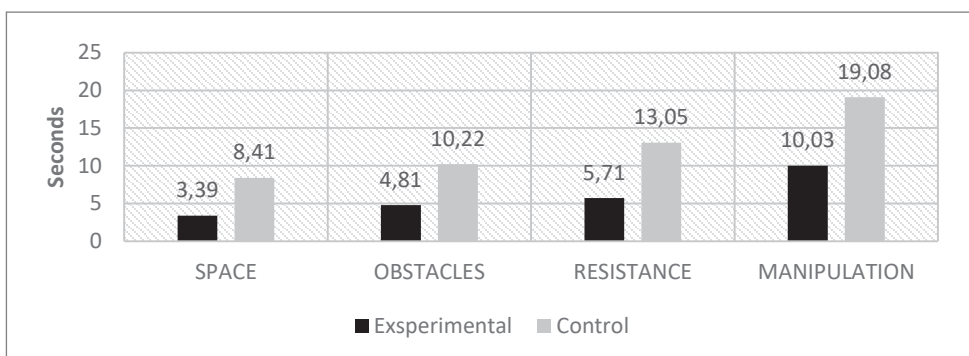


Chart 1. Comparison of average motor achievements values between the experimental and control group

In terms of statistics, the experimental group is significantly better ( $p=0.00$ ) in motor achievements in all biotic motor knowledge domains. In almost all domains, children of the experimental group achieved more than a 100% better average result than the control group children. It can be said that the approach to integrated learning with movement has a significant effect on the development of motor achievement in all biotic motor knowledge domains of children of an early age.

Table 3. Differences in motor achievements between the experimental and control group

Variables	Mean – Exp.	Mean – Con.	t-value	p
SPACE	3.39	8.41	11.81	0.000
OBSTACLES	4.81	10.21	7.62	0.000
RESISTANCE	5.71	13.05	6.87	0.000
MANIPULATION	10.03	19.07	2.09	0.047

## Discussion

Experimental group children achieved statistically ( $p=0.00$ ) better motor achievement results in all biotic motor knowledge results. It can be said that the physical environment which stimulates movement has a significant impact on the integral development of early-aged children’s motor achievement. The experimental group children’s daily activities in all spaces of the kindergarten (living room, gym, halls, outdoor spaces) are intertwined and permeated with various contents belonging to all the four biotic motor knowledge domains. Results show that experimental group children, continuously and regardless of the space they spend their time in, apply their biotic motor knowledge from all domains and adapt them kinesiological to solve everyday challenges.

Former research on the effect on nursery children motor achievements indicate that an advancement in the same emerges from a continuous work and detailed activity curriculum which includes all domains to an equal extent (Petrić et al, 2018). The authors emphasize the importance of directing them to an overall motor development which will equally develop a child’s motor knowledge and abilities in the domains mastering space, obstacles, resistance and object manipulation, but also toward contents including different areas of a child’s development, such as cognitive, social, motor, etc. The comparison between children’s motor achievements in the research about the effect of the integrated physical exercising programme on nursery children’s motor achievements conducted by Petrić et al. (2018) and motor achievement results obtained by children participating in this research shows that integrated learning with movement has a greater effect on the development of children’s motor achievements than the integrated sport programme (the physical exercising programme). The integrated sport programme was conducted only in the gym at a certain time of the day, while integrated learning with movement was conducted continuously and flexibly in different kindergarten rooms, during the whole day. It can be said that the integrated sport programme is a part of integrated learning with movement and therefore its effect on children’s motor achievements is lower.

Since to set movement, or moving, as the base of integrated learning is not only one of the greatest challenges for scientists today, but also a necessity if children’s health wishes to be preserved and improved. At the early childhood and preschool age, the lack of basic motor literacy which is the base for children’s further development and life quality can be more and more observed. Children’s motor abilities are directly connected to the development of the central nervous system, and later on it is not possible to make up for the lack of movement during childhood (Petrić, 2021). Each generation

of children is worse than the former generation regarding the physical activity level, so their growth and development is seriously jeopardized (Petrić, 2016). Research shows that the enrolment of children in educational institutions makes their motor abilities stagnate or regress (Novak et al., 2014), which could also indicate the limited understanding which preschool teachers have about the importance of implementing movement in everyday activities (Farkaš et al., 2015).

This research indicates that the physical environment which stimulates movement can be one of the solutions on which integrated learning with movement can be based on, and thus make a significant contribution to the integral motor development of children.

## Conclusion

The physical environment which stimulates movement is firmly linked to the integral development of children's motor achievements. Such an approach enables children to satisfy their need for movement, but also to enjoy in the learning process, which in fact stimulates them to further construct and co-construct knowledge. It is normal for a child to *seek* movement as an unavoidable part of integrated learning (Vujičić and Petrić, 2021), so it has to be constantly stimulated by the physical environment. Children thus *live and learn by moving*.

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## MANIFESTATION OF GENDER DIFFERENCES IN TEMPERAMENT OF PRESCHOOL CHILDREN CONCERNING THE ENGAGEMENT IN PHYSICAL ACTIVITY IN LEISURE TIME

Vanja Petrović, Jelena Alić, Gordana Ivković

University of Zadar, Croatia

### Abstract

Temperament is one of the personality aspects which involve expressing emotions and reactions to stimuli in the immediate surroundings. It describes a person's behavioural style; not what the person does but how he or she does something. It is determined at birth; however, it can be modified by learning. Environmental factors may have an impact on the development of temperament. The existing research has given contrasting results; on the one side the low level on the activity scale in early childhood presents a risk factor for low physical activity in late childhood and adolescence and contrary to this, the dimensions of temperament are not relevant for the prediction of the level of physical activity or the overall sedentary time in children. Children have an innate need for movement as a form of physical activity (PA) and children are constantly in motion. The aim of this research is to determine whether there are differences in temperament between children engaged in organized physical activity in leisure time (OPA LT) and children who are not engaged in this type of activity. Croatian version of EASI questionnaire was used in order to assess children temperaments. The convenient sample consisted of 50 girls and 51 boys age 6 and 7. The results show that there exist statistically relevant differences between children engaged in OPA LT and those who are not engaged in this type of activity. Among boys this difference is shown in the particle related to activity while among girls it is shown in particles related to all dimensions of temperament. Boys who do not practice OPA LT prefer more tranquil games. Girls who do not practice OPA LT are more easily prone to tears, easily scared, tend to be more irritable, more shy and prefer less demanding games; they are also more impulsive and tend to get more easily bored when practicing PA. Girls who practice OPA LT are constantly in motion, they like to go out and they like to run as soon as they wake up in the morning and they also like to be in company during engagement in PA.

**Key words:** preschoolers, differences, temperament, physical activity

### Introduction

Temperament is part of our personality; it shapes our thoughts, ideas, impressions and the way we respond to our surroundings and to other people. This reaction is automatic and innate. (Bennett & Bennett, 2012). The individual differences in children's emotionality are closely linked to their regulatory physiology and their control of emotions. It is therefore important to approach children in accordance with the traits of their individual temperaments (Brajša-Žganec, 2014). The assessment of children temperament can be done by using the updated EAS model that along with the three existing dimensions of temperament: emotionality, activity and sociability adds the fourth dimension: impulsivity (EASI model) (Plomin, 1984). *Emotionality* indicates the rate at which a child becomes upset and starts to react negatively to stimuli from its surroundings. For example, a child that easily bursts to tears when it hears a sudden noise is evaluated 'high' on the scale/dimension of emotionality. Plomin (1984) maintains that the differences in children's reactions to stimuli from the environment are the result of inborn differences in their nervous system. Emotionality of a child manifests at an early age through its general reactions of disapproval in unpleasant situations, and later on it starts to develop towards expressions of fear or anger. *Activity* indicates a child's tempo and the use of energy, which means that the children who are evaluated highly on this particular scale/dimension are constantly in motion, exploring new places and new activities. Activity denotes a child's behaviour and it does not determine what a child likes or doesn't like doing. *Sociability* pertains to children's sociability. A child who likes to be around other people, who initiates interaction with others and does not like to be alone, is evaluated 'high' on this scale. This does not measure child's intimacy with its family and friends but the degree to which a child prefers to react to stimuli from social environment. "While a child's level of emotionality, activity and sociability may be genetically determined, its overall social development will depend on the quality of interrelationship of these traits with the traits of its social and physical surroundings." (Vasta, Haith & Miller, 2005). *Impulsivity* is a children's trait that makes them act without thinking about the possible consequences. Impulsive children react spontaneously without possibility to prevent their behaviour.

Movement at preschool age is one of children's needs necessary for regular growth and development, which is why physical activity is of utmost importance at this stage of development. (Tomic, Vidranski and Ciglar, 2015). The existing research has given contrasting results. The research by Song et al. (2017) proved that the low level on the *activity* scale in early childhood presents a risk factor for low physical activity in late childhood and adolescence. Contrary to this, the research by Irwin et al. (2015) established that the dimensions of temperament are not relevant for the prediction of the level of physical activity or the overall sedentary time in children. Furthermore, this research established that there were gender related differences in the manifestation of individual dimensions of temperament. In the research conducted by Marković (2019) boys had statistically significant higher results in comparison with girls on the scales/dimensions of *emotionality*, *activity* and *impulsivity*, while girls were *socially more competent* than boys. Considering that environmental factors may have an impact on the development of temperament, this research will try to determine existence of differences in temperament of the preschool children concerning their involvement in organized physical activity.

## Methods

The research was conducted on the sample of 101 children of preschool age from the kindergarten "Radost" in Zadar (50 girls and 51 boys) age 6 to 7. The sample of participants was then divided into subsamples according to two criteria: gender and engagement in organized physical activity of children in their leisure time. According to the first criterion this research differentiates boys from girls, and according to the second criterion it differentiates children engaged in organized physical activity from the children who are not engaged in organized physical activity in leisure time. Croatian version of the updated EASI questionnaire was used in order to assess the children's temperament (Sindik, Basta-Frljić, 2008). This questionnaire performs assessment of four behavioural categories (types of temperament) according to which a child can be: emotional, active, sociable and impulsive. Each subscale has five particles which makes the total of 20 statements of the questionnaire. A scale of five degrees was used with the overall range of results from 5 to 25 points. The results were shown separately for each of the particles of the questionnaire and for each subscale. The existence of differences in children's temperament considering their engagement in additional organized physical activity was tested by using t-test for independent samples. The data were processed using the application package Statistics for Windows Version 10.0.

## Results

From the total of 51 boys, 29 of them practice some kind of organized physical activity in leisure time and these boys achieved the highest score on the scale of *sociability* (AM=16,69) and the lowest score on the scale of *impulsivity* (AM=12,07). Among boys who do not practice any kind of organized physical activity in leisure time (N=22) the highest scores were achieved on the scales of *activity* (AM=16, 18) and *sociability* (AM=16, 18), while the lowest score was achieved on the scale of *emotionality* (AM=13, 14).

From the results shown in Table 1 we may conclude that there exists a statistically significant difference between boys who are engaged in organized physical activity in leisure time and boys who are not engaged in this type of activity in leisure time in the particle pertaining to the scale of activity ("Prefers more tranquil games (e.g. drawing, playing with building blocks) than active ones"). The results indicate that the boys who are not engaged in organized physical activity in leisure time prefer more tranquil games ( $p=0,02$ ).

From the total of 50 girls, 29 of them practice organized physical activity in leisure time and in this group the highest score was achieved on the scale of *sociability* (AM=16, 76) and the lowest score on the scale of *emotionality* (AM=11,41). Among girls who do not practice organized physical activity in leisure time (N=21) the highest scores were achieved on the scale of *sociability* (AM=16, 48), and the lowest scores on the scales of *emotionality* (AM=13, 62) and *impulsivity* (AM=13, 62).



Table 1. Results of T-test (differences between boys who practice organized physical activity in leisure time and boys who do not practice organized physical activity in leisure time)

Particle	Scale	AM (1) N(1)=29	AM(2) N(2)=22	t	df	P
Easily aroused	EMOTIONALITY	2,48	2,82	-1,09	49	0,28
Easily bursts into tears		1,86	2,09	-0,76	49	0,45
Easily scared		1,62	2,00	-1,59	49	0,12
Carefree and cheerful		4,38	4,00	1,97	49	0,06
Irritable		1,97	2,23	-0,86	49	0,39
Constantly in motion	ACTIVITY	4,10	3,95	0,68	49	0,50
Likes to go out running as soon as he wakes up in the morning		3,93	3,68	1,05	49	0,30
Can't seat still for longer periods		2,86	3,14	-0,94	49	0,35
Prefers more tranquil games (e.g. drawing, playing with building blocks) to more active games		2,38	2,91	-2,37	49	0,02*
Restless during meals and in similar situations		2,14	2,50	-1,23	49	0,22
Likes to be in company	SOCIABILITY	4,38	4,09	1,50	49	0,14
Makes friends easily		4,28	3,91	1,73	49	0,09
Shy		1,69	2,18	-1,77	49	0,08
Tendency to be independent		3,79	3,36	1,37	49	0,18
Prefers to play alone than with others		2,55	2,64	-0,33	49	0,74
Prone to impulsivity	IMPULSIVITY	2,24	2,64	-1,13	49	0,26
Hard for him to learn self-control		1,97	2,18	-0,76	49	0,45
Easily/quickly becomes bored		2,21	2,59	-1,25	49	0,22
Learns easily how to face challenges		3,24	3,41	-0,57	49	0,57
Playing with different toys more easily		2,41	2,77	-1,50	49	0,14
EMOTIONALITY	RESULTS ON THE SCALES	12,31	13,14	-0,92	49	0,36
ACTIVITY		15,41	16,18	-1,32	49	0,19
SOCIABILITY		16,69	16,18	0,85	49	0,40
IMPULSIVITY		12,07	13,59	-1,71	49	0,09

Legend: AM (1)–arithmetic median for boys who practice organized physical activity in leisure time, AM (2)– arithmetic median for boys who do not practice OPA LT, t– T test values, df –degrees of freedom, p–the level of significance, N(1) – number of boys who practice OPA LT, N(2) – number of boys who do not practice OPA LT, \*– denotes statistically significant difference.

Statistically significant differences among girls who in their leisure time are engaged in organized physical activity and those who are not engaged in OPA LT are visible in a greater number of particles on all scales of temperament and summarily on the scale of emotionality (Table 2). On the scale of *emotionality* three significant differences were obtained: girls who are not engaged in organized physical activity in leisure time easily burst into tears ( $p=0,01$ ), are easily scared ( $p=0,00$ ) and become irritable ( $p=0,04$ ) in comparison with the girls who are engaged in organized physical activity in leisure time. On the *activity* scale three significant differences were also obtained: namely girls who practice organized physical activity in leisure time are constantly in motion ( $p=0,00$ ) and like to go out running as soon as they wake up in the morning ( $p=0,00$ ), while girls who do not practice organized physical activity in leisure time prefer more tranquil games ( $p=0,01$ ).

Table 2. The results of T-test (differences between girls who are engaged in organized physical activity in leisure time and those who are not engaged in organized physical activity in leisure time)

Particle	Scale	AM(1) N(1)=29	AM(2) N(2)=21	t	df	P
Easily aroused	EMOTIONALITY	2,14	2,57	-1,54	48	0,13
Easily bursts into tears		1,55	2,33	-2,79	48	0,01*
Easily scared		1,41	2,19	-3,04	48	0,00*
Carefree and cheerful		4,45	4,14	1,52	48	0,14
Irritable		1,86	2,38	-2,08	48	0,04*
Constantly in motion	ACTIVITY	4,28	3,57	3,41	48	0,00*
Likes to go out running as soon as she wakes up in the morning		3,90	3,24	3,09	48	0,00*
Can't seat still for longer periods		2,90	3,00	-0,37	48	0,71
Prefers more tranquil games (e.g. drawing, playing with building blocks) to more active games		2,28	3,00	-2,71	48	0,01*
Restless during meals and in similar situations		2,52	2,48	0,13	48	0,90
Likes to be in company	SOCIABILITY	4,52	4,14	2,03	48	0,05*
Makes friends easily		4,34	4,00	1,51	48	0,14
Shy		1,86	2,57	-3,00	48	0,00*
Tendency to be independent		3,41	3,14	0,83	48	0,41
Prefers to play alone than with others		2,62	2,62	0,01	48	1,00
Prone to impulsivity	IMPULSIVITY	1,83	2,38	-2,14	48	0,04*
Hard for her to learn self-control		2,31	2,29	0,09	48	0,93
Easily/quickly becomes bored		1,86	2,71	-3,35	48	0,00*
Learns easily how to face challenges		3,38	3,29	0,32	48	0,75
Playing with different toys more easily		3,10	2,95	0,47	48	0,64
EMOTIONALITY	RESULTS ON THE SCALES	11,41	13,62	-2,80	48	0,01*
ACTIVITY		15,86	15,29	1,05	48	0,30
SOCIABILITY		16,76	16,48	0,46	48	0,65
IMPULSIVITY		12,48	13,62	-1,47	48	0,15

Legend: AM (1)– arithmetic median for girls who practice organized physical activity in leisure time OPA LT, AM(2)– arithmetic median for girls who do not practice organized physical activity in leisure time OPA LT, t- T test values, df –degrees of freedom, p–the level of significance, N(1) – number of girls who practice OPA LT, N(2) – number of girls who do not practice OPA LT, \*– denotes statistically significant difference.

On the *sociability* scale two statistically significant differences were obtained. Girls who practice organized physical activity in leisure time like to be in company ( $p=0,05$ ) in comparison to the girls who do not practice organized physical activity. Alongside the aforementioned, girls who do not practice organized physical activity are more shy in comparison with girls who participate in organized physical activity in leisure time ( $p=0,00$ ). On the *impulsivity* scale statistically significant differences were obtained from two particles. Girls who do not engage in organized physical activity in leisure time are more impulsive ( $p=0,04$ ) and they easily and quickly become bored ( $p=0,00$ ) in comparison with the girls who participate in organized physical activity in leisure time. Through the observation of summary results on all scales a statistically significant difference was obtained on the scale of *emotionality* ( $p=0,01$ ). Girls who engage in organized physical activity in leisure time are better at expressing emotions in comparison with the girls who do not engage in additional organized physical activity in their leisure time.

## Discussion

The results obtained which indicate that boys who do not participate in organized physical activity in leisure time prefer more tranquil games may be explained by the fact that this dimension of their temperament (activity) is possibly the cause why such children do not choose to engage themselves in this kind of activity. Alongside the aforementioned, children who participate in organized physical activities in leisure time have a bigger range of learned motor games and activities and consequently they have better developed motor skills (Popović et al., 2010) which give them greater possibilities to participate more frequently in more intense games. The results of this research indicating that the girls who participate in organized physical activities in leisure time achieve statistically significant lower values on the scale

which evaluates their emotionality in comparison with the girls who do not participate in this kind of activity can be explained by the fact that the environmental factors i.e. the kinetic activities as such teach the girls how to react properly in unpleasant situations for them. For example, encountering defeat while playing a kinetic game may provoke unwanted reactions of anger in a girl that a kinesiologist must detect and then teach a child a proper reaction in such circumstances. Additionally, girls who participate in kinetic activities which enable them to acquire motor skills will encounter less stimulant unpleasant situations while performing motor activities and it can be assumed that the frequency of crying, fear and irritable mood episodes will be lower than among the girls who do not participate in organized kinetic activities. The results obtained in this research indicating that the girls who do not participate in organized physical activities are more shy and more impulsive than the girls who practice this kind of activity may be helpful to parents, teachers and kinesiologists in their efforts to overcome shyness in such children and to make them learn how to control their impulsive reactions. Social contacts and relationships established during engagement in organized physical activity may contribute to reduce shyness. It is necessary to point out that through participating in kinetic activities, alongside with developing their social skills, children also develop tolerance, work habits and team spirit and acquire discipline which is necessary for their functioning properly within a group and, of course, for their control of undesirable reactions.

## Conclusion

The results of the study showed statistically significant differences between children who engage in OPA LT and those who do not engage in OPA LT. Boys who do not engage in physical activity in their free time prefer less intensive motor games than boys who are engaged in this type of activity. Similar to boys, girls who do not engage in physical activity in their free time prefer less demanding motor games. Furthermore, girls not involved in OPA LT cry easily, get scared easily, and become more irritable during physical activities, they are shyer, more impulsive, and quirkier become bored during physical activity compared to girls who perform OPA LT. Girls who engage in physical activity in their spare time are constantly in the move and like to go outside and run as soon as they wake up in the morning, also they like being in company during physical activity. It can be concluded that organized physical activity as an environmental factor may have a positive impact on the dimensions of temperament in children of preschool age and it is therefore desirable to conduct organized physical activity at this age.

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## INCLUSIVE PHYSICAL EDUCATION IN OPINIONS OF HIGH SCHOOL MALE STUDENTS FROM SLOVAKIA, CZECH REPUBLIC AND CROATIA

Michal Průžek<sup>1</sup>, Branislav Antala<sup>1</sup>, Iveta Cihová<sup>1</sup>, Dario Novak<sup>2</sup>, Jana Vašíčková<sup>3</sup>, Martina Luptáková<sup>1</sup>, Xueshuang Wang<sup>4</sup>, Ľubor Tománek<sup>1</sup>

<sup>1</sup>Comenius University in Bratislava, Faculty of Physical Education and Sports, Slovakia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>3</sup>Palacký University Olomouc, Faculty of Physical Culture, Czech Republic

<sup>4</sup>Beijing Sport University, China

### Abstract

The aim of the research was to compare the opinions of intact male students on inclusive education in physical education and to compare them from the perspective of the country. The research was attended by 247 male students attending the last year of secondary school in Slovakia (N = 94, Mage = 18.13, SDage = 0.34), Czech Republic (N = 79, Mage = 18.06, SDage = 0.25) and Croatia (N = 74, Mage = 18.15, 0.36). Students' opinions were measured using a questionnaire used at the International Comparative Research. The Shapiro-Wilk test was used to assess the normality of the data. The Mann-Whitney U test was used to compare opinions between participating countries. The Mann-Whitney showed significant differences in student opinions in all statements except Statement No. 3. We found that students from Slovakia agree with every student's right to receive education in mainstream school more than students from other countries. Students from Croatia had the most positive opinions on integrating a physically impaired student into physical education lessons. Overall, we found that students from Croatia had the most positive opinions on statements concerning inclusive education, followed by students from Slovakia, and the least positive opinions were from students from the Czech Republic. This issue needs to be explored to a large extent, since if inclusive education is implemented without hearing the needs and perspectives of all its participants, this form will not have much success.

**Key words:** inclusion, inclusive education, physical education, opinions, pupils with special education needs

### Introduction

Inclusion has long been a much-discussed topic not only among professionals but around the world in society. According to Resman (2003), the inclusion represents an important change in people's behavior and thinking, in terms of life, coexistence, and a higher form of community integration than just integration, which has played an important role in the past, for example in integrating pupils with special educational needs (SEN) (Seman, 2009). The idea of inclusion is currently being implemented in education as a new form of education, labeled as inclusive education, in which SEN pupils are also educated together with intact pupils. According to experts, inclusive education should create suitable conditions for the education of and create an overall acceptable environment that will help SEN students to join other pupils and later in society (Knight, 1996; Carey, 2005; Vančová, 2005). Many authors consider inclusive education to be beneficial for SEN pupils, but it is questionable how much benefit it has for intact pupils. Inclusive education in physical education lessons is, in our opinion, a good place to integrate these pupils, mainly through physical activity, which can help them increase their internal motivation (Šmela et al, 2018), build new friendships, and integrate them into the collective (Bailey 2005; Liba, 2010). If we want inclusive education to be successful and beneficial for all pupils, it is important, according to several experts, to find out what those who participate in this process think about it. This is because opinions and attitudes are a very important factor contributing to the success of inclusive education (Robinson, 2017). In our research, we address the opinions of intact students, who we believe also contribute to the success of inclusive education.

### Methods

In our research participated 247 male students attending the last year of high school in Slovakia (SK) from Bratislava, the Czech Republic (CZ) from Olomouc, and Croatia (HR) from Zagreb. 94 students from our research were from SK, 79 students were from the CZ and 74 students were from HR. The average age of all students was  $18.11 \pm 0.32$  years. An extract from the questionnaire used in the international comparative research by Antala et al. (not yet published) was used to collect the data. The extract contained 10 statements aimed at identifying pupils' opinions on inclusive education

in physical education and sports lessons. Students expressed their opinions anonymously, using a 5-point Likert scale that contained options (1) Strongly disagree, (2) Disagree, (3) Neither disagree nor agree, (4) Agree, (5) Strongly agree. The options “Strongly disagree” and “Disagree” were negative opinions and the options “Agree” and “Strongly agree” meant positive opinions. In this paper, we focus only on five selected statements from the questionnaire. The answers (Mean score) to these statements are shown in Table 1, for better readability.

## Results

In statement no. 1, which reads: “*Every student, regardless of gender, nationality, race, language background, social background, level of performance or disability, should be able to receive education in the normal (normal) class, respectively school*”, using the Mann-Whitney U test we found statistically significant differences in opinions of students from SK and CZ as well as SK and HR. There were no significant differences between the opinions of students from CZ and HR ( $U = 2527, p = 0.14$ ). Between SK and CZ ( $U = 2887, p = 0.001^{**}, p \leq 0.01$ ) and between SK and HR ( $U = 2235, p = 0.001^{**}, p \leq 0.01$ ), significant differences were confirmed and we found that the most positive opinions on the given opinion were achieved by SK students ( $M = 4.26, SD = 1.06$ ), whose score represents a positive to very positive opinion. SK students were followed by students from CZ ( $M = 3.70, SD = 1.36$ ), whose scores represented slightly positive opinions, and lastly, students from HR ( $M = 3.36, SD = 1.43$ ), whose scores ranged between neither negative nor positive values. and slightly positive values.

In statement no. 2, which reads: “*Inclusive education has a positive impact on the social and emotional development of students with disabilities*”, we found significant differences among the opinions of students from SK and CZ ( $U = 2760, p = 0.002^{**}, p \leq 0.01$ ) and between CZ and HR ( $U = 2090, p = 0.001^{**}, p \leq 0.01$ ). There were no significant differences between the opinions of SK and HR students ( $U = 3352, p = 0.67^{**}$ ) in this statement. The most positive opinions were shown for students from HR ( $M = 3.76, SD = 0.96$ ), whose opinions were just below the positive values. Almost identical opinions were found in the students from SK ( $M = 3.73, SD = 0.88$ ), whose score was almost the same as in the HR students. The last were students from CZ ( $M = 3.19, SD = 1.10$ ), whose score indicates neither negative nor positive opinions.

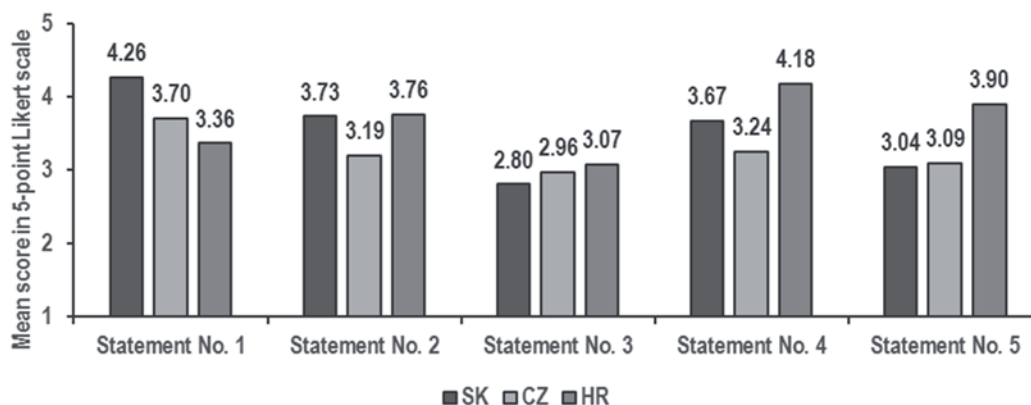


Figure 1 Mean score in statements No. 1- 5

The results of the Mann-Whitney test show that in opinion on statement no. 3: “*I have personal experience with a student with a health disadvantage in my class*”, we did not find any significant differences in the opinions of SK and CZ students ( $U = 3522, p = 0.55$ ) neither between SK and HR ( $U = 3156, p = 0.29$ ) nor between CZ and HR ( $U = 2804, p = 0.65$ ). We found that students from all countries had neither negative nor positive opinions on statement # 3. The lowest personal experience with a student with a health handicap had students from SK ( $M = 2.80, SD = 1.57$ ) with negative answers, followed by students from CZ ( $M = 2.96, SD = 1.59$ ) and finally students from HR ( $M = 3.07, SD = 1.57$ ) that scored highest in all three countries.

Another statement was statement no. 4: “*I wouldn't mind having a student with physical handicaps in physical education*”. Here we found significant differences between the opinions of students from SK and CZ ( $U = 2916, p = 0.012^{*}, p \leq 0.05$ ), SK and HR ( $U = 2548, p = 0.002^{**}, p \leq 0.05$ ), and also between CZ and HR ( $U = 1600, p = 0.001^{**}, p \leq 0.01$ ). We found that among students of all countries the positive opinions prevailed over the negative ones. Students from SK achieved lower values in this statement ( $M = 3.67, SD = 1.08$ ), which represents almost positive opinions, and the least positive were students from CZ ( $M = 3.24, SD = 1.17$ ), whose scores were just above the threshold of neither negative or positive opinions.



The last statement no. 5, was: "The boys and girls should have common lessons of physical education and sport". Here we found out that students from the SK and CZ do not have a unified view of co-educated physical education lessons. Students from SK ( $M = 3.04$ ,  $SD = 1.29$ ) and CZ ( $M = 3.09$ ,  $SD = 1.40$ ) had identical neither negative or positive opinions on co-educated physical education lessons. It was interesting to find out the opinions of students from HR ( $M = 3.90$ ,  $SD = 1.05$ ), where only positive opinions prevailed. Using the Mann-Whitney U test, we found significant differences between SK and HR ( $U = 2192$ ,  $p = 0.001$  \*\*,  $p \leq 0.01$ ) and also between CZ and HR students ( $U = 1955$ ,  $p = 0.001$  \*\*,  $p \leq 0.01$ ). There were no statistically significant differences between SK and CZ ( $U = 3668$ ,  $p = 0.89$ ).

## Discussion

The aim of this study was to compare the opinions of intact male students from SK, CZ, and HR on inclusive education in physical education lessons. Through their opinions, we wanted to learn how intact pupils are tolerant of pupils with certain limitations today, what their opinion is about the possibility of teaching all pupils together in regular school, or how they can imagine their teaching together in physical education. We have differentiated students' opinions on inclusive education in our research from a country perspective. Considering the results of the international Dataset Cross-country report 2016 (EASIE), we assumed significant differences in the opinions of SK, CZ, and HR intact male students.

Statement no. 1 in our study investigated whether high school students think that every student has the opportunity to get an education in mainstream school. We found that the most positive opinions on this statement were most prevalent among students from SK, followed by students from CZ, and the least positive by students from HR. Based on our findings, we can consider whether the opinions of students from HR are based on their real experience with SEN pupils, while students from SK and CZ respond only based on their conviction because they do not have as many percent of pupils integrated into regular schools. These statements confirm the findings of the Dataset Cross-country Report 2016, which states that HR is among the countries where up to 83.1% of all SEN pupils are enrolled in inclusive education in mainstream schools with intact pupils. It is 48.9% for SK and 59.5% for CZ, which is a big difference.

Statement no. 2, which examined whether intact students think that inclusive education has a positive impact on the social and emotional development of students with health disadvantages, has found the overall presence of neither negative nor positive responses of all students. We found the most positive answers from HR students whose answers were closer to positive. Nearly the same values were also found in students from SK, who had almost positive answers. The least positive opinion on the impact of inclusive education had students from the Czech Republic, who were just above the level of neither negative nor positive answers.

In statement no. 3, in which we examined whether students have personal experience with a student with health disadvantage, we found that the lowest experience with SEN pupils has students from SK who expressed themselves most negatively. We found a little more experience with students from the CZ, but their answers were below the level of neither negative nor positive. HR students had the most experience with SEN pupils and therefore we can consider a possible relationship with the opinions of the first statement since HR students have the greatest experience with health disadvantages in their class but still think that not every pupil has the right to go to regular school.

In the penultimate statement no. 4, where pupils were asked whether they would not mind having a classmate with physical disabilities in physical education, we found out that the most positive opinions were given to HR students who were the only ones who achieved positive answers. These were followed by students from SK, whose responses ranged from "neither negative nor positive" and "positive". The least positive were the students from CZ, whose answers were neither negative nor positive. Interestingly, despite the previous findings from statements no. 1 and no. 2, students from all countries were more or less positive and can imagine an hour together with a pupil with a health disadvantage.

In the last statement no. 5, we found that only HR students think that physical education lessons should be common to both boys and girls, as their opinions were more or less positive. These findings are based on the fact that HR education is taught mostly in co-education. In contrast, we found a great deal of indecision and inconsistency in the opinions of SK and CZ students, who we believe are affected by the separation in physical education lessons that is common in these countries. The same issue was dealt with in research by Park and Park (2007), who examined the opinions of intact students on pupils with SEN. Their research was carried out on 271 pupils from 4 schools in Korea. When comparing integrated and non-integrated classes, they found that pupils from integrated classes have more negative opinions towards pupils with SEN than pupils with non-integrated classes. The authors also found more negative opinions prevail more in older than younger pupils.



## Conclusion

In conclusion, students' opinions are influenced in our opinion by their experience with SEN pupils so far, and also by the education system in their country, which implements inclusive education to a greater extent than the countries SK and CZ. Based on our findings, we recommend better exploring the opinions of intact male pupils on inclusive education in physical education lessons and other subjects, and to determine if there is a relationship between these opinions and personal experience with SEN pupils. We also recommend investigating the issue of co-educated physical education lessons on a larger scale, as the opinions on this issue have been shown in SK and CZ as inconsistent compared to HR, where we found more or less positive opinions.

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## CORRELATION OF MORPHOLOGICAL CHARACTERISTICS AND COORDINATION PERFORMANCE

Ozren Radenović, Ivan Jurak, Vjeran Švaić

*University of Applied Health Sciences, Zagreb, Croatia*

### Purpose

Main goal of this study was to determine the correlation between morphological characteristics and coordination test performance.

### Methods

Study was conducted on 247 subjects, of which 157 male and 90 female students of the first-year study of Physiotherapy, University of Applied Health Sciences, Zagreb. Morphological variables used in the study were: body height (ATV) and body mass (ATM). Three motor ability tests were used for assessing coordination: side steps (MAGKUS), backwards polygon (MBKPOL), jumping and sliding polygon (MREPOP). Morphological measurements are used for describing body structure and somatotype of a human body, while coordination or also addressed as motor intelligence is the ability to timely use different motor abilities while conducting a meaningful motor movement which is, in its realization, composed of different motor skills. Morphological characteristics are usually the first factor used in selecting future high-performance athletes. It is also valuable to use motor ability testing for assessing the level of motor development in selection criteria. While the above-mentioned tests have been used for many years, our main interest was to explore the correlation of body height and body mass and those motor tests. T-test was used to determine the statistical difference of motor ability between male and female subjects.

### Results

The results showed significant differences ( $p < 0,01$ ) in two tests MBKPOL and MREPOP. There was a statistically significant correlation among female subjects between body mass (ATM) and the results in tests MBKPOP ( $r = .47$ ,  $p < 0,01$ ) and MREPOL ( $r = .21$ ,  $p < 0,01$ ). Similar results are seen within male subjects with the correlation of  $r = .42$ ,  $p < 0,01$  between ATM and MBKPOP, and  $r = .33$ ,  $p < 0,01$  between ATM and MREPOL. There was also significant correlation of the variables MBKPOP ( $r = .40$ ,  $p < 0,01$ ) and MREPOL ( $r = .26$ ,  $p < 0,05$ ) with male body height (ATV). The results indicate that body height and body mass have a significant correlation with the execution of coordination tests where higher body mass and body height prolong the time for executing of the applied motor tasks.

### Conclusions

Based on these results the authors conclude that metric characteristics of those tests can be increased by changing the distance between the obstacles used in those two coordination tests.

**Key words:** *motor abilities, motor tests, morphological characteristics*

## RELATION OF MOTOR LEARNING PROCESS AND SKILL RELATED ANXIETY IN JUDO

Ivan Segedi, Dominik Žanetić, Hrvoje Sertić

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

According to the multidimensional theory, anxiety consists of two subcomponents: cognitive and somatic anxiety. Some studies show that high level of anxiety symptoms, influenced by external and internal factors such as task difficulty, risk for one owns safety, outcome uncertainty, individuals' abilities, experience and attitudes, usually have a negative effect on performance. The main goal of this paper is to identify differences in anxiety before and after the process of learning a new motor task, and establishing whether there is a relationship between anxiety levels and performance grade. The level of anxiety during the learning process of two judo techniques of falls has been tested on a sample of 64 subjects with a questionnaire CSAI-2C (Stadulis et al, 2002.). The results showed that the level of anxiety decreases during the learning process of a more complex technical element, but this decrease is not significantly related to the average performance grade. In the structurally less demanding technique there is no statistically significant decrease in anxiety, but the correlation of its level with the final performance grade has been established.

**Key words:** *Teaching process, techniques of falls, judo techniques, conative dimensions*

### Introduction

The area of competitive anxiety and its influence on sport performance have been in the center of sport psychology attention for a considerable amount of time. Competitive anxiety could be defined as a specific negative emotional response to the environmental stimuli associated primarily and directly with competitive performance (Mellalieu, Hanton & Fletcher, 2006). According to the multidimensional theory, anxiety consists of two subcomponents: cognitive and somatic anxiety. Cognitive anxiety is defined as the mental component which manifests as worries, doubts or negative thoughts, generally as negative expectations of performing a task. The theory states that cognitive state anxiety follows an inverse relationship with performance, in other words it is never good for the performance. Somatic anxiety is defined as the physiological component which manifests as increased heart rate, stomach discomfort, sweating, blushing or tense muscles. In the case of somatic state anxiety, the theory suggests it follows an inverted-U shape relationship with performance, which would mean that lower and higher levels of somatic anxiety have a negative effect on performance. Although not included as a subcomponent of anxiety in this theory, self-confidence was studied in regard to the relationship between anxiety and performance, and refers to an individuals' belief in ability to control themselves and the environment. A positive linear relationship between self-confidence and performance was proposed (Martens, Vealey & Burton, 1990).

Some studies show that high level of anxiety symptoms usually have a negative effect on performance, while other challenge the assumption that anxiety always debilitates performance as it was shown that it can also have a facilitative effect (Mellalieu, Hanton & Fletcher, 2006). Self-confidence was shown to play a major part in these findings, as high values in self-confidence provide athletes with a possibility to control negative emotions more effectively (Hanton, Mellalieu & Hall, 2004). Most researchers focus solely on the intensity of symptoms experienced by an athlete, which seems to be an incomplete way of viewing competitive anxiety as it was shown that, while measuring anxiety, additional dimensions of responses such as direction and frequency should be considered as well (Mellalieu, Hanton & Fletcher, 2006).

In the motor domain, motor learning and performance can be hindered by anxiety influenced by external and internal factors such as task difficulty, risk for one owns safety, outcome uncertainty, individuals' abilities, experience and attitudes (Bortoli and Robazza, 1994). Different factors, such as threat to a person's ego, threat of personal harm, ambiguity, disruption of routine and threat of a negative social evaluation may also be responsible for an increase in anxiety (Ender, 1978). Although it has been said that anxiety impairs performance of difficult tasks, especially under test conditions, there are numerous exceptions, mostly because of compensating strategies (such as increased effort) used by the athletes. Eysenck and Calvo (1992) conclude that anxiety characteristically impairs processing efficiency (quality of performance divided by effort) more than the quality of performance.

Judo falls, or ukemi encompass techniques to protect oneself when being thrown or falling down, these techniques are always taught first in judo lessons, as one cannot practice judo safely without knowing how to fall without causing injury.

In this paper we focused on two falls: 1) rolling forward fall and 2) two-stroke fall, which are considered structurally more complex than other falls taught to the subjects of this paper.

One of the most applied sport-specific instruments for competitive anxiety evaluation is Competitive State Anxiety Inventory-2 (CSAI-2; Martens, Burton, Vealey, Bump & Smith, 1990) and its variations, preferred by most researchers over other such instruments including Sport Competition Anxiety Test (SCAT; Martens, 1977), State Trait Anxiety Inventory (STAI; Spielberg, Gorsuch & Lushane, 1970), Sports Anxiety Scale (SAS; Smith, Smoll & Shutz, 1990) and many more (Mellalieu, Hanton & Fletcher, 2006), which is why it was used in this paper as well.

There have been numerous papers published about the influence of anxiety on motor learning (Mullen & Hardy, 2000; Hordacre, Immink, Ridding & Hillier, 2016; Ariza-Vargas, Lopez-Bedoya, Dominguez-Escribano & Vernetta-Santana, 2011), but not so much about the influence of motor learning on anxiety, which leads us to the main goal of this paper, to identify differences in anxiety before and after the process of learning a new motor task, and establishing whether there is a relationship between anxiety levels and performance grade of a new motor task.

## Methods

The sample of subjects consisted of 64 students from the Faculty of Kinesiology who attended classes of the subject Judo within the second year of their study. All the subjects had first contact with judo techniques during the Judo lessons.

A questionnaire CSAI-2C (Stadulis et al., 2002.), adapted to evaluate the performance of judo techniques, was used for anxiety assessment. The questionnaire is composed of 15 items assessing three dimensions of competitive anxiety (every dimension is assessed by five items): cognitive anxiety, somatic anxiety, and self-confidence in a five-point Likert-type scale from 1 (very little) to 5 (very much). Items for assessment the Self-confidence dimension are inversely scaled variables in regard to items for assessment other two dimensions. That means that higher values in these items reflect a better result for the subject, unlike other items in which a better result is expressed by lower values.

The result of the subjects in each dimension is the arithmetic mean of the five items.

Subjects were asked to complete an anxiety questionnaire at the beginning and at the end of the learning process of two new motor tasks from the group of judo falls; 1.) Rolling forward fall and 2.) the Two-strokes fall. The learning process was conducted over two 90-minute sessions. Respondents completed the questionnaire at the beginning of the first session, after new technical elements were presented (demonstrated) to them, and at the end of the second session, after a total of 180 minutes of learning process.

Afterwards, the subjects performed these two falls in front of the three teachers from the subject Judo. For their performance, teachers give them a grade ranging from 0 to 5.

Descriptive parameters were calculated for all three anxiety dimensions for both assessments. Student's t-test for dependent samples was calculated to assess differences between the anxiety levels at the beginning and at the end of learning process, and also the correlation to assess connection between the anxiety and the performance grade of two falls.

## Results and discussion

Table 1. Descriptive parameters of anxiety dimensions and performance grade for rolling forward fall

	Mean	Minimum	Maximum	Std.Dev.
Cognitive factor - initial testing	2,58	1,00	5,00	1,00
Cognitive factor - final testing	2,44	1,00	5,00	0,97
Somatic factor - initial testing	1,66	1,00	4,20	0,84
Somatic factor - final testing	1,65	1,00	5,00	0,89
*Self-confidence - initial testing	3,03	1,00	5,00	1,07
*Self-confidence - final testing	3,18	1,00	5,00	1,04
Performance grade - rolling forward fall	3,48	1,00	5,00	1,05

\* inversely scaled variables

Table 2. Descriptive parameters of anxiety dimensions and performance grade for two-strokes fall

	Mean	Minimum	Maximum	Std.Dev.
Cognitive factor - initial testing	2,90	1,00	5,00	0,96
Cognitive factor - final testing	2,67	1,00	5,00	1,06
Somatic factor - initial testing	1,77	1,00	5,00	0,92
Somatic factor - final testing	1,76	1,00	5,00	0,97
*Self-confidence - initial testing	2,48	1,00	4,60	1,02
*Self confidence - final testing	2,85	1,00	5,00	1,13
Performance grade - rolling forward fall	2,22	0,00	5,00	1,12

\* inversely scaled variables

Tables 1 and 2 provide insight into the average levels of anxiety dimension in the process of learning a new technique of falls. One can notice that the level of anxiety rises and the level of self-confidence drops, when one has to approach the learning of a more complex element - falls two strokes fall. The complexity of this technique is also evident in the average performance grade received by subjects for demonstrating a learned element, which is lower for a two-stroke fall compared to a rolling forward fall.

Table 3. Results of the differences analysis (Student's t-test) in anxiety dimensions between two assessments for rolling forward fall

	t	df	p
Cognitive factor	0,85	58	0,39
Somatic factor	0,10	58	0,91
Self confidence	-1,07	58	0,28

Table 4. Results of the differences analysis (Student's t-test) in anxiety dimensions between two assessments for two-strokes fall

	t	df	p
Cognitive factor	-2,24	57	0,02
Somatic factor	0,05	57	0,95
Self confidence	3,01	57	0,00

The 180 minutes learning process did not have the effect of reducing anxiety with technique rolling forward, but with technique two strokes it did (table 3 and 4). The cognitive anxiety factor is declining and the level of self-confidence has increased in the process of learning this new element. (table 4)

It seems that the application of adequate methodological procedures can significantly reduce anxiety in the process of learning more complex motor tasks. This fact emphasizes the importance of the expert who is conducting the process of acquisition of new motor knowledge.

Knowing and applying adequate methods is especially important when working with younger age groups who do not have extensive „motor experience“ that could help them in acquisition and performance of new elements.

Table 5. Correlation between overall performance grades for two techniques of falls

	performance grade - two-strokes fall
performance grade - rolling forward fall	0,59

Since these are two structurally similar elements, the main difference is in the amplitude and intensity of the performance, it is logical that there is a statistically significant correlation in the average performance grade achieved by the subjects in the performance of these two elements.

Table 6. Correlation between overall performance grade for rolling forward fall and anxiety dimensions in two measurements

	Cognitive factor - initial testing	Somatic factor - initial testing	Self-confidence - initial testing	Cognitive factor - final testing	Somatic factor - final testing	Self-confidence - final testing
performance grade - rolling forward fall	-0,16	-0,17	0,39	-0,34	-0,33	0,50

Table 7. Correlation between overall performance grade for two-strokes fall and anxiety dimensions in two measurements

	Cognitive factor - initial testing	Somatic factor - initial testing	Self-confidence - initial testing	Cognitive factor - final testing	Somatic factor - final testing	Self-confidence - final testing
performance grade - two-strokes fall	-0,07	-0,09	0,24	-0,24	-0,14	0,42

In an attempt to determine the relationship between anxiety factors and the performance grade of a measured techniques of falls, interesting insights have emerged. Namely, while in the structurally simpler fall (rolling forward fall) the performance grade and almost all anxiety factors had statistically insignificant correlation (especially after the final testing), and in a more structurally complex technique of fall, there is no such correlation. The only anxiety factor that was associated with performance grade was the self-confidence factor.

For the techniques that do not require a lot of time to learn, such as rolling forward fall (which is indicated by an average higher performance grade achieved compared to a two-strokes fall after the same learning time), one of the bigger obstacles in the learning process may be individual cognitive dimensions, especially one's measured in this work. In this case the importance of the teacher, responsible for the learning process, is emphasized. It is he who will have a significant impact on the quality of performance by applying appropriate methods.

For a more structurally complex element this obviously does not happen to such an extent. It seems that the time factor and the number of repetitions will nevertheless be a more important item in the element's adoption.

## Conclusion

It can be concluded that the level of anxiety decreases statistically significantly during the learning process of a more complex technical element in initial phases of acquisition, but this decrease is not significantly related to the average performance grade.

In the structurally less demanding technique there is no statistically significant decrease in anxiety (mainly because it was initially low), but the correlation of its level with the final performance grade has been established.

It seems that the role of the teacher in learning process of a complex technical element will be most emphasized in reducing the fear of the performance technical element, but the number of repetitions will nevertheless one of the crucial aspects for the final performance.

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## AN INVESTIGATION OF DECISION-MAKING STRATEGIES AND SOLUTION – FOCUSED APPROACH OF STUDENTS IN THE FACULTY OF SPORT SCIENCES

Mümine Soytürk<sup>1</sup>, Özden Tepeköylü Öztürk<sup>2</sup>

<sup>1</sup>Manisa Celal Bayar University, Sports Sciences Faculty, Department of Physical Education and Sports Teaching, Turkey

<sup>2</sup>Pamukkale University, Sports Sciences Faculty, Recreation Department, Turkey

### Introduction

By its nature, the sports environment presents conditions that require athletes to focus on decision making and on finding solutions to specific problems in the face of frequently changing situations. For this reason, the examination of the decision-making strategies and solution-focused approach of students in the faculty of sport sciences who are to work in various fields of sport is important for determining their needs at the preparation stage of their future professional lives. The aim of this study was to investigate the decision-making strategies and solution-focused approach of students in the faculty of sport sciences.

### Methods

A total of 383 students in the faculty of sport sciences were included in the study, 154 (40.2%) of whom were females and 229 (59.8%) of whom were males ( $Mean_{age} = 21.69 \pm 1.77$ ). The “Decision-Making Strategies Scale (DMSS)” and “Solution-Focused Inventory (SFI)” were used as the data collection tools, and a “Personal Information Form (PIF)” was used to obtain the independent variables of the study. T-test, Pearson correlation test, one-way ANOVA test and descriptive statistics were used to analyze the data.

### Results

As a result of the analyses, it was observed that from the subscale scores of the decision strategies scale, Recreation Department (RD) students obtained higher scores from independent decision strategies when compared to Physical Education Teaching (PET) students; and that RD students obtained higher scores from indecisive decision strategies when compared to Sports Management (SM) students. In addition, from the subscales of the solution-focused inventory, Recreation students obtained higher scores from goal orientation when compared to Training Education (TE) students; they obtained lower scores from withdrawal from the problem when compared to TE students; and they obtained higher scores from source activation when compared to TE students. In terms of gender, there was no significant difference in any sub-scales of the two dependent parameters. According to regular physical activity (at least 3 times a week for at least 60 minutes in each training session), the scores of participants who did physical activity regularly were higher than those of the ones who did not do physical activity in the withdrawal from the problem subscale. When the correlations between the subscales of the two dependent variables were examined, it was determined that there was a low but significant correlation between the subscales of the two parameters.

### Conclusions

To develop decision-making strategies and a solution-focused approach in students in the faculty of sports sciences, in addition to their course contents, they can be supported with opportunities such as conducting activities (e.g., athletics, refereeing and coaching) in out-of-school environments.

**Key words:** Decision Making Strategies, Solution-Focused Approach. Students in the Faculty of Sport Sciences

## THE IMPORTANCE OF DIFFERENT FORMS OF WITHIN-CLASS GROUPING AND TEACHER'S NONVERBAL COMMUNICATION FOR ACHIEVING HIGHER MVPA AND VPA LEVELS IN PE LESSONS

Vesna Štemberger, Tanja Petrušič

University of Ljubljana, Faculty of Education, Slovenia

### Abstract

This study investigated if different forms of within-class grouping and teacher's nonverbal communication influenced the implementation of efficient Physical Education (PE) lessons. To obtain the data, 6 accelerometers, 4 stopwatches, a tablet, and an observation form were used. In a non-randomized purpose sample, fifty-one lessons of physical education were observed, which were taught by primary school students. A total of 306 second- to fifth-grade pupils wore accelerometers to determine the intensity of their physical activity during PE classes. The effective time of the 204 pupils was measured by stopwatches. 11 school lessons were efficient above the established standard (a 50% sum of minutes spent in moderate to vigorous physical activity (MVPA) or in vigorous physical activity (VPA) and 50% of minutes of the effective time). Different forms of within-class grouping in one lesson and practical usage of teacher's nonverbal communication (mastering the teaching topic; showing an open level of communication with the pupils; silencing the pupils with nonverbal communication) were common of all the efficient PE lessons, therefore, they influenced on a higher level of pupil activity.

**Key words:** physical education, effective time, MVPA, VPA, forms of within-class grouping, nonverbal communication.

### Introduction

PE teachers play an important role for pupils, as they can successfully motivate and engage them with an appropriate approach to be physically active (Kalajas-Tilga et al., 2020). PE teachers need to be understanding, compassionate and sympathetic in their teaching, and also ensuring pupils such tasks that they can perform with all their diversity (Cale & Harris, 2013). Most pupils between the ages of five and 16 worldwide have the opportunity to participate in PE (Green 2008), however, many children do not have the opportunity to participate in the qualitative process of the subject (Hardman 2008). Various quality indicators can measure the quality of the process of PE, such as pupils' well-being, their effective times or times when pupils are active during PE lessons according to the teacher's instructions (Maeda & Randall 2003, Ridgers et al. 2006) and the level of their activity within individual lessons (Hollis et al. 2016). The pupils of elementary and secondary schools should be moderately to vigorously active for at least 50% of the time during their PE lessons (Hollis et al. 2016). The quality of PE determined by the two abovementioned quality indicators (effective times of the pupils and the level of the pupils' activity) can be influenced by the teacher through various teaching items (i.e., by using different methods and forms of within-class grouping in one lesson, nonverbal communication, etc.) (Petrušič & Štemberger, 2021), as well as differentiating and individualising the lessons (Arefiev et al. 2020, Štemberger 2003). By selecting different methods and forms of within-class grouping in one lesson, the teacher can enable a higher quality of lessons because his or her teaching is not monotonous. However, to influence as many indicators as possible for the quality of school lessons, it is not sufficient to select only the appropriate forms of within-class grouping and teaching methods. In the gym, the teacher's nonverbal communication with pupils is also very important, such as a smile, a considerate touch of the pupil's hands or elbows, through which he or she can get the pupils' attention, positioning of the teacher in the gym, hand movements and so forth (Pease & Pease 2016). Nonverbal communication is far more than mere body language because in addition to gestures (hand movements), posture and dynamics of the body and facial expressions, proximal zones (space around the teacher), touch and other types of nonverbal communication must also be respected because in these zones, individuals occupy space (Burger 2000), which can significantly improve or worsen the quality of PE lessons.

Empirical research dealing with the influence of different teaching approaches on the efficiency of PE lessons is scarce. Therefore, the current research aimed to identify if different forms of within-class grouping and teacher's nonverbal communication influenced the implementation of efficient PE lessons (higher effective times and higher MVPA and VPA levels of the pupils during PE lessons) and in which way.

## Methods

The performed research used a quantitative research approach.

## Participants

In a nonprobability sample, 51 PE lessons were observed, which were taught by 51 primary school students. Primary school students taught second- to fifth-grade pupils of two of Ljubljana's primary schools. There were 23 to 27 pupils in the classes (average age: 8.5 years old). A total of 306 pupils wore accelerometers during the lessons. The effective times of 204 pupils were measured.

## Procedure

The research took place every Monday and Tuesday for four school hours at two primary schools in Ljubljana (a total of two months in 2018). In addition to the primary school student who taught the observed lesson, seven primary school students were present in the gym (fourth year at the Faculty of Education in Ljubljana, from the Department of Primary Teacher Education; within the framework of the class Theory of Sports with Didactics of Physical). These seven primary school students were attaching the accelerometers to the pupils, measuring effective times and recording the lessons. In each lesson, six pupils wore an accelerometer on their quadriceps (three girls and three boys). The accelerometers were installed by students. They also used stopwatches to measure effective times during the lessons (two girls and two boys; were randomly selected). Whenever a pupil who was measured was active according to the student's instructions, the observer primary school students measured the seconds of the pupil's activity with a stopwatch. All lessons were analysed based on the observation form and with the consent of the parents of the pupils and the primary school teachers; this was recorded on a tablet computer so that the later analysis and testing of the results were possible. The purpose of the research was explained in writing to the parents of the pupils participating in the research; complete anonymity was guaranteed for all.

## Measuring instruments

Three different measuring instruments were used for the research:

- Six accelerometers (MMOXX1.07).
- Four stopwatches.
- An observation form.

Accelerometers measured the level of intensity of the activity of pupils during the lessons: how many minutes they spent in low (< 3 METs), moderate to vigorous (MVPA) (3 ≤ 6 METs) and vigorous activity (VPA) (> 6 METs) (Colley & Tremblay 2011). Our observation form had one dimension with 5 teaching approaches related to different forms of within-class grouping, methods of work and teacher's nonverbal communication. Lessons were observed with nine time intervals. Each interval of observation was five minutes long. Then, we marked 1 point for each approach if it was observed in the previous five minutes or 0 points if the approach was not observed. Because a single measurement lasted 45 minutes (a single lesson), we evaluated nine intervals. The span of possible evaluations ranged from 0 (the approach was never noticed) to 9 (the approach was noticed in every interval). By choosing this method of observation, we achieved a more objective evaluation of the individual's teaching.

## Statistical analysis

The acquired data were processed with IBM SPSS Statistics 22 software for MS Windows. We divided the lessons into two groups based on the results obtained using the accelerometers and stopwatches:

- Efficient (the effective times of the pupils amounted to 22 minutes or more, as measured by stopwatches; in addition, the amount of MVPA and VPA amounted to at least 22 minutes (the level of activity measured by accelerometers) of the pupils during the lesson).
- Inefficient (the effective times of the pupils were lower than 22 minutes, along with the amount of vigorous and moderate intensity of the activity, or they spent more than 50% of the time in low intensity of the activity or were even inactive).

We connected the primary school students who gave efficient lessons to the observation form. First, we checked whether the variables within the dimension were distributed according to a normal distribution. We verified the normality of the distribution using the Shapiro–Wilk test. Because of the small sample size and the fact that the distribution of the variable deviate statistically significantly from normal, we continued to use a nonparametric Mann–Whitney test to check the differences in the dimension between primary school students with efficient and inefficient lessons. We continued to use the Mann–Whitney test to verify in which individual approaches these two groups differed.

## Results

*Table 1. Descriptive statistics for the effective times and number of minutes of moderate and vigorous intensity of the activity of pupils during the PE lessons*

		N	Minimum (minutes)	Maximum (minutes)	Mean (minutes)	Std. Deviation
Effective times	Efficient lessons	11	22.02	23.36	22.57	0.45
	Inefficient lessons	40	4.23	21.59	11.23	5.05
Number of minutes of MVPA and VPA	Efficient lessons	11	22.00	29.01	25.04	2.25
	Inefficient lessons	40	4.04	28.01	15.03	5.32

Table 1 presents data on the effective times and levels of intensity of the activity of pupils in 51 measured PE lessons (efficient and inefficient lesson): 11 (21.6%) of 51 lessons were efficient, and 40 (78.4%) were inefficient. The average of the effective times of the measured efficient lessons amounted to 22.57 minutes and inefficient to 11.23 minutes, which is quite low in view of the established criteria, for which 22 minutes of effective time is one of the conditions for an efficient lesson. The data on minutes spent in MVPA and VPA (at least 22 minutes is one of the set conditions for an efficient lesson) is the average of the measured six pupils who wore accelerometers (i.e., three girls and three boys). The average amount of MVPA and VPA of the measured efficient lessons amounted to 25.04 minutes and inefficient to 15.03 minutes, which is quite low in relation to the established criteria for the efficiency of PE lessons.

*Table 2. Differences in the dimension regarding the efficiency of PE lessons*

Dimension	Group	N	Mean	St. Deviation	Mann–Whitney U	Asymp. Sig. (2-tailed)
Teaching approaches	Efficient lessons	11	7.29	0.33	22.500	.000
	Inefficient lessons	40	4.87	1.67		
	Total	51				

Table 2 shows the results of the Mann–Whitney U statistics of the whole dimension Teaching approaches. Here, the students with efficient lessons had a statistically important higher value of the use of teaching approaches during PE lessons compared with the students with inefficient lessons ( $p < 0.001$ ).

In continuation, we analysed the differences between individual approaches within the dimension (Table 3).

Table 3. Differences between the primary school students with efficient and inefficient lessons for each approach

Dimension	Approach	Mean		St. Deviation		Mann–Whitney U	Asymp. Sig. (2-tailed)
		Efficient	Inefficient	Efficient	Inefficient		
The primary school students:							
Teaching approaches	... lets the pupils know with nonverbal communication that (s)he masters the topic (s)he teaches (stand-up posture, walking among the pupils and raised chin)	9.00	5.78	0.00	2.07	38.500	.000
	... shows an open level of communication with the pupils with nonverbal communication (does not cross legs suddenly, does not cross arms on his/her chest, has open palms against the pupils and establishes eye contact with the pupils)	9.00	5.85	0.00	1.96	27.500	.000
	... silences the pupils with nonverbal communication to have the opportunity to speak (a short touch of the pupil's elbow/upper arm/forearm, index finger on his/her mouth and rapidly raising his/her hand)	9.00	5.37	0.00	1.85	16.500	.000
	... uses various methods of work (explanation, conversation, etc.)	6.45	5.23	1.04	1.51	151.000	.074
	... uses various forms of within-class grouping (frontal (work in lines, range, relay games, etc.) and group (work on the stations, additional and supplementary tasks, playgroups, orbital exercise, etc.))	3.00	2.12	0.63	0.97	132.000	.012

The results of the Mann–Whitney test are presented in Table 3. We checked whether there were differences in the average ranges of the individual approaches of a lesson related to different forms of within-class grouping and teacher's nonverbal communication in terms of efficient and inefficient lessons. Statistically significant differences with a risk lower than 0.05 are marked in italics. Table 3 shows which approaches (based on the results obtained) proved to have a significant influence on the efficiency of PE lessons and which approaches occurred among primary school students whose PE lessons were the most efficient.

## Discussion

The most significant advantage of the current study was the identification of different teaching approaches related to different forms of within-class grouping, methods of work and teacher's nonverbal communication common to all efficient PE lessons, that is, the approaches that influenced efficiency in PE lessons.

Therefore, these findings have important implications for practice because a significant problem arises here, given that only 11 of the 51 observed PE lessons in our study were efficient per established standards. Such a result was extremely low and below expectations given that the primary school students who taught the lessons had the appropriate knowledge about the content of their lesson. However, we wanted to examine the five approaches, which focused on their potential influence on the successful performance of PE lessons. The results showed that the primary school students who used nonverbal communication to show mastery of the topic they taught, who maintained an open level of communication with their pupils and looked them in the eye and who were able to silence the pupils by certain signs without raising their voice, were more successful in teaching more efficient PE lessons. During the successful lessons, the primary school students attributed great importance to nonverbal communication (by raising their hands, they called the pupils to come to them; by a considerate touch of the pupils' palm, shoulder or elbow, they silenced the individuals so that they could speak; they established eye contact with all pupils and informed them by facial expressions that they were satisfied with their work, etc.), thus achieving a higher level of MVPA and VPA and high effective times. The primary school students who, for example, performed two or more forms of within-class groupings in parallel (e.g., frontally in one half of the gym and in the stations in the other half) were also successful. There is an indication that the use of different teaching methods could also impact the efficiency of the lessons because the level of statistical significance of the differences in the use of different teaching methods between efficient and inefficient lessons is on the border of significance ( $p = 0.074$ ).



## Conclusion

Based on the results of our research the important approaches for efficiently and qualitatively performed PE lessons are different forms of within-class grouping in one lesson and practical usage of nonverbal communication (mastering the teaching topic; showing an open level of communication with the pupils; silencing the pupils with nonverbal communication).

In the current study, we examined 5 approaches that we linked to the efficiency of the lesson. This was shown by the pupils' MVPA and VPA data obtained through accelerometers and the measured effective times. Nevertheless, the present study was restricted, because the content of the lessons and didactic level of the learning process varied; therefore, generalizability is limited.

Notwithstanding the additional conclusions of future research, we believe that the approaches that have been shown to be important in achieving a high level of pupil activity in the efficient and quality lessons should be taken into account to a greater extent in studies of primary school teachers.

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## THE BELIEFS OF RELEVANT ADULTS (COACHES AND PRESCHOOL TEACHERS) REGARDING THE OPTIMAL TIME FOR INTRODUCING CHILDREN TO SPORTS

Nataša Sturza Milić<sup>1</sup>, Tanja Nedimović<sup>1</sup>, Tamara Korać Živojinović<sup>2</sup>

<sup>1</sup>Preschool Teacher Training College „Mihailo Palov“ Vrsac, Serbia

<sup>2</sup>“Akademija Stars”, Serbia

### Introduction

The way in which adults organize children sport, is not always adequate for children. Numerous social and cultural activities, including sports activities, are under the influence of dominant beliefs. In recent years children sport has been the subject of many scientific research and declarations which have been cautioning against early specialization and misuse of children in sport.

### Methods

The aim of this paper has been to examine the opinions of successful trainers and preschool teachers about the actual age at which motor gifted children get involved in various sports disciplines and the optimal age of involvement in sports. The method of conducting a survey has been used in the paper, while the instrument has been a questionnaire particularly made for this purpose.

### Results

Having used Mann Witney U Test it has been confirmed that there is a statistically significant difference ( $Z = -2,945$ ;  $p = 0,003$ ) between the opinions of sports trainers and preschool teachers about the variables - The age in practice (Mean = 7.9 years) and The optimal age (Mean = 11.0 years).

### Conclusion

Although the results show that children get involved in sports on average at the age of 7.9, the analysis of the opinions of experienced coaches and preschool teachers indicates the need for later involvement of children in various sports disciplines. The intention of this paper is to contribute to a change in the perception of relevant adults regarding the optimal inclusion of children in sports. Therefore, new research is needed to provide information regarding this topic.

*Key words: child sports, preschool Physical Education*

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## AN ANALYSIS OF EXTRACURRICULAR PHYSICAL ACTIVITIES AMONG MIDDLE-SCHOOLERS

Anca-Raluca Tanasă, Florin-Petruț Trofin, Cristina-Elena Moraru

Faculty of Physical Education and Sport, "Alexandru Ioan Cuza" University of Iasi, Romania

### Abstract

The purpose of this study is represented by the analysis of differences between genders at the level of factors such as body mass index (BMI), the type of physical activities practised, the parameters of physical effort made, the level of performance attained, the access to sports bases, for students aged between 11 – 15. The sample of the research comprised 179 students (98 girls and 81 boys). We analysed the general health state and the habits of the students by using anthropometric monitoring and a questionnaire. After interpreting the results, we have concluded as follows: boys have a body mass larger than girls ( $t=4.611$ ,  $p<0.0001$ ), the BMI values are also higher among boys compared to girls ( $t=4.587$ ,  $p<0.0001$ ). In what concerns the duration of physical exercises, it indicates similar values, for both girls and boys ( $t=1.966$ ,  $p<0.05$ ); both genders practice extracurricular physical activities throughout the same period of the year (7 months) ( $t=0.4950$ ,  $p<0.05$ ). Referring to the volume of physical activities in a year, we have identified that boys have higher values than boys ( $t=1.982$ ,  $p<0.0001$ ), while the perceived intensity of physical activities is similar for both genders ( $t=0.03324$ ,  $p<0.05$ ). The data processing has shown that the level of practising the extracurricular physical activities is one of leisure for both genders ( $t=0.04689$ ,  $p<0.05$ ), while access to sports bases is identified as easy ( $t=1.356$ ,  $p<0.05$ ). Consequently, it may be noted that the results obtained after this analysis are higher in boys than in girls concerning the following indicators: body mass, BMI and the volume of physical activities, while in what regards the duration of physical exercises, perceived intensity, the practice level (leisure), and the access to sports bases, we have not found any differences between the two genders.

**Key words:** *health, harmonious development, physical activities, monitoring*

### Introduction

Education means getting out the individual nature in every man and woman to its true fullness. At school, children learn about many cognitive subjects forming the foundation of the school curriculum. Schools usually support these cognitive curriculum subjects featuring extracurricular school activities. Such activities may be both sport-based and non-sport-based (Brandly, 2013; Braithwaite, et al., 2017; Sahoo, et al., 2015).

The majority of young people are involved in some type of organised physical education (PE) in their primary and secondary school years. Efficient use of time in PE is seen as relevant for numerous reasons; not least because it determines children to make informed significant choices, become proficient in movement skills, and stimulate lifelong participation in physical activity (Dudley, Okely, Pearson et al., 2011; Kay, 2005; Kirk, 2005; Morgan, et al., 2005; Bailey, 2006).

People have become ever more interested in the developmental outcomes of extracurricular participation, initiated partially by alarming alienation and boredom reported by students in school; problems with school behaviour and performance, and evidence of more time spent by students without supervision from adults. Both scientists and youth policy advocates state that participation in high-quality extracurricular activities, such as sports and school clubs, is a great use of adolescents' leisure time. It may offer further chances for growth and development (Fredircks, et al., 2006; Eccles, et al., 2002; Larson, 2000).

Physical activity is a relevant aspect of health awareness programs generally, and an absence in this respect represents a primary risk factor for a range of lifestyle-related diseases. Promoting health and physical activity represents the responsibility of many bodies and institutions, and schools are essential to most policies. Furthermore, school reactions to the physical activity and health necessities of society have usually been reflected through physical education (PE) in the majority of over the world (Fairclough, et al., 2015; Fox, et al., 2004; Dobbis, et al., 2013).

Physical education in national schools is an important part of a student's comprehensive, well-rounded education program and a means of positively affecting life-long health and well-being. At a minimum, the physical education program should offer physical activity to improve present health while teaching knowledge and abilities that foster a long-term involvement in physical activity as part of a healthy lifestyle. The goal is to help children prevent numerous

diseases, including abnormal cholesterol, high blood pressure, hyperglycaemia, obesity, and ultimately heart disease as well as many other non-communicable conditions and mental health issues (Ascan, 2005).

Extracurricular activities have been included in the education system. Pupils are part of such activities, and they are not included in the normal curriculum and instructional methods. Pupils of all ages participate in such activities, for all age groups and standards (Kapur, 2018).

Students who choose to conduct extracurricular activities generally benefit from the numerous opportunities provided to them. Benefits of choosing extracurricular activities include better school performance, higher standardised test scores and improved educational attainment, regular school attendance, and enhanced self-concept (Wilson, 2009).

## Methods

Our study sample comprised 179 students (98 girls and 81 boys). In this research, we analysed the general health state and the habits of the students. To this end, we used anthropometric monitoring (height and weight) and a questionnaire (where the scale items comprised information related to the type of leisure sports activity, session duration, weekly frequency, perceived intensity, practice for performance or pleasure, and children's access to the sports bases).

We determined the type of sports activity practised by students given the characteristics of the subjects (which they reported as favourite). They mentioned both cyclical and noncyclical types. When processing the data statistically, we ascribed a numerical equivalent to the subjects: number 1 for cyclical activities and 2 for noncyclical activities. Concerning the performance level, we noted 1 for leisure activities and 2 for performance activities. We ascribed values from 1 to 5 – 1, accounting for the lowest level, 5 for the opposite – the perceived intensity while practising the favourite spot subjects and the degree of access to the sports bases.

## Results

After interpreting the results, we have concluded: boys have a body mass larger than girls ( $t=4.611$ ,  $p<0.0001$ ) and the BMI values are  $t=4.587$ ,  $p<0.0001$ . In what concerns the duration of physical exercises, it indicates similar values ( $t=1.966$ ,  $p<0.05$ ); both genders practice extracurricular physical activities throughout the same period of the year (7 months) ( $t=0.4950$ ,  $p<0.05$ ). Referring to the volume of physical activities, we have identified that boys have higher values than girls ( $t=1.982$ ,  $p<0.0001$ ), while the perceived intensity of physical activities is similar for both genders ( $t=0.03324$ ,  $p<0.05$ ). The level of practicing the extracurricular physical activities is one of leisure, for both genders ( $t=0.04689$ ,  $p<0.05$ ), while access to sports bases sportive is identified as easy ( $t=1.356$ ,  $p<0.05$ ). Table 1 illustrate centralized study data.

Table 1. Study results and gender differences

	Girls	Boys	t, p
Height (cm)	158.9 ± 9.04	161.3 ± 10.63	$t=1.685$ ; $p=0.093$
Weight (kg)	47.84 ± 12.35	56.82 ± 13.69	$t=4.611$ ; $p<0.0001$ ****
Age (years)	13.42 ± 10.35	12.22 ± 1.33	$t=0.757$ ; $p=0.449$
BMI (kg/m <sup>2</sup> )	18.84 ± 4.08	21.7 ± 4.23	$t=4.587$ ; $p<0.0001$ ****
Type of sports activity	1.23 ± 0.80	1.04 ± 0.74	$t=0.842$ ; $p=0.400$
Duration of an activity	49.6 ± 49.81	65.44 ± 57.64	$t=1.966$ ; $p=0.050$
Weekly frequency	2.63 ± 2.19	2.81 ± 2.50	$t=0.311$ ; $p=0.755$
Duration of sports activities (months)	7.11 ± 5.11	7.49 ± 5.09	$t=0.495$ ; $p=0.621$
Annual volume (min)	6599 ± 8701	10197 ± 15216	$t=1.982$ ; $p=0.049$ **
Perceived intensity (1 – 5)	2.60 ± 1.8	2.61 ± 1.81	$t=0.033$ ; $p=0.973$
Performance level	0.89 ± 0.60	0.90 ± 0.62	$t=0.046$ ; $p=0.962$
Access to spaces (1 – 5)	1.59 ± 1.25	1.33 ± 1.29	$t=1.356$ ; $p=0.177$

Table 1 synthesises the study results and their analysis. We featured the anthropometrical data (height and weight), age, BMI, type of activity practised by students in their free time, the average duration of the sports activity practised, weekly frequency, the period when the motor activities are possible. We also analysed the annual extracurricular physical activities volume for the subjects and the perceived intensity. Finally, we appraised the performance level of sports activities and the possibilities of accessing facilities for such activities.

## Discussion

In this study, we have shown that out of 179 subjects, 98 were girls and 81 boys, encouraged by parents to practice at least one extracurricular sports activity. Most of them practice them for leisure, not performance. In addition, the rate of physical activities related to a year is higher among boys than among girls, which indicates that boys are more motivated than girls in this respect. In another study, Koca, 2006, reported that in Turkish society, boys are encouraged to do sports by their parents in order to develop their masculinity while girls are kept away especially from risky sports requiring strength, to protect their bodies and femininity. Hence, the rate of sports participation among girls is lower than the among boys. From this perspective, the result of the higher participation rate among male students compared to female students in this study the same thesis (Koca, 2006). The study carried out by Meester et. al., 2014, to appraise the participation motivation in extracurricular activities, they found significant differences in participation between genders. The participation of male students was reportedly 82.77% while only 68.11% for female students (Meester, et al., 2014).

Daley and Leahy (2003) conducted study that included 126 randomly selected children aged 8 or 9 years old, involved in physical extracurricular activities. All of them performed some form of physical extracurricular activity organised by the school at least once a week either at lunchtime or after school. The second group comprised 63 children who did not perform physical activities. Those with regular physical activity saw themselves in a positive light. Researchers found a positive association between participation in physical activity and positive self-image. It is suggested that participation can provide teenagers with confidence about their physical and maybe even social selves. Another relevant part of a teenager's identity is social skills, and many of them believe that socialisation and friendships are essential in their lives. When teenagers participate in extracurricular activities, they often have more occasions to interact with others, develop friendships and social confidence. Such participation may also be interpreted as a sign of maturity and as a self-asserting behaviour. The study proves that those who participated displayed a developed sense of commitment. Consequently, students having participated in extracurricular physical activities reported higher self-esteem than those who did not perform such activities (Dealey, et al., 2003).

Another relevant extracurricular activity is participation in athletics. Student athletes interact with their peers, work for the best interest of their team, and learn to obey the team leader. Such an interaction may help a student athlete to develop their self-identity. Identification and involvement with school sports form a social network for student athletes. It underscores the value of school, academics, and continuing their education after graduating from high school (Darling, et al., 2005).

The purpose of another study was to determine the participation motivation for extracurricular activities; the study concerned primary school students. It also appraised whether such factors as age and gender change concerning their participation motivation. Students involved in the extracurricular activities were included in an activity each month. Research continued for seven months. The activities were implemented, "Participation Motivation Scale", as a data collection tool, was applied to the students. The study has shown that male and female students participating in the activities considered "skill development" as the essential factor. There was statistically significant difference between female and male students in such sub-dimensions as "fun", "success/status" and "movement/being active" within the research. The authors also noted the positive impacts of participation motivation, enthusiasm and joy as well as the students' physical, psychological and social developments (Acar, 2017).

## Conclusion

The results of our research reflect a significant difference between girls and boys in terms of weight, body mass index, and the total annual volume of physical effort made by the latter.

Whereas making more effort throughout the year, boys have higher BMI and greater weight. We can explain these aspects through the natural gender differences given the age of our subjects. On the contrary, the components of volume are not different between genders. The duration of an effort session, their weekly frequency, and the months of the extracurricular activity have recorded similar values for the two genders.

Boys and girls have reported similar preferences for cyclical or noncyclical sports activities.

The performance level attained by the subjects of our study is leisure-related. We can explain this aspect by the low access to sports bases. Hence, low performance may be an of the lack of children's unlimited access to sports facilities.

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## EFFECTS OF USING MOBILE APPLICATION DURING CLASSES ON STUDENT ATTITUDES TOWARD PHYSICAL EDUCATION

Margareta Teskera, Krešimir Hrg, Mirela Šunda, Boris Neljak, Hrvoje Podnar

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The aim of this paper is to determine the effects of the use of a mobile application during classes on student attitudes toward physical education. The students of elementary school participated in this research. Those 99 of average age  $13.48 \pm 0.61$  were attending the seventh and the eighth grade. They were randomly assigned to 4 experimental and 2 control groups. In this research, the Mogy application was used. The students used the Mogy mobile application by having installed it on their smartphones. The Croatian version of questionnaire for assessment of attitudes toward physical education was used and a structured interview was conducted. The covariance analysis (ANCOVA) was used to establish the effects of the experimental programme on results of the final measurement, with the inclusion of covariates age, gender and results of pre-intervention scores. No statistically significant difference was observed between control and experimental groups in connection with the satisfaction,  $F(1, 89) = 0.004$ ,  $p = .952$ ,  $\eta^2 = .000$  and the perception of the usefulness,  $F(1, 89) = 0.001$ ,  $p = .972$ ,  $\eta^2 = .000$  of the physical education class. With the implementation of the Mogy, the class was easier for the teacher because the students were already prepared prior to the class. In addition to the conversation about important issues such as importance of hydration, healthy eating and regular sleep rhythm, performed in the final part of the class, the use of application made the class more interesting and dynamic.

**Keywords:** *information and communications technology; mobile application; physical education; elementary school*

### Introduction

The modern lifestyle and development of society with an indispensable and increased use of information and communications technology (ICT) resulted in lack of movement and reduced physical activity of children and young people particularly. With increased development of technology, the growth of its use in various aspects of everyday life has been noticed. The use of smartphones, watches and PDAs for purposes of communication, information gathering and monitoring physical activity is increased. ICT has found its place in sport and education and thus became its component. The benefits of ICT such as facilitated communication with students and video demonstrations of motor skills greatly help the teacher in conducting classes.

Physical education (PE) is uniquely positioned to promote physical activity and health of children and youth in (Barkoukis, Chatzisarantis & Hagger, 2020; Escriva-Boulley, Tessier, Ntoumanis & Sarrazin, 2018) and out of school (Wang & Chen, 2020). The implementation of ICT in PE classes is possible by introducing Mogy (Mogy, 2019) mobile application for personal trainers, adjusted for use in education system. Monitoring progress and feedbacks to students and teachers through the application are important motivation factors for the improvement of PE classes. Many studies confirm positive relationship between using ICT and improved physical activity (Kim & Seo, 2019; Islam et al., 2020) and ICT based interventions seem to be effective in promoting physical activity (Laranjo et al., 2020).

The aim of this paper is to determine the effects of the use of a mobile application during classes on student attitudes toward physical education.

### Methods

#### Participants

The students of elementary school participated in this research. Those 99 of average age  $13.48 \pm 0.61$  were attending the seventh and the eighth grade, and the male population was 51,5%. They were randomly assigned to 4 experimental and 2 control groups. Prior to the research, the parents signed a consent for participation of students in the research.

## The Mogy application

In this research, the Mogy application was used. The students used the Mogy mobile application by having installed it on their smartphones. The teacher used internet application. Prior to each class, the teacher entered in the application contents for introductory, preparatory and final part, as well as topics conducted in main part of the class. A detailed description of topics and tasks was followed by pictures or videos; a demonstration of a certain motor task as well as a given number of repetitions were available to the student. In this way, the student had the opportunity to prepare himself/herself for each class and to communicate directly and monitor personal progress with the teacher.

## Measuring instruments

The questionnaire for assessment of attitudes toward physical education

The Croatian version of questionnaire for assessment of attitudes toward physical education (Subramaniam and Silvermana, 2009) was used in this research as a measuring instrument. The questionnaire consisted of 20 items about which the students expressed their attitudes on a Likert scale from 1 to 5 (1 – I totally disagree, 5 – I totally agree). The translation from English language was made by two independent translators, while the review of the translation and adaptation of terminology was made by an expert for physical education.

## Structured interview

The second measuring instrument used in this research was a structured interview. The students expressed their attitudes toward physical education by answering questions in form of an essay.

The asked questions:

1. Should a mobile phone be used in lessons to help with learning?
2. Have you been preparing and how for the PE class by using the Mogy application? Did the preparation require a lot of time?
3. Indicate advantages and disadvantages of the Mogy application.
4. Did the video demonstration and task description in the Mogy application help with learning motor tasks?
5. If comparing the teacher's demonstration and video demonstration in the Mogy application, which type of demonstration of motor tasks was the most helpful while learning?
6. Do you support a regular use of mobile application in the class of physical education?

## Measurement protocol

The research was conducted in elementary school. The students were randomly divided into 4 experimental and 2 control groups. Prior to 6-week experiment, the students were initially examined and provided with clear instructions before completing each questionnaire. The class of physical education of experimental group has been conducted using the mobile application under the guidance of the PE teacher. The content of the application was adjusted to the age of students and based on knowledge and professional information (Bardus et al., 2016).

## Data processing methods

The covariance analysis (ANCOVA) was used to establish the effects of the experimental programme on results of the final measurement, with the inclusion of covariates age, gender and results of pre-intervention scores.

## Results

Table 1. Control and experimental adjusted means and variability for post-intervention scores with age, gender and pre-intervention scores as a covariate

	Control (AS±SE)	Experimental (AS±SE)	F	p
Satisfaction at the PE class	3.65±0.15	3.67±0.11	.004	.952
Perceptions of the usefulness of PE	3.49±0.15	3.5±0.11	.001	.972

Remark: AS=arithmetic mean, SE=Standard Error

Table 1 shows research results. After conducted experiment, the experimental and control groups assessed their satisfaction with the class of physical education as very good, with the average grade of  $3.65 \pm 0.15$  in control groups and  $3.67 \pm 0.11$  in experimental groups. The use of the mobile application during classes of the physical education did not affect the perception of the usefulness of the class (control  $3.49 \pm 0.15$ ; experimental  $3.5 \pm 0.11$ ). No statistically significant difference was observed between control and experimental groups in connection with the satisfaction,  $F(1, 89) = 0.004$ ,  $p = .952$ ,  $\eta^2 = .000$  and the perception of the usefulness,  $F(1, 89) = 0.001$ ,  $p = .972$ ,  $\eta^2 = .000$  of the class.

Table 2. Results of structured interview ( $n=99$ )

QUESTIONS	YES	NO	ABSTAINED	NO ANSWER
1. Should a mobile phone be used in lessons to help with learning?	30	14	-	55
2. Have you been preparing and how for the PE class by using the Mogy application? Did the preparation require a lot of time?	29 did not take much time	12 did not prepare	-	58
3. Indicate advantages and disadvantages of Mogy application.	38 advantages	53 disadvantages	-	
4. Did the video demonstration and task description in the Mogy application help with learning motor tasks?	27	5		67
5. If comparing the teacher's demonstration and video demonstration in the Mogy application, which type of demonstration of motor tasks was the most helpful while learning?	9 Mogy app	24 teacher's demonstration	6	60
6. Do you support regular use of mobile application in the class of physical education?	16	29	9	45

Table 2 shows results of structured interview, thirty of 44 students consider that mobile phones should be used in the class. Prior to each class, the students had to look in the application in order to find out what they are going to do in the next class and 29 students considered that such a type of preparation did not require a lot of time. In spite of larger number of disadvantages such as consumption of data traffic, taking up storage space of the mobile phone and increased consumption of battery, the students listed 38 advantages of the Mogy application, such as availability of exercises at all times, faster adoption of new tasks and simple use, while most of the students considered the application as an aid in the lesson. In conclusion, 24 students would choose the teacher's demonstration rather than the application, and many students did not support the regular use of mobile phones during all classes of physical education.

## Discussion and conclusion

By following the development of ICT through years, the positive impact was observed in the field of physical activity. The use of mobile application is effective in promoting physical activity, and participants often respond positively to the use of the applications that monitors the physical activity (Coughlin et al. 2016). Furthermore, a number of researches confirm effectiveness of mobile application delivered interventions or use of physical activity tracking devices on increasing the level of daily physical activity. Effects are found to be small to moderate, increasing daily steps count by up to 1850 steps (Gal et al., 2018; Laranjo et al., 2020). Using mobile applications for learning is sometimes challenging and many factors influence its effectiveness. Internet and mobile device availability or using suitable teaching methods and appropriate content are some of the factors that are determinant to successful use of mobile applications for learning. Like any tool used for teaching, mobile devices have both advantages and disadvantages (Bączek et al., 2021) and it is the responsibility of the teacher to implement mobile application teaching in the most appropriate way. The availability of information at all times is another positive factor for using the mobile applications both for health purposes and for upbringing and education. This makes it easier for students to prepare for the class, which the results of this research confirmed. Furthermore, students' satisfaction with the class of physical education did not change before and after experiment, while the application was helpful to many students. Moreover, no negative perception of usefulness of the PE class was observed while using the Mogy application. With the implementation of the Mogy, the class was easier for the teacher because the students were already prepared prior to the class. In addition to the conversation about important issues such as importance of hydration, healthy eating and regular sleep rhythm, performed in the final part of the class, the use of application made the class more interesting and dynamic. Majstorović et al. (2018) described the possibility of implementation of the Mogy application through each part of the class, making the use of ICT during PE classes more accessible. Using Mogy application also proved useful in promoting physical activity of adolescents during COVID-19 pandemic (Šunda, Babić & Andrijašević (2020). It is important to mention that the teacher, with all the benefits of using ICT, shall keep the key role in the educational process. However, the teacher should monitor its development and use it in the teaching process as an aid. The future research shall be conducted on students of secondary schools, while finding additional possibilities of using ICT in the PE classes is an encouragement for further researches.

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## DIFFERENCES IN KINANTROPOLOGICAL CHARACTERISTICS IN YOUNGER SCHOOL CHILDREN WITH REGARDS TO ENGAGEMENT IN SPORTS ACTIVITIES

Zvonimir Tomac<sup>1</sup>, Biljana Trajkovski<sup>2</sup>, Bojan Babin<sup>3</sup>

<sup>1</sup>University of Osijek, Faculty of Kinesiology, Croatia

<sup>2</sup>University of Rijeka, Faculty of Teacher Education, Croatia

<sup>3</sup>University of Split, Croatia

### Abstract

Playing sports at a younger school age contributes to better development of kinanthropological characteristics since the level of physical activity that takes place in physical education (PE) classes has an impact on the development of these characteristics; however, due to the sedentary lifestyle of children, this activity has proved insufficient. This paper aims to determine whether children involved in additional sports activities develop their kinanthropological characteristics better than children who do not participate in them. Research on the morphological, motor and functional characteristics, and grouping into sports and non-sports children was conducted in one elementary school in Rijeka (Croatia) on a sample of 158 pupils enrolled in grades one through four, 97 of whom were included in sports activities, while 61 were not. Kinanthropological characteristics were assessed with 15 variables ( morphological, 6 motor, and 1 functional). The results obtained show that children who engage in sports activities have better motor and functional abilities than children who do not participate in them, except in the flexibility test (seated forward bend) and the coordination test (polygon backward). In contrast, they do not differ significantly in morphological characteristics.

*Key words: pupils, kinanthropological characteristics, sports, differences*

### Introduction

The exercise process can influence a favorable constellation of anthropological characteristics, motor skills, and health status. Unlike the devastating condition of a non-exercising subject, the condition of an exercising person guarantees that many of the modern man's adversities can be effectively prevented. The prerequisite for this is the engagement in exercise throughout life, and the understanding of exercise as an irreplaceable cultural act, a kind of civilizational "image" (Mraković, 1992).

Chan Kai-Ming and Sung (1998) highlight that it is an accepted fact that children who participate in sports have a higher level of health and that young athletes can develop better intellectual and learning skills.

The problem of the modern lifestyle is reflected in the increasing limitations in meeting biotic needs, despite the increasing achievements in all areas of human activity.

The kinanthropological characteristics that develop to the highest possible limits will disintegrate more slowly and will remain at a certain level for a longer period. Therefore, it is necessary, and especially in the period of younger school age, to provide stimuli, i.e., those motor activities that will be in the function of maximum transformation of characteristics and abilities. The basic legality to be respected and enforced is reflected in the statement that during the growth and development of an organism, characteristics and abilities should be raised to the highest possible level as they will be maintained at that level for a longer person; of course, if one engages in regular exercise.

Therefore, it should be emphasized that muscular activity has always, even today, been the only active force necessary for the activation and normal functioning of all organs and organ systems and that adequate physical exercise represents for children-pupils, a basic need. In other words, it is an integral and necessary part of their daily routine.

For this reason, the aim of this paper is to determine whether children involved in additional sports activities develop their kinanthropological characteristics better.

## Methods

### Sample of participants

The total sample consisted of 158 children between the ages of 7 and 10, including 33 male and 11 female first-grade pupils, 23 male and 12 female second-grade pupils, 18 male and 22 female third-grade pupils, and 21 male and 18 female fourth-grade pupils in Rijeka. The sample of participants was divided into two categories with regards to physical activity (playing sports), namely 97 students who were involved in sports activities and 61 students who were not involved in sports activities.

### Sample of variables

The sample of variables consisted of a total of 15 variables for assessing kinanthropological characteristics, 11 of which are used in the education system (Pejčić and Trajkovski, 2018), starting with motor skills tests: sit-ups (MPT), standing long jump (MSD), seated forward bend (MPR), hand-tapping (MTR), polygon backward (MPN), and bent arm hang (MIV), one functional assessment test: three-minute running test (F3), and four measures to check anthropometric characteristics: body mass (ATT), body height (ATV), upper arm skinfold (ANN), and body mass index (BMI), as well as four measures not commonly used in the school system: belly circumference (OTRB), hip circumference (OKUK), upper arm circumference (ONAD), and back skinfold (KNL) measured according to (Weiner and Lourie, 1969; Mišigoj-Duraković, 2008).

Basic descriptive parameters (arithmetic mean and standard deviation) were calculated in each variable. The t-test for independent samples was used to determine differences in physical activity.

## Results and discussion

The results of the kinanthropological characteristics of children who are engaged in sports and those who are not, including their differences, are presented in Table 1.

Table 1. Results of the t-test (AS sport and SD sport = arithmetic mean and standard deviation of children engaged in sports; AS nonsport and SD nonsport = arithmetic mean and standard children not engaged in sports; t-value = t-test; df = degrees of freedom; p = level of significance)

	AS sport	SD sport	AS nonsport	SD nonsport	t-value	df	p
ATV	139.48	9.50	137.68	10.06	0.89	125.00	0.37
ATT	35.94	11.21	35.47	11.06	0.20	125.00	0.84
BMI	18.23	3.44	18.14	3.72	0.12	125.00	0.90
KNL	13.59	9.23	14.24	9.63	-0.28	125.00	0.78
KNN	14.96	8.67	16.23	8.18	-0.72	126.00	0.47
OTRB	65.24	9.66	66.34	10.89	-0.53	126.00	0.59
OKUK	75.43	9.57	75.81	10.12	-0.19	126.00	0.85
ONAD	21.35	3.71	21.42	2.98	-0.09	126.00	0.93
MPN	23.73	33.33	22.14	5.06	0.26	126.00	0.79
MTR	<b>23.86</b>	<b>3.49</b>	<b>21.97</b>	<b>3.19</b>	<b>2.68</b>	<b>126.00</b>	<b>0.01*</b>
MSD	<b>137.66</b>	<b>20.05</b>	<b>123.42</b>	<b>17.44</b>	<b>3.55</b>	<b>126.00</b>	<b>0.00*</b>
MPT	<b>33.96</b>	<b>8.59</b>	<b>28.60</b>	<b>7.57</b>	<b>3.06</b>	<b>124.00</b>	<b>0.00*</b>
MPR	64.08	15.45	62.39	10.62	0.57	126.00	0.57
MIV	<b>17.15</b>	<b>15.65</b>	<b>10.49</b>	<b>9.44</b>	<b>2.13</b>	<b>114.00</b>	<b>0.04*</b>
F3	<b>492.72</b>	<b>83.89</b>	<b>452.63</b>	<b>71.48</b>	<b>2.40</b>	<b>126.00</b>	<b>0.02*</b>

p=0.05

The findings show that children involved in sports activities perform better in most tests for the assessment of motor and functional abilities. However, in the seated forward bend test (MPR), these differences are not significant. In contrast, in the polygon backward test (MPN), children who are not involved in sports demonstrate a slightly better result.

Furthermore, the results show that no differences were found among children in morphological characteristics. However, from their average results, it can be seen that children tend to be slightly overweight (BMI = 18.2), according to Cole et al., 2000. Also, the standard of body fat percentage for school children and adolescents (ages 6 to 17), based on the back and upper arm skinfold measures obtained in a population of American children (Lohman, 1987 according to



Mišigoj-Duraković), indicate that our children pertain to the category of moderately high to high body fat percentage (29 and 31) and that children who do not engage in sports show slightly higher values, which is a concern for both groups. The obesity risk index or the waist-to-hip ratio index (WHR) above 0.8 is also risky for both groups. We, therefore, conclude that our children do not have harmonious body proportions, i.e., a sedentary lifestyle is taking place. Furthermore, physical activity, as part of PE classes, as well as additional sports activities, is not sufficient for the proper growth and development of the child. Our children are becoming increasingly overweight, i.e., are showing a tendency towards obesity and as a community we must prevent this by providing a better quality of life (healthier eating habits, good nutrition at school, sufficient physical activity including extracurricular physical activities, ensuring better material conditions for carrying out kinesiological activities throughout the day, as well as teach children and parents to spend their free time actively).

Similar findings were obtained in preschool children, whereby it was found that the children in the experimental group significantly improved their motor skills under the influence of a sports program. At the same time, in the area of morphological characteristics, there were no significant changes between the children in the experimental and control group except in the measure of subcutaneous fat in girls (Trajkovski Višić, 2004; Trajkovski Višić et al., 2008); the ratios (BMI, WHR, and body fat percentage), however, were much better in preschool than in school children in this research.

Janssen et al. (2005) find that increased movement and reduced time spent watching television should be the focus of a strategy aimed at preventing overweight and obesity at a young age.

Better results in the area of motor skills were achieved by those children who were additionally involved in physical activity in all three strength tests: in the explosive leg strength, measured with the standing long jump test (MSD), the children exceeded the result by 15 cm; in the repetitive torso strength, measured with the sit-ups test (MPT) with five repetitions and the static arm and shoulder strength measured with the bent arm hang test (MIV), the children exceeded the result by 17 seconds, indicating that children can be further affected by developmental activities forces. A slightly better result was achieved by children who additionally engage in after-school sports activities, usually two to three times a week, in the hand-tapping test (MTR), which observes the speed of alternative movements, by two additional repetitions. In the flexibility test, measured with the seated forward bend test (MPR), the children engaged in additional physical activity achieved a result that exceeded that of other children by 2 cm. However, given that the difference was not significant, this may indicate insufficient implementation of stretching exercises with children in general, even with those children who are more involved in sports activities. It is interesting to note that children who do not play sports are better in the coordination test (polygon backward – MPN) by 1.5 seconds. Despite not being a significant difference, this also indicates insufficient implementation of activities that can influence the improvement of coordination, which is certainly a priority at this age. Many authors have demonstrated an association of increased physical activity with better motor skills (Oliver et al., 2007; Katić et al., 2004).

Functional abilities tested by the three-minute running test (F3) are better in children who are involved in sports activities by almost 50 meters. However, we should not be satisfied with the result since it must certainly be improved for all children, and we can conclude that if aerobic endurance were raised to a higher level, there would be a greater chance of transformation of morphological characteristics as well.

## Conclusion

A burning issue in our society is the lack of movement, which has already had a profound impact on the growth and development of children, and the role of the school (kinesiologist, teacher) is possible only if society's strategy is to care for the health of children. All those working in the education system, especially younger school children, must, within the scope of their competences, encourage and take concrete actions to establish such a mode of life in which regular physical exercise will be treated as a factor in the health and culture of life and the right of every child.

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## DISCRIMINANT ANALYSIS OF PRIMARY EDUCATION FOURTH GRADE FEMALE AND MALE PUPILS IN MEASURES OF MORPHOLOGICAL AND ANTHROPOMETRIC FEATURES

Braco Tomljenović<sup>1</sup>, Damir Lauš<sup>2</sup>, Sanjin Tomljenović<sup>3</sup>

<sup>1</sup>University in Zadar, Department of Teacher Education Studies, Gospić, Croatia

<sup>2</sup>Polytechnic, Bjelovar, Croatia

<sup>3</sup>Student on faculty of Economics Zagreb, Croatia

### Abstract

By analysing differences between male and female primary education fourth grade pupils in the field of 19 standard indicators of measures of anthropometric features, it is proved that male pupils, in comparison to female pupils, show significantly higher measures of transversal skeleton dimensionality in the following measures: wrist diameter, elbow diameter, knee diameter, foot width and biacromial range. Female pupils show higher values in volume, body mass and subcutaneous fat tissue based on the following measures: upper leg extent, bicristal range, back skinfold, lower leg skinfold, body mass, lower leg extent, central chest extent, upper arm extent. The results of discriminant analysis show differences between male and female anthropometric features. Male pupils are more robust and show higher values in latent dimensions of longitudinal and transversal skeleton dimensionality. Female pupils have more subcutaneous fat tissue which is seen in higher body mass and body volume. The differences are explained by the intensity of segmental body growth and different organ systems. Female pupils reach adolescence growth around the age of 10. The results indicate the need to consider gender differences when planning Physical Education classes in the fourth grade with the option of holding classes in homogenous groups.

**Key words:** primary school, morphology, differences, female pupils, male pupils

### Introduction

One of the most important tasks when working with early primary school pupils, is the care for their optimal growth and development. While growing and developing, pupils' anthropological features are continuously influenced by biological principles which mark segments of their growth. The dynamics and the quality of changes of anthropometric features depends on numerous internal and external factors, among which physical activity is the most important (Mišigoj-Duraković, M. 2008).

Anthropological features, growth and development, are not strictly defined and divided into regular developing periods because of exogenous and endogenous factors. Exogenous factors are defined as time for doing physical activities, material conditions, experts and agents. Endogenous factors can be defined as the interaction of genetic and not genetic part of every human characteristic and ability. The second endogenous factor refers to the change in human characteristics and abilities during life. Pupils of the same chronological age can develop slowly or fast. The third endogenous factor refers to the pupils' health. (Mraković, 1996).

Researches which aimed towards defining morphological features of primary school fourth grade pupils, were rarely conducted in Lika region. Rarely were conducted researches to determine differences between fourth grade female and male pupils in morphological anthropometric features. The influence of physical activity is possible, if it is well planned and aims towards morphological dimensions possibly influenced by the teaching process. It includes developing adequate programmes in applied kinesiology as well as planning, programming, controlling and evaluation in scientifically acceptable way.

### Methods

The number of participants in this research was randomly taken from the population of primary school fourth grade female and male pupils age 10 years  $\pm$  6 months, attending schools in Lika. The number of participants equaled 200 (100 male and 100 female pupils) attending primary schools in Gospić, Otočac, Gračac, Lički Osik, Brinje and Korenica.

The number of measures of morphological features was formed out of 19 morphological measures, which were taken and measured by International biological programme (IBP-Weiner and Lourie, 1969 (according to Mišigoj-Duraković, M., 2008). Each variable was measured three times in sequence or in alternation. The chosen variables are commonly used which makes it possible to compare the obtained results with the previous researches.

Longitudinal skeleton dimensionality was estimated by five measures: Body height (ALDTV), Arm length (ALDDR), Leg length (ALDDN), Foot length (ALDDS) and Biacromial range (ALDBR). Body volume and mass were estimated by five measures: Body weight (AVMTM), Central chest extent (AVMSOK), Upper arm extent (AVMONA), Upper leg extent (AVMONAT) and Lower leg extent (AVMOPOT). Subcutaneous fat tissue was estimated by four measures: Back skinfold (APMLE), Belly skinfold (APMTR), Upper arm skinfold (APMNAD) and Lower leg skinfold (APMPOT). Transversal skeleton dimensionality was estimated by five measures: Elbow diameter (ATDLA), Wrist diameter (ATDRZ), Bicristal range (ATDBKR), Knee diameter (ATDKO) and Foot width (ATDST).

Basic statistical parameters were calculated based on the collected data: arithmetic means and standard deviation. Differences between male and female pupils in the field of 19 measures of morphological anthropometric features were analysed by t-test and canonical discriminant analysis. Data were processed by STATISTICS package on the Department of Teacher Education Studies in Gospić, University in Zadar.

## Results

Based on the obtained results (table 1) we can see statistically important differences between primary school fourth grade female and male pupils in Lika region, in the following variables: Biacromial range (ALDBR), Elbow diameter (ATDLA), Wrist diameter (ATDRZ), Knee diameter (ATDKO) and Upper leg extent (AVMONAT).

Table 2. shows the results of discriminant function values ( $\lambda$ ), canonical correlation (Rc), and  $X^2$ -significance test ( $X^2$ ,  $df$ ,  $p$ ). The obtained canonical discriminant function shows significantly important difference between female and male pupils on the level of significance 0.00 ( $p < 0,05$ ), together with relatively high canonical correlation (0.60). It is stated that 19 standard measures of morphological anthropometric features distinguish female pupils from male pupils well.

Table 1. T-test results, (Arithmetic mean -Mean, standard deviation – Std. Dev) male pupils (M) and female pupils (F)

	Mean	Mean	Std. Dev	Std. Dev	t	p
	M	F	M	F		
ALDTV	142,74	142,79	7,07	6,37	-0,06	0,95
ALDBR	33,56	32,91	2,25	2,38	<b>1,98</b>	<b>0,05</b>
ALDDR	61,99	61,89	3,80	3,52	0,19	0,85
ALDDN	80,88	81,32	4,64	4,40	-0,68	0,50
ALDDS	22,89	22,54	1,52	1,31	1,73	0,09
ATDLA	5,72	5,56	0,49	0,53	<b>2,15</b>	<b>0,03</b>
ATDRZ	4,65	4,52	0,34	0,32	<b>2,67</b>	<b>0,01</b>
ATDBKR	25,04	25,76	2,43	2,73	-1,96	0,05
ATDKO	8,75	8,52	0,74	0,76	<b>2,16</b>	<b>0,03</b>
ATDST	8,79	8,70	0,79	0,71	0,85	0,40
AVMTM	38,29	39,86	9,13	10,25	-1,15	0,25
AVMSOK	71,03	71,10	7,46	7,99	-0,06	0,95
AVMONA	22,73	22,84	3,23	3,21	-0,25	0,80
AVMONAT	42,05	43,65	5,24	5,65	<b>-2,08</b>	<b>0,04</b>
AVMPOT	30,71	31,27	3,24	3,72	-1,13	0,26
APMLE	13,16	14,94	7,32	6,18	-1,86	0,06
APMTR	15,94	15,64	9,42	6,48	0,27	0,79
APMNAD	15,97	15,54	6,61	4,79	0,52	0,61
APMPOT	13,77	15,05	5,84	5,06	-1,65	0,10

Body height (ALDTV), Arm length (ALDDR), Leg length (ALDDN), Foot length (ALDDS) and Biacromial range (ALDBR). Body weight (AVMTM), Central chest extent (AVMSOK), Upper arm extent (AVMONA), Upper leg extent (AVMONAT) and Lower leg extent (AVMOPOT). Back skinfold (APMLE), Belly skinfold (APMTR), Upper arm skinfold (APMNAD) and Lower leg skinfold (APMPOT). Elbow diameter (ATDLA), Wrist diameter (ATDRZ), Bicristal range (ATDBKR), Knee diameter (ATDKO) and Foot width (ATDST).

Table 2. Eigenvalue ( $\lambda$ ), canonical correlation (Rc), Wilks'  $\lambda$ ,  $X^2$ -test, degrees of freedom (df), the level of importance (p) diskriminant functions

	$\lambda$	Rc	Wilks' $\lambda$	Chi-Sqr.	df	p
DF1	0,58	0,60	0,63	85,89	19	0,00

Table 3. shows the structure of discriminant function and the results of centroids of female and male pupils on discriminant function. Male pupils are shown on the positive pole of discriminant function and female pupils on the negative pole. The structure of discriminant function is bipolar. The positive pole is best defined by variable *wrist diameter*, followed by small projection of variables *elbow diameter*, *knee diameter*, *biacromial range* and *foot length* and by insignificant projection of the variables *foot length*, *central chest extent*, *upper arm extent* and *body height*.

Table 3. Structure and position of centroid groups on discriminant function

Variables	DF1
ALDTV	-0,01
ALDBR	0,19
ALDDR	0,02
ALDDN	-0,06
ALDDS	0,16
ATDLA	0,20
ATDRZ	0,25
ATDBKR	-0,18
ATDKO	0,20
ATDST	0,08
AVMTM	-0,11
AVMSOK	-0,01
AVMONA	-0,02
AVMONAT	-0,19
AVMPOT	-0,11
APMLE	-0,17
APMTR	0,02
APMNAD	0,05
APMPOT	-0,15
Groups	DF1
M	0,76
F	-0,76

Body height (ALDTV), Arm length (ALDDR), Leg length (ALDDN), Foot length (ALDDS) and Biacromial range (ALDBR). Body weight (AVMTM), Central chest extent (AVMSOK), Upper arm extent (AVMONA), Upper leg extent (AVMONAT) and Lower leg extent (AVMOPOT). Back skinfold (APMLE), Belly skinfold (APMTR), Upper arm skinfold (APMNAD) and Lower leg skinfold (APMPOT). Elbow diameter (ATDLA), Wrist diameter (ATDRZ), Bicristal range (ATDBKR), Knee diameter (ATDKO) and Foot width (ATDST).

## Discussion

The aim of this research was to determine if 19 standard measures of morphological anthropometric features distinguish female pupils from male pupils. The differences between male and female pupils in the field of 19 standard indicators of morphological anthropometric features were analysed by canonical discriminant analysis. The obtained canonical discriminant analysis shows significant differences between female and male pupils on the level of importance 0,05 ( $p < 0,05$ ), followed by relatively high canonical correlation (0,60). It can be stated that 19 indicators of morphological anthropometric features distinguish female pupils from male pupils well and therefore confirm high predictive value of 19 standard indicators of morphological anthropometric measures for the final distinction defined as differences between male and female pupils. According to the obtained results the highest positive contribution to primary school fourth grade pupils' distinction (distinction between male and female pupils) is seen in the value *wrist diameter* (0,25) as wrist diameter shows transversal skeleton dimensionality. Since bone structure is continuously being developed under mechanical pressures, metabolic needs and hormonal status, the bones of primary education fourth grade pupils increase in diameter due to physical activity, growth, sport activities and appropriate nutrition. It can be concluded that the second phase of rapid growth of female pupils hasn't started yet and it is known that it starts two years earlier than with male pupils. Significant positive correlation with discriminant function is also shown in other indicators of transversal dimensionality, *elbow diameter* (0,20), *knee diameter* (0,20), *foot length* (0,16) and insignificantly by projection of variable *foot width* (0,08). Significant contribution to differences between male and female pupils is shown in *biacromial range* (0,19), the indicator of longitudinal skeleton dimensionality. Other indicators of longitudinal skeleton dimensionality show insignificant correlation with discriminant function *arm length* (0,02), *body height* (-0,01) and *leg length* (-0,06). Between two phases of rapid growth and in the first phase of slow growth, increase in longitudinal skeleton dimensionality is similar between boys and girls, except for shoulder width which belongs more to transversal skeleton dimensionality. In this variable boys show higher values. Significant contribution to defining discriminant analysis is given by variable *upper leg extent* (-0,19), by variables *lower leg extent* (-0,11) and *body weight* (-0,11). Such correlations are derived from the fact that female pupils have more subcutaneous fat tissue and total body weight. Variables *back skinfold* (-0,17) and *lower leg skinfold* (-0,15) significantly contribute to structuring discriminant functions. These correlations are derived from the fact that female pupils show higher values in body weight, volume and continuous increase in fat tissue, which does not reduce by growth, as it does with male pupils. By analysing differences between male and female pupils in the field of 19 anthropometric features it has been determined that male pupils are more robust and show higher values in latent dimensions of longitudinal and transversal skeleton dimensionality. Female pupils show higher values in body weight and volume which are influenced by subcutaneous fat tissue. Many researches indicate differences in morphological features of early primary school pupils (Džibrčić i sur., 2014.; Prskalo i sur.2008.;

Tomljenović, i sur.2009, Malina, 2008,; Pena i Mallina, 2003). Obtained differences can be explained by different growth intensity of morphological body segments and different organ systems. Female pupils reach the period of adolescent growth at the age of 10.

## Conclusion

The research was held in order to determine the differences between male and female pupils relating to the 19 measures of morphological anthropometric features. The respondent sample was based on 200 male and female pupils (100 male and 100 female pupils) attending fourth grade primary schools in six rural areas in Lika.

Canonic discriminant function shows differences between male and female pupils based on the significance 0,05 ( $p < 0,05$ ) with canonic correlation (0,06). Male pupils are taking the positive pole and female pupils the negative pole of discriminant function. The positive pole is best defined by variables *wrist diameter, elbow diameter, knee diameter, foot length, biacromial breadth* and by insignificant projections *foot width, arm length, leg length*. The negative pole is defined by variables *thigh circumference, back skinfold, lower leg skinfold, lower leg circumference and body mass*.

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## DIFFERENCES IN MANIFEST MOTOR SKILL TESTS BETWEEN PUPILS ATTENDING THE FOURTH GRADE IN URBAN AND RURAL SCHOOLS

Frane Tomljenović<sup>1</sup>, Filip Bolčević<sup>2</sup>, Braco Tomljenović<sup>3</sup>

<sup>1</sup>Primary School Markuševac, Croatia

<sup>2</sup>Zagreb Canoe Association, Croatia

<sup>3</sup>University of Zadar, Department of Teacher Education Studies, Gospić, Croatia

### Abstract

The aim of research was to define the differences in motor ability between fourth grade pupils who live in urban and those who live in rural environment of Lika region. The sample consisted of 100 primary school pupils, 50 pupils from urban area and 50 pupils from rural area.

Research was conducted with 18 standardized tests for motor ability. Each ability; agility, explosive strength, flexibility, coordination, repetitive strength and balance was measured with three different tests. The basic statistical parameters were calculated on collected data: arithmetic mean and standard deviation. Differences between pupils from urban and rural area within 18 motor skills tests were analysed by t-test and canonical discriminant analysis. The canonical discriminant function obtained significantly differentiates students from urban and rural areas at a significance level of 0.00 ( $p < 0.05$ ), with a relatively high canonical correlation (0.64). It can be stated that the 18 standard tests of motor ability distinguish between students of urban and rural areas. The obtained differences that define the different urban and rural environments are important and should be considered while Physical Education Curriculum planning and programming.

**Key words:** elementary school, motor skills, discrimination analysis, physical activity

### Introduction

Is it possible that growth, development and pupils' maturity depend on the place of living? Are the better living conditions as better access to quality health care services, place of living, nourishment and opportunities for active exercising, the result of decreased differences of morphological features, motor and functional abilities of pupils attending the first four grades in urban and rural schools? Does the sedentary lifestyle effect pupils' growth and development in a positive or negative way, while using the social media pupils satisfy their necessity for social interaction, communication and playing games using the minimal effort? The differences between the motor abilities and morphological features of male and female pupils in urban and rural area decreased due to the improvement of the lifestyle during the 1930s. Urban-rural comparison of American pupils in State of Missouri shows the irrelevant differences in lung capacity, hand power grip, rapidity of moving legs and hands. Differences in the maturity are almost negligible between urban and rural area of the USA, Canada and the Western Europe. On the contrary, the research done in some Eastern European countries as Poland, Romania and Greece has shown the differences in the growth and development of pupils in urban and rural area, as well as the difference is evident in some still developing countries in Africa, Asia and South America (Malina, R., 2004, Mészáros, Z. 2008). Living environment, by Walhain, F., et al. (2016) was significantly associated with certain components of health-related fitness and motor coordination, physical and sedentary activities of seven-year-old children in Suriname. Urban children had a lower cardiorespiratory fitness and were less physically active than rural children. The research that define the motor skills of pupils attending the fourth grade of primary school have rarely been taken in the area of Lika. There are only a few studies that define the relation of motor skill tests and the place of living. Therefore, the aim of this research was to define the differences between the pupils attending the fourth grade of primary schools in urban and rural areas in Lika in manifest tests of motor skills.

### Methods

The subjects of the research were divided into urban and rural area according to socioeconomic factors and place of living. These two environments are defined on the basis of the model of differentiation of urban, rural and transitional settlements of the Republic of Croatia, the Central Bureau of Statistics in 2011. A sample of subjects in the urban area was based on 50 primary school pupils in Gospić and Otočac. A sample of subjects in the rural area was based on 50 primary school pupils in Gračac, Lički Osik, Brinje and Korenica.

The set of motor abilities' tests consists of 18 tests. Measurement of subjects' motor abilities was done in accordance with the Validation of Measures and Tests for the Assessment of the Anthropological Characteristics of Primary and Secondary School Students (Neljak, 2008).

Agility was estimated by three tests: Side steps (MAGKUS), Doing the 8 with bending (MAGOSS) and Carrying over by running (MAGPRP). Explosive strength was estimated by three tests: Standing long jump (MESSDM), High start 20 m sprint (MESS20) and Throwing medicine ball (1kg) from lying down (MESBML). Flexibility was estimated by three tests: Forward bend with legs widely spread (MFLPRR), Forward bend on a bench (MFLPRK) and Forward bend with legs slightly spread (MFLPRU). Coordination was estimated by three tests: Ground practice backwards (MKOPLN), Rolling a ball by undominant hand (MKOKLR) and Ground practice with a turn (MKOPLO). Repetitive strength was estimated by three tests: Lifting the upper body from lying down (MRSPTL), Lifting the upper body – short (MRSPTK) and Squats (MRSCUC). Balance was estimated by three tests: Standing on one leg on a balancing bench with eyes closed (MBAU1Z), Standing on a balancing bench with eyes open (MBAU20) and Standing on a turned over balancing bench with eyes open (MBAOKO).

The basic statistical parameters were calculated on collected data: arithmetic mean and standard deviation. Differences between pupils from urban and rural area within 18 motor skills tests were analysed by t-test and canonical discriminant analysis. The data were elaborated by the STATISTICS package 13.

## Results

Based on the results (Table1), it is evident that statistically significant difference between pupils living in urban and rural area exists in variables: doing the 8 with bending (MAGOSS),

standing long jump (MESSDM), high start 20 m sprint (MESS20), lifting the upper body from lying down (MRSPTL) and standing on a turned over balancing bench with eyes open (MBAOKO).

Table 1. The results of t-test (arithmetic mean, standard deviation -Std. Dev) of pupils living in urban area (G) and pupils living in rural area (S)

	Mean	Mean	Std. Dev	Std. Dev	t	p
	U	R	U	R		
MAGKUS	13,01	13,34	1,48	2,13	-0,90	0,37
MAGOSS	11,40	10,47	1,59	1,27	3,23	<b>0,00</b>
MAGPRP	12,79	12,45	1,02	1,15	1,55	0,12
MESSDM	147,93	157,35	22,35	18,09	-2,32	<b>0,02</b>
MESS20	4,91	4,57	0,48	0,41	3,87	<b>0,00</b>
MESBML	469,75	504,64	95,52	89,36	-1,89	0,06
MFLPRR	38,17	35,42	7,81	8,26	1,71	0,09
MFLPRK	36,02	37,31	5,41	5,88	-1,14	0,26
MFLPRU	36,18	37,82	6,31	6,82	-1,25	0,21
MKOPLN	19,72	17,87	5,87	4,34	1,79	0,08
MKOKLR	23,87	22,44	5,20	3,31	1,64	0,10
MKOPLO	13,34	12,13	3,50	3,05	1,84	0,07
MRSPTL	31,28	35,02	8,65	9,17	-2,10	<b>0,04</b>
MRSPTK	44,18	48,44	13,05	14,59	-1,54	0,13
MRSCUC	47,36	44,38	9,94	10,10	1,49	0,14
MBAU1Z	2,19	2,38	1,03	1,32	-0,77	0,44
MBAU20	2,72	3,09	1,47	1,49	-1,22	0,23
MBAOKO	1,64	1,92	0,59	0,80	-2,02	<b>0,05</b>

Side steps (MAGKUS), Doing the 8 with bending (MAGOSS), Carrying over by running (MAGPRP), Standing long jump (MESSDM), High start 20 m sprint (MESS20), Throwing medicine ball (1kg) from lying down (MESBML), Forward bend with legs widely spread (MFLPRR), Forward bend on a bench (MFLPRK), Forward bend with legs slightly spread (MFLPRU), Ground practice backwards (MKOPLN), Rolling a ball by undominant hand (MKOKLR), Ground practice with a turn (MKOPLO), Lifting the upper body from lying down (MRSPTL), Lifting the upper body – short (MRSPTK), Squats (MRSCUC), Standing on one leg on a balancing bench with eyes closed (MBAU1Z), Standing on a balancing bench with eyes open (MBAU20), Standing on a turned over balancing bench with eyes open (MBAOKO)

Table 2. presents the results of specific discriminant function ( $\lambda$ ), the canonical correlation (Rc), and the X<sup>2</sup>-significance test (X<sup>2</sup>, df, p). The canonical discriminant function obtained significantly differentiates students from urban and rural areas at a significance level of 0.00 ( $p < 0.05$ ), with a relatively high canonical correlation (0.64). It can be stated that the 18 standard tests of motor ability distinguish between students of urban and rural areas.

Table 2. Eigenvalue ( $\lambda$ ), canonical correlation (Rc), Wilks'  $\lambda$ , X<sup>2</sup>-test, number of degrees of freedom (df), and significance level (p) of discriminant function

	$\lambda$	Rc	Wilks' $\lambda$	Chi-Sqr.	df	p
DF1	0,70	0,64	0,59	47,01	18,00	<b>0,00</b>

Table 3. presents the structure of discrimination function and the results of centroid of pupils in urban and rural area on discriminant function. Inversely scaled variables in original results were multiplied with (-1). On the negative pole of the discriminant function are students of the rural environment, and on the positive students of the urban environment. The structure of the discriminant function is also bipolar. The positive pole is best defined by the variable forward bend with legs slightly spread, then by a small projection of the variable squats and steps aside. Negative pole is best defined by the variables in high projection 20 m high sprint, doing the 8 with bending, standing long jump, lifting the upper body from lying down, standing on a balancing bench with eyes opened, throwing medicine ball from lying down, ground practice with a turn, ground practice backwards and ball rolling, then a small projection of the variable transfer by running, ground short body lifting, standing on the reverse balancing bench with eyes opened, bend with legs slightly spread and bend on the bench, and with a slight projection of variable standing on one leg on the balancing bench with eyes opened.

Table 3. Structure and position of centroids groups on discriminant function

Variables	DF1
MAGKUS	0,11
MAGOSS	<b>-0,39</b>
MAGPRP	-0,19
MESSDM	<b>-0,28</b>
MESS20	<b>-0,47</b>
MESBML	<b>-0,23</b>
MFLPRR	<b>0,21</b>
MFLPRK	-0,14
MFLPRU	-0,15
MKOPLN	<b>-0,22</b>
MKOKLR	<b>-0,20</b>
MKOPLO	<b>-0,22</b>
MRSPTL	<b>-0,25</b>
MRSPTK	-0,19
MRSCUC	0,18
MBAU1Z	-0,09
MBAU20	-0,15
MBAOKO	<b>-0,24</b>
Groups	DF1
U	0,83
R	-0,83

## Discussion

According to the structure of the discriminant function it is evident that in the latent dimension of explosive power, the 20 m sprint variable (-0.47) contributes most to the difference between pupils from urban and pupils from rural area. Significant contributions to the determination of discriminant function are given by the variables long jump (-0.28) and throwing medicine ball from lying down (-0.23) where rural students perform better. A very significant contribution to the determination of discriminant function in the latent dimension of agility is the variable doing the 8 with bending (0.09) and transfer by running (-0.19) where pupils from rural area perform better. The results of the discriminant function

show that the variables ground practice backwards (-0.22), rolling a ball (-0.20) and ground practice with a turn (-0.22) make a significant contribution to the latent dimension of coordination for rural students who perform better. The results of discriminant function in latent dimension of repetitive strength indicate the important contribution of that lifting the body from lying down short (-0.25) and lifting the body off the floor (-0.19) variables where pupils from rural area perform better from pupils in rural area who are better in doing squats (0,18). Very significant contribution to the determination of discriminant function in the latent balance dimension is given by the variables standing on the turned over balancing bench with eyes open(-0.24), standing on one leg on a balancing bench with eyes closed (-0.15) and standing on a balancing bench with eyes opened (-0.09) where pupils from rural area perform better. There are also significant differences in the latent dimension of flexibility. The results indicate a significant contribution to determination of discriminant function in forward bend with legs slightly spread (-0,15) and forward bend on a bench (-0.14) where pupils from rural area have better results while pupils in urban area are better in doing the bend forward (0,21). The differences could be explained by different living conditions, nourishment and place of living, work and opportunities to do some sports and playing games. Pupils who live in rural area spend more free time playing outside as well as they have working obligations. By the Mendoza-Castejón, D., & Clemente-Suárez, V. J. (2020). „school location is a variable that can affect anxiety levels and ability to modulate the internal stress of students. City students had higher anxiety scores and higher records on variables related to sympathetic system activation than rural students. However, no differences in academic performance were observed (excepting the higher mark of rural students in physical education).“ They also say that regarding to eating habits, results show that a worse body composition (associated with an unhealthy physical condition) correlates with lower grades. In the study by Walhain, F., et al.(2016.) there was a significant difference in cardiorespiratory fitness; urban children scored significantly lower than rural children on the 20-meter shuttle run test. Impact of the sedentary lifestyle is more expressed among pupils from urban area. The results of the former research indicate statistically significant difference in the manifest tests of pupils' motor skills. Pupils from rural area achieve better results in most tests (Džibrić, D. , 2014; Pena Reyes, M.E. , 2003; Cetinić, J. , 2011; Prskalo, I. , 2009; Šumanović, M. , 2008; Pejčić, A. , 1997).

The study made by Sjöberg, A., et al (2011) show that, overweight and obesity was found in 17% of Swedish schoolchildren in school year 1 and 2, while 7.5% were classified to be thin and the remaining 76% were normal weight. Both socioeconomic gradients as well as urban–rural gradients were found, with a higher risk for both overweight and obesity in low-SES areas compared with high-SES areas and for overweight in rural compared with urban areas. Interesting study made by Baldinger N., et al. (2012) underlines the importance of breakfast for school-aged children: Children eating breakfast almost every day had better motor functional skills and a lower BMI than children not regularly eating breakfast. The study further hints at the importance of generally healthy nutritional habits with regard to both motor functional skills and healthy weight status. The obtained differences that define the different urban and rural environments are very important and should be considered while Physical Education Curriculum planning and programming.

## Conclusion

The aim of this research was to define the differences between the pupils attending the fourth grade of primary schools in urban and rural areas of Lika in manifest tests of motor skills. The sample consisted of 100 primary school pupils, 50 pupils from urban area and 50 pupils from rural area. The analysis of differences between pupils are done by 18 motor skill tests. The canonical discriminant function obtained significantly differentiates students from urban and rural areas at a significance level of 0.00 ( $p < 0.05$ ), with a relatively high canonical correlation (0.64). It is defined that pupils who live in rural area have significantly more robust body structure in comparison with pupils living in urban area, who achieve better results in most motor tests.

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## IMPACT OF DIFFERENT GENERAL PREPARATORY EXERCISES ON THE PHYSIOLOGICAL WORKLOAD IN PUPILS IN PHYSICAL EDUCATION

Biljana Trajkovski<sup>1</sup>, Iva Blažević<sup>2</sup>, Tatjana Gerekarovska<sup>3</sup>

<sup>1</sup>University of Rijeka, Faculty of Teacher Education, Croatia

<sup>2</sup>University of Pula, Croatia

<sup>3</sup>Osnovna škola Mladost, Zagreb, Croatia

### Abstract

The use of different types of general preparatory exercises encourages a greater or lesser physiological workload during Physical Education. Due to the importance of the role of general preparatory exercises, this paper presents the research findings on the impact of different exercises on the physiological workload of younger pupils. The study was conducted in one elementary school in Rijeka (Croatia) on a sample of 185 pupils ranging from the first to the fourth grade. The physiological workload was measured by taking the pupils' pulse. The results show that the physiological workload in boys and girls is higher when performing general preparatory exercises with aids than without aids and that the physiological workload in children is higher when performing general preparatory exercises with music than with aids and without aids. Various props and music have a motivational effect on children and encourage them to be more active, thus achieving a higher physiological workload.

**Key words:** *pupils, general preparatory exercises, physiological workload, differences*

### Introduction

The consequence of physical activity to which pupils are exposed during Physical Education (PE) is a series of functional changes in their body resulting in increased work of the cardiovascular and respiratory systems (Findak, 2003).

The teacher should predict the physiological load based on the set goal and tasks of a particular class (Pejčić and Trajkovski, 2018).

Functional abilities of the organism and endurance have a preventive role in the development of cardiovascular diseases but also allow working efficiency; therefore, their development must be encouraged from early childhood.

The teacher greatly influences the physiological workload of the pupil as he/she plays a major role in the preparation and implementation of a lesson. Activities used to induce the development and alteration of anthropological features of the organism must contain a certain amount of intensity and frequency to reach the level of stimulation of the organism. Achieving optimal workload is especially important for transforming the anthropological traits of pupils and facilitating adaptation processes. Also, children's motivation is essential to enable quality and optimal development of all traits and abilities through participation in various motor activities (Marić et al., 2013).

General preparatory exercises are designed exercises that are tailored to fit the needs and challenges experienced by certain body parts. They accomplish important tasks in maintaining the biological balance of a child's body. This is why the child should be provided with daily activity because the physical movement is a fundamental way of maintaining health and not just a characteristic of life. Considering that the general preparatory exercises train the locomotor apparatus, we can state that their primary influence is focused on the muscles and joints (Pejčić and Trajkovski, 2018). When planning general preparatory exercises, care should be taken to select those exercises that gradually increase and reduce the workload of the organism and allow it to take rest at intervals (Kosinac, 2001).

Through regular physical activity, we improve preschool children's functional abilities, whereby it has been determined that children's sex and group significantly influence the development of functional abilities. Thus, boys achieve better results than girls, and children in the experimental group show more developed functional abilities than children who attend a regular preschool program (Trajkovski et al., 2014).

General preparatory exercises also develop the quality of movement, thus achieving the refinement of the body itself. The organism grows and develops by doing, and to be able to do this, it is necessary to stimulate it, which is very often missing due to insufficient physical movement (Kosinac, 2001). Lack of movement can lead to the weakening and atrophy of the muscles and even to the weakening of the respiratory apparatus. Very often, there are difficulties such as disorders



in the regulation of blood flow, respiratory disorders, etc. To avoid this, general preparatory exercises should be introduced as early as possible to cause a strong enough and necessary stimulation of the organism. For this reason, the physical activity of children is considered necessary, and the habits adopted in childhood remain present for life (Milanović and Kolman, 1993). The proper physical activity of children greatly affects their health status. Physically active children have stronger muscles and bones, leaner bodies because they balance and regulate the amount of body fat, are less likely to become obese, less frequently develop diabetes, and have a lower blood pressure and cholesterol level (Gavin et al., 2007).

The implementation of different types of general preparatory exercises encourages a greater or lesser physiological load during PE classes. Since it is vital to achieve an adequate physiological workload in all parts of the PE lesson, this paper aims to determine which general preparatory exercises in the preparatory part of the PE lesson achieve a particular physiological workload in pupils. The aim is also to identify which sets of general preparatory exercises (general preparatory exercises without aids, with aids, and with music) can be used to achieve a higher physiological workload for pupils.

## Methods


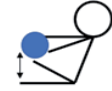





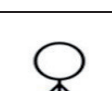

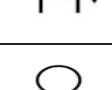


### Sample of participants

The sample consisted of 185 elementary school pupils in one elementary school in the City of Rijeka (Croatia). The total number of participants included 87 boys and 98 girls.

### Sample of variables

The sample of variables comprised variables of the pulse value after the physiological workload, that is, at the end of the preparatory part of the lesson. After each performance of a set of preparatory exercises, the pupil's pulse was measured, i.e., their heart rate for 10 seconds in the preparatory part of the lesson. The time was measured with a stopwatch, and the obtained results of the manually measured heart rate were subsequently multiplied by 6 to obtain a one-minute pulse measurement result.

The pupils performed 38 different sets of general preparatory exercises. Some pupils performed sets of general preparatory exercises without aids, some with aids, and others with music. Because the children were more interested in performing general preparatory exercises with aids, we have provided an example of a set of general preparatory exercises with the ball in the continuation of this paper.

1. Upright posture, arms extended forward, ball in hands. Bend the arms towards the chest, touch your chest, and extend the arms out.		7. Sit with legs extended forward, the soles of the feet touching. Lift one leg and push the ball under it, switching from one hand to the other.	
2. Straddle-leg stance. Ball in hands, arms up over the head. Stretch sideways to the left and right.		8. Push-up position, hands flat on the ground. Roll the ball from one hand into the other.	
3. Straddle-leg stance, arms stretched forward, ball in hands. Transfer the ball from one hand into the other by circling the ball around the torso.		9. Lying on the back, the hands are on the sides of the torso. Bring the torso forward, bend the knees at the right angle. Lift them towards the torso, and return to the starting position.	
4. Straddle-leg stance, arms extended forward, ball in hands. Lift one leg to the front to touch the ball, alternate legs.		10. An upright posture with the soles of the feet touching, arms extended forward, palms facing up, ball in hands. From the starting position, lower the body down to the squatting position, and move back up to the starting position.	
5. Standing, upright posture. The ball is on the ground, in front of the body. Jump over the ball with a two-foot takeoff.		11. Straddle-leg stance, arms extended forward, ball in hands. In the position of a deep bend, roll the ball between the legs in the form of figure-eight circles.	
6. Sit with legs extended forward. The ball is placed between the feet. Raise the feet, hold the position for a few seconds, then lower them.		12. Upright posture, ball between the lower legs. Perform two-leg jumps in place.	

The collected data were processed using a standard statistical procedure, and the following basic descriptive parameters were calculated: arithmetic mean (AS), standard deviation (SD), minimum value (Min) and maximum value (Max), and ANOVA with the subsequent Bonferroni post-hoc test.

## Results and discussion

Thirty-eight different sets of general preparatory exercises (GPE) were performed in the study, 10 of which were without aids, 19 with aids, and 9 with music. The results obtained by means of pulse measurement are shown in Table 1.

Table 1. Pulse measurement results

	AS	SD	Min	Max
GPE WITHOUT AIDS	122.74	22.95	78.00	180.00
GPE WITH MUSIC	152.89	27.74	84.00	216.00
GPE WITH AIDS	134.45	17.87	78.00	186.00

By analyzing the results from Table 1, it can be observed that the pulse is the lowest after performing general preparatory exercises without aids, averaging 122.74 beats per minute, it is moderate in general preparatory exercises with aids, averaging 134.45 beats per minute, while it is the highest after performing general preparatory exercises with music, averaging 152.89 beats per minute.

The minimum pulse after performing general preparatory exercises without aids was 78 beats per minute as well as after performing general preparatory exercises with aids, while it was 84 beats per minute after performing general preparatory exercises with music.

The maximum pulse after performing general preparatory exercises without aids was 180. It was 186 following general preparatory exercises and 216 beats per minute after general preparatory exercises with music. The obtained results indicate that the highest pulse is achieved when performing general preparatory exercises with music, and it can be concluded that music has the greatest motivational effect on achieving a higher physiological workload, which has already been confirmed by Trajkovski et al. (2015).

The significance of differences was determined with additional analyses. Table 2 shows the results of the analysis of the variance, where differences between different types of general preparatory exercises (without aids, with aids, and with music) were identified.

Table 2. Differences between set types

	SS	Degr. of	MS	F	p
Intercept	5453003.31	1.00	5453003.31	10425.77	0.00
Group	42348.66	2.00	21174.33	40.48	0.00
Error	162662.70	311.00	523.03		

The obtained results indicate the existence of significant differences in the achievement of higher or lower physiological workloads between different types (without aids, with aids, and with music) of general preparatory exercises. Examples of complex preparatory exercises, in addition to music, included the elements of aerobics as a specific form of exercise with music, through which rhythmic steps of low and high intensity adapted to young children are connected. It has been found that aerobic exercise is the most activated in the aerobic application, but as jumps and jumps are used, anaerobic energy processes are also activated (Furjan Mandić, 2002); thus, a higher physiological load is achieved. Furthermore, the achievement of a higher physiological workload when conducting general preparatory exercises with aids was confirmed by Vrbik et al. (2013).

Table 3 shows the results of the Bonferroni post-hoc test, and the results show that there is a statistically significant difference between the different types of general preparatory exercises.

Table 3. Differences between the set types of general preparatory exercise

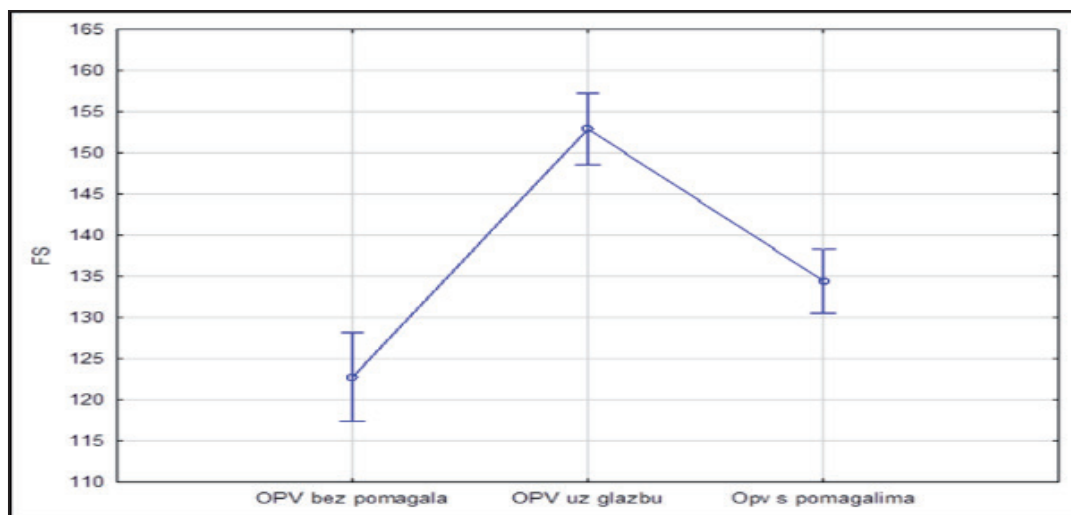
Bonferroni post-hoc	Versus	Mean	Standard	p
GPE WITHOUT AIDS	GPE WITH MUSIC	-30.15	3.50	0.00
	GPE WITH AIDS	-11.70	3.37	0.00
GPE WITH MUSIC	GPE WITH AIDS	18.44	2.94	0.00

Table 3 shows the difference in the results between the general preparatory exercises without aids and general preparatory exercises with music, which amounts to -30.15. This indicates that general preparatory exercises without aids do not achieve a greater physiological workload in pupils compared to exercises with music.

The difference between the results of general preparatory exercises without aids and general preparatory exercises with aids is -11.70, which shows that general preparatory exercises without aids do not achieve a greater physiological workload in pupils compared to general preparatory exercises with aids.

The difference between the results of general preparatory exercises with music and general preparatory exercises with aids is 18.44, which shows that general preparatory exercises with music achieve a greater physiological workload in pupils compared to general preparatory exercises with aids.

These results confirm that the pulse increased significantly when performing general preparatory exercises with music, which is also evident from *Figure 1*.



(OPV bez pomagala = GPE without aids; OPV uz glazbu = GPE with music, OPV s pomagalima = GPE with aids)

*Figure 1. Graphical representation of the pulse rate in various general preparatory exercises*

*Figure 1* also shows that the pulse, i.e., the physiological workload is the highest during the performance of general preparatory exercises with music and the lowest during the execution of general preparatory exercises without aids.

When working with children, care must be taken to achieve an optimal physiological workload in order to improve the aerobic endurance through physical activity, since the positive effects of physical activity are inevitably significant on improving them (Haskwell et al. 1985; Hofman et al. 1987; Oliver et al., 2007). Furthermore, by developing this ability, we inevitably protect children from the risk of obesity and cardiovascular disease.

## Conclusion

It is of great benefit to highlight the importance of physical activity through engaging in exercises and proper access to children in order to stimulate their proper growth and development from the youngest age. This paper presents the research findings on the impact of different exercises on the physiological workload of younger pupils. The physiological workload was measured by taking the pulse, and the results show that the physiological workload in boys and girls is higher when performing general preparatory exercises with aids than without aids as well as that the physiological workload in children is higher when performing general preparatory exercises with music than with aids and without aids. Various props and music have a motivational effect on children and encourage them to be more active, thus increasing their physiological workload. Motivation is an important factor as it influences the long-term incentive for children to participate in motor activities that aim to develop all abilities and traits.

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## DIFFERENCES IN ATTITUDES OF MALE AND FEMALE PUPILS TOWARDS THE SUBJECT OF PHYSICAL EDUCATION WITH RESPECT TO AGE

Donata Vidaković Samaržija<sup>1</sup>, Lara Pavelić Karamatić<sup>2</sup>

<sup>1</sup>University of Zadar, Croatia

<sup>2</sup>MORH, Croatia

### Abstract

Attitudes are often the subject of researches in the field of kinesiology education, and are conducted with the aim of better understanding, explaining, and predicting pupils' behaviour and approach to teaching. The aim of this research is to evaluate pupils' attitudes towards the subject of Physical Education (P.E.), and to identify differences in attitudes towards the subject with respect to age. The research was conducted on the sample of 292 pupils (143 fourth-grade pupils and 149 eighth-grade pupils) in primary school. Attitudes towards P.E. were evaluated on the basis of eleven items exploring the characteristics of the subject: interest, difficulty, comprehensibility, usefulness, and popularity (Rastovski, Šumanović, and Tomac, 2013). The basic descriptive parameters were calculated, and the Man-Whitney U test was used to determine differences in attitudes of the 4<sup>th</sup> and 8<sup>th</sup> grade pupils towards the subject of P.E. with respect to age. On the sample of pupils, statistically significant differences were obtained in only one variable (4<sup>th</sup> grade pupils have significantly higher scores in the variable *P.E. is my favourite subject* than the 8<sup>th</sup> grade pupils), while on the sample of female pupils, the significant difference was obtained in 10 of 11 variables (female 4<sup>th</sup> grade pupils find P.E. *more interesting, comprehensible, useful and popular* than the 8<sup>th</sup> grade female pupils). To conclude, the age is one of the factors influencing attitudes towards the subject of P.E., but the assumption is that gender has a greater influence on the significance of differences in attitudes towards P.E.

**Key words:** attitudes, age, gender, subject of Physical Education

### Introduction

Attitudes are often the subject of researches in the field of kinesiology education, and are conducted with the aim of better understanding, explaining, and predicting pupils' behaviour and approach to teaching. By examining pupils' attitudes, teachers receive feedback on their work and the curriculum itself, as well as on pupils' motivation to complete the program. The link between attitudes and behaviour and motivation is very complex (Prišlin, 1991). Respecting pupils' attitudes and adapting teaching to their needs and desires contributes to greater motivation and activity during the lesson, and indirectly encourages further development of positive attitudes. One of the aims of the subject of Physical Education (P.E.) is to create and adopt the habit of systematic physical exercise with children, but some authors point out that there is no direct connection between present and future attitude towards physical exercise, but also emphasize that by encouraging positive attitudes towards the subject of P.E. can indirectly influence future attitudes towards physical exercise (Boronyai, Vass, & Csányi 2018).

The aim of this research is to evaluate pupils' attitudes towards the subject of Physical Education and to identify differences in attitudes of male and female pupils towards the subject with respect to age.

### Methods

The research was conducted on the sample of 292 pupils (143 fourth-grade pupils and 149 eighth-grade pupils). It was conducted in accordance with the regulations of the Code of Ethics for Research with Children. The research included only pupils who were willing to participate and for whom parental consent was obtained. The attitudes towards the subject of P.E. were evaluated on the basis of eleven items exploring the characteristics of the subject: *interest, difficulty, comprehensibility, usefulness, and popularity* (Rastovski i sur., 2013). For each of the eleven offered items, the participants had to determine to what extent they agreed with the statement on the Likert-type scale (strongly disagree, disagree, neither agree or disagree, agree, strongly agree). Data obtained were processed with Statistica 7.0. Basic descriptive parameters were calculated: AM – arithmetic mean, SD – standard deviation, MIN and MAX – minimum and maximum score, SKEW – distribution coefficient of skewness and KURT – result distribution coefficient of curvature. Distribution normality was tested by the Kolmogorov-Smirnov test. A Man-Whitney U test was used to determine differences in attitudes of the 4<sup>th</sup> and 8<sup>th</sup> grade pupils towards the subject of Physical Education with respect to age.

## Results

The basic descriptive indicators of measured variables were calculated to evaluate the attitudes of the 4<sup>th</sup> and 8<sup>th</sup> grade pupils towards the subject of P.E.: arithmetic mean (AM), standard deviation (SD), minimum score (MIN), maximum score (MAX), coefficient of skewness (SKEW), and coefficient of curvature (KURT), while the normality distribution was tested by the Kolmogorov test as well (Table 1).

The fourth-grade pupils have higher values of arithmetic means in variables that evaluate the *interest* and *popularity* of the subject than the 8<sup>th</sup> grade pupils (I find Physical Education interesting ( $4.70 \pm 0.59$  vs.  $3.98 \pm 1.28$ ); Physical Education is my favourite subject ( $4.09 \pm 1.23$  vs.  $3.11 \pm 1.49$ ); I wish we had Physical Education every day ( $4.34 \pm 1.32$ ) vs.  $3.25 \pm 1.64$ ); I enjoy games and activities during P.E. ( $4.79 \pm 0.55$  vs.  $3.99 \pm 1.22$ ); I like attending classes of Physical Education ( $4.76 \pm 0.56$  vs.  $3.87 \pm 1.32$ ); I want to learn as much as possible during classes of Physical Education ( $4.63 \pm 0.85$  vs.  $3.85 \pm 1.32$ )). In variables evaluating *subject difficulty*, the 4<sup>th</sup> grade and 8<sup>th</sup> grade pupils have the same values of arithmetic means- Physical Education is not a difficult subject ( $4.23 \pm 1.27$  vs.  $4.27 \pm 1.26$ ); I am not afraid to exercise during classes of Physical Education ( $4.65 \pm 0.86$  vs.  $4.32 \pm 1.12$ ); I do all the exercises during Physical Education with ease ( $4.36 \pm 0.88$  vs.  $4.24 \pm 1.00$ ). Also, in variables that evaluate the *comprehensibility and usefulness* of the subject, the 4<sup>th</sup> and 8<sup>th</sup> grade pupils have the same values of arithmetic means (I understand everything that is required of me during classes of Physical Education ( $4.68 \pm 0.70$  vs.  $4.42 \pm 1.07$ ); I find Physical Education useful ( $4.68 \pm 0.78$  vs.  $4.10 \pm 1.22$ )). High values of arithmetic means point out that most pupils have positive attitudes towards the subject of P.E., but there is also a decrease in the value of arithmetic means with respect to age. The standard deviation values in all variables are very low, indicating a small dispersion of results.

Table 1. Descriptive indicators of variables for the evaluation of pupils' attitudes towards the subject of Physical Education on the sample of the 4<sup>th</sup> and 8<sup>th</sup> grade pupils

	Mean $\pm$ SD		MIN		MAX		SKEW		KURT		Max D	K-S
	4 <sup>TH</sup> GR	8 <sup>TH</sup> GR	4 <sup>TH</sup> GR	8 <sup>TH</sup> GR	4 <sup>TH</sup> GR	8 <sup>TH</sup> GR	4 <sup>TH</sup> GR	8 <sup>TH</sup> GR	4 <sup>TH</sup> GR	8 <sup>TH</sup> GR		
I find Physical Education interesting	4.70 $\pm$ 0.59	3.98 $\pm$ 1.28	1	1	5	5	- 2.86	- 1.22	12.16	0.33	0.34	p < .01
Physical Education is not a difficult subject	4.27 $\pm$ 1.26	4.23 $\pm$ 1.27	1	1	5	5	- 1.75	- 1.53	1.86	1.01	0.38	p < .01
I understand everything that is required of me during classes of Physical Education	4.68 $\pm$ 0.70	4.42 $\pm$ 1.07	1	1	5	5	- 3.24	- 2.02	15.02	3.33	0.42	p < .01
I find Physical education useful	4.68 $\pm$ 0.78	4.10 $\pm$ 1.22	1	1	5	5	- 3.73	- 1.27	17.49	0.51	0.38	p < .01
Physical Education is my favourite subject	4.09 $\pm$ 1.23	3.11 $\pm$ 1.49	1	1	5	5	- 1.29	- 0.22	0.71	- 1.29	0.22	p < .01
I wish we had a Physical Education every day	4.34 $\pm$ 1.32	3.25 $\pm$ 1.64	1	1	5	5	- 1.96	- 0.26	2.69	- 1.55	0.33	p < .01
I enjoy games and activities during P.E.	4.79 $\pm$ 0.55	3.99 $\pm$ 1.22	1	1	5	5	- 3.06	- 1.00	10.02	- 0.09	0.39	p < .01
I like attending classes of Physical Education	4.76 $\pm$ 0.56	3.87 $\pm$ 1.32	1	1	5	5	- 2.70	- 1.04	8.31	0.06	0.36	p < .01
I am not afraid to exercise during classes of Physical Education	4.65 $\pm$ 0.86	4.32 $\pm$ 1.12	1	1	5	5	- 3.64	- 1.74	15.14	2.18	0.41	p < .01
I do all the exercises during Physical Education with ease	4.36 $\pm$ 0.88	4.24 $\pm$ 1.00	1	1	5	5	- 1.61	- 1.37	3.01	1.34	0.31	p < .01
I want to learn as much as possible during classes of Physical Education	4.63 $\pm$ 0.85	3.85 $\pm$ 1.32	1	1	5	5	- 2.79	- 0.98	8.07	- 0.18	0.35	p < .01

Mean – arithmetic mean; SD – standard deviation; MIN – minimum score; MAX – maximum score; SKEW – coefficient of skewness; KURT – coefficient of curvature



Normality of distribution was tested by the Kolmogorov-Smirnov test (Table 1). Since the distributions of the measured variables deviated significantly from normality, the Mann - Whitney U test was used to evaluate differences in attitudes towards the subject of P.E. with respect to age (grade). The significance of differences with respect to age was tested on gender-sub-samples (63 fourth-grade male pupils and 74 eighth-grade male pupils, and 80 fourth-grade female pupils and 73 eighth-grade female pupils). Statistically significant differences in only one variable were obtained on the measured sample of pupils. The fourth-grade pupils have significantly higher scores in the variable *Physical Education is my favourite subject* than the eighth-grade pupils. There are no statistically significant differences in other variables, which points out that the attitudes of the 4<sup>th</sup> and 8<sup>th</sup> grade pupils towards P.E. are the same. Regardless of age, pupils equally find the subject *interesting, difficult, comprehensive, useful, and favourite* (Table 2).

Table 2. Differences in pupils' attitudes towards the subject of Physical Education with respect to age divided by gender

	MALE PUPILS						FEMALE PUPILS					
	4 <sup>TH</sup> GRADE		8 <sup>TH</sup> GRADE		Z	p	4 <sup>TH</sup> GRADE		8 <sup>TH</sup> GRADE		Z	p
	MED	QR	MED	QR			MED	QR	MED	QR		
I find P.E. interesting	5.00	0.00	5.00	0.00	0.15	0.88	5.00	1.00	4.00	2.00	6.86	0.00*
P.E. is not a difficult subject	5.00	1.00	5.00	0.00	-0.73	0.47	5.00	1.00	5.00	2.00	1.20	0.23
I understand everything that is required of me during classes of P.E.	5.00	1.00	5.00	0.00	-1.06	0.29	5.00	0.00	5.00	1.00	2.97	0.00*
I find P.E. useful	5.00	1.00	5.00	0.00	-0.31	0.76	5.00	0.00	4.00	2.00	5.95	0.00*
Physical Education is my favourite subject	5.00	1.00	4.00	2.00	2.60	0.01*	4.00	2.00	2.00	3.00	6.05	0.00*
I wish we had P.E. every day	5.00	0.00	5.00	1.00	1.29	0.20	5.00	1.00	2.00	2.00	7.69	0.00*
I enjoy games and activities during P.E.	5.00	0.00	5.00	1.00	0.77	0.44	5.00	0.00	4.00	3.00	7.18	0.00*
I like attending classes of Physical Education	5.00	0.00	5.00	1.00	0.52	0.60	5.00	0.00	3.00	2.00	8.20	0.00*
I am not afraid to exercise during classes of P.E.	5.00	0.00	5.00	0.00	0.56	0.58	5.00	1.00	4.00	1.00	3.11	0.00*
I do all the exercises during Physical Education with ease	5.00	1.00	5.00	1.00	-1.45	0.15	5.00	1.00	4.00	2.00	2.69	0.01*
I want to learn as much as possible during classes of Physical Education	5.00	1.00	5.00	1.00	1.35	0.18	5.00	0.00	4.00	1.00	6.38	0.00*

MED - median; QR - quartile rank; Z - z-value; p - statistical significance

In contrast to male pupils, significant differences were found in 10 of the 11 measured variables on the measured sample of female pupils. No statistically significant differences were obtained in the variable evaluating the *difficulty of the subject* (*Physical Education is not a difficult subject*), while in the other ten variables significant differences were obtained. The significant differences obtained indicate that the attitudes of the 4<sup>th</sup> grade female pupils are more positive than those of the 8<sup>th</sup> grade female pupils, and that the 4<sup>th</sup> grade female pupils find the subject of P.E. more *interesting, comprehensible, useful and popular* than the 8<sup>th</sup> grade female pupils (Table 2).

According to the results obtained, it can be concluded that age is one of the factors influencing attitudes towards the subject of Physical Education, but the assumption is that gender has a greater influence on the significance of differences in attitudes towards the subject of P.E. It is evident that pupils have approximately the same attitudes irrespective of age, while with regard to age, the interest in the subject of P.E. decreases with the female pupils, and thus the interest in physical activity is reduced.

## Discussion

The participants in the conducted research have predominantly positive attitudes towards the subject of Physical Education, which is similar to the previous researches (Bartík, Kubiš, 2016; Stanojević, 2016). The results showed that there are statistically significant differences in attitudes towards the subject according to age groups, but also that gender differences contribute significantly to the obtained differences. Fourth-grade pupils have more positive attitude towards P.E. than the 8<sup>th</sup> grade pupils, which is similar to the results of previous researches (Rastovski i sur., 2013; Atan, & Imamoglu, M. 2016; Mašanović B. 2019.). More specifically, by comparing the significance of differences in attitudes towards P.E. with respect to age, but in gender-sub-samples, it was found that, regardless of age, pupils had approximately the same

attitudes towards the subject, whereas the fourth-grade female pupils had more positive attitudes than the eighth-grade female pupils. Williams, (2013) points out that with age, positive attitudes towards P.E. teaching in girls decrease, and states that as they age, girls do not get the opportunity to participate in all activities involving boys and thus do not develop their full potential (Williams, 2013). The author also points out that boys are considered to be faster, more agile and better at performing activities during classes of P.E. than girls, which certainly contributes to the development of more positive attitudes towards the subject, and vice versa. In the research of Višnjić, Ilić, Martinović and Marković (2011), girls showed less positive attitudes regardless of age as well. The authors point out that age, gender, practicing sport, and self-understanding of knowledge acquired during classes of P.E. can be key factors in developing attitudes.

Regardless of age, gender and preferences for sports activities, pupils should be systematically encouraged to be active during P.E. classes, while respecting their attitudes and interests. In particular, pupils who are not involved in any other physical activity outside of school should be encouraged. In this way, at least little can be contributed to their health, quality growth and development.

## Conclusion

The subject of Physical Education is still a favourite subject for most pupils, but with increasing age the interest in P.E. declines, more significantly among female pupils than among male pupils. As this and earlier studies have identified more negative attitudes of female pupils towards the subject of Physical Education, especially older female pupils. In some future research, it would be interesting to determine the structure of the attitude, more precisely to define the reasons for the negative attitude towards the P.E. class, which increases by age and by gender. This would more clearly define guidelines for teachers on planning individual content while respecting the interests of students, which would contribute to greater motivation to participate. Contributing positive attitudes to pupils towards the subject of Physical Education would also contribute to positive attitudes generally about physical activity, which would reduce the negative trend of decreasing physical activity levels with age.

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# THE ORIGIN AND DEVELOPMENT OF INTERNATIONAL AND COMPARATIVE PHYSICAL EDUCATION IN CHINA — ALSO ON THE CONSTRUCTION OF A NEW KNOWLEDGE SYSTEM

Xueshuang Wang<sup>1</sup>, Jin Sun<sup>2</sup>

<sup>1</sup>*School of Education/Physical Education Teachers College, Beijing Sport University, Beijing 100084*

<sup>2</sup>*Faculty of Education, Institute of International and Comparative Education, Beijing Normal University, Beijing 100875*

## Purpose

This study aims to describe and explain the origin and development of comparative physical education in China. In new era China, with the acceleration of internationalization in physical education and sports. Comparative physical education has irreplaceable mission. The study will explore the time value of comparative physical education in China; describe the history and current development, then forecasting the future development of it.

## Methods

In China, the development of comparative physical education dates back to 1980s. It is a young subject with a short history. Interview method was used in this study. The participants of the interviews include the pioneers and prominent scholars in the areas of comparative physical education in China since comparative physical education is established. The total participants of the study is 15 including the leaders and administrators in related academic association and higher education institution and scholars in this area.

## Conclusions

Through the preliminary analysis, the findings are as follows, in the new era of China, comparative physical education has its own time value; in the development of comparative physical education prominent leaders and prominent scholars played key roles; the crisis of comparative physical education still exist in China; More efforts and work need to be paid in the development of comparative physical education.

Through this study, we give a clear development path of comparative physical education in China, exploring the mission of this subject in modern times of China, and point out the future trends of it. It makes great significance to the development of comparative physical education in China.

**Key words:** *Comparative Physical Education, International and Comparative Education, Physical Education and Sports, History and Development*

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## MORPHOLOGICAL CHARACTERISTICS OF YOUNGER ADOLESCENTS IN RELATION TO AGE AND SEX

Marija Zegnal Koretić<sup>1</sup>, Marija Lorger<sup>2</sup>, Romana Romanov<sup>3</sup>

<sup>1</sup>*Polytechnic of Međimurje, Čakovec, Croatia*

<sup>2</sup>*University of Zagreb, Faculty of Teacher Education, Croatia*

<sup>3</sup>*Faculty of Sport and Tourism, Novi Sad, Serbia*

### Abstract

The aim of this study was to estimate the morphological characteristics of young adolescents on the basis of body composition by measuring the basic and derived anthropometric parameters. The study was conducted on a sample of 1122 respondents (590 of whom were boys), students ranging from fifth to eighth grade, attending elementary schools in Koprivnica-Križevci County. Both children from rural and urban areas are represented in the study. The percentage of body fat was used to estimate body composition and body mass index (derived from the relation between body mass and body height) and waist circumference for assessment of a respondent's nutrition state. The results showed that the natural processes of growth and development are the most significant predictors of morphological characteristics for younger adolescents, while sex has no statistically significant effect on dissimilarities between average anthropometric dimensions.

**Key words:** *anthropometrical characteristics, body composition, male and female students ranging from fifth to eighth grade*

### Introduction

Family and school are equally important social units that play an important role in forming a healthy lifestyle. The acquisition of regular exercise habits represents the essential segment of any healthy lifestyle. Earlier research has shown that kinesiological activities have a positive impact on humans' health, especially on the children and the young (Swaminathan et al., 2011). Although the majority of studies indicate a positive association between physical activity and subjective health assessment, some European countries have conducted research that did not confirm this interconnection. Possible reasons for the inconsistency of the results are the difficulty in interpreting and differentiating models of physical activity in individual countries (during leisure time, at home, at school or work). The results of the previous research (Petrić, Novak, Matković, Podnar, 2012; Diethelma et al., 2014) indicate the large percentage of physically inactive respondents amongst children and the young. Cordova et al., (2013) investigated the association between physical activity, body mass, and energy expenditure amongst children in Spain. The results showed that a lower percentage of fat is found in physically active children, and they indicate the importance of physical activity in the overweight prevention. Guerra et al. (2006) research has shown that the lower the BMI, the greater the amount of physical activity. Trends in the morphological status of children and young people over a period of time were researched by Sigmund, El Ansari & Sigmundova (2012). They found that regarding children from 6 to 9 years of age, the school environment and additional programs play a key role in the prevention of childhood obesity in primary education. Risk factors for abdominal obesity in a sample of students from 4 to 18 years of age was also researched by Suder & Chrzanowska (2013). At two points in time (1983 and 2000) the subjects' body height, body mass, waist circumference, waist-to-height ratio were measured. The questionnaire was used to collect data on the respondents' habits and their environment. The results showed that children measured in 2000 were significantly more obese. Longitudinal studies are more demanding to conduct because of the time period and duration, however, the results of such studies are extremely important. Kunješić (2015) monitors the dynamics of the nutritional status and physical activity of primary and secondary school male and female students over the period of four years. Fels physical activity questionnaire for children – FELS PAQ (Treuth et al., 2005b) was used to determine the level of physical activity. The results obtained showed a significant correlation between body composition indicators and variables for assessing physical activity levels only in female respondents. Moore et al., (2003) also, in a longitudinal eight-year study monitored the impact of children's physical activity on work ability and morphological status. The positive effects of physical activity were evident in both boys and girls, that is, higher levels of physical activity during childhood is negatively related to the weight gain. Body composition is an important factor for the analysis of human nutrition. Sorić (2010) measured BMI, waist and hip circumference for nutritional testing and concluded that BMI is not always a reliable nutritional indicator. Likewise, Mišigoj-Duraković, Duraković, Sorić (2014) have expressed doubts about BMI

reliability in their research. The shortcoming of BMI is explained by the fact that obesity is primarily dependent on the proportion of fat in the body composition, that is, increased weight does not automatically mean the onset of obesity. The results of numerous studies analyzing the impact of physical activity on the physical composition of adults have been published (Hagströmer, Oja, Sjöström 2007; Candido, Freitas, et Machado-Coelho, 2011), as well as research on school children about their physical activity that decreases as children get older (Basterfield et al, 2011; Pate et al, 2002). Despite the objective remarks, BMI is still the most used measurement to assess body composition data of both children and adults (Colditz et al., 1995; Badrić et al., 2012). To correct the potential disadvantages of this indirect indicator of body characteristics, anthropometric analyses are usually supplemented by measuring the percentage of body fat, waist circumference, hip circumference, as well as mathematical relationships between individual body dimensions. Bulum, Blaslov & Duvnjak (2016) wanted, by using anthropometric features of thickness, to evaluate complications in obese patients with type 2 diabetes mellitus, and prove that waist-to-height and waist-to-hip ratios were more reliable indicators of the development of type 2 diabetes mellitus than BMI. The results of their study showed that waist-to-height ratio and waist-to-hip ratio can be a simple and non-invasive method of assessing the incidence of chronic non-communicable diseases in obese diabetic patients. Changes during growth indicate significant changes in body composition that occur with maturation and lead to sexual dimorphism that will be reflected in both functional and motor maturation (Trunić, 2007) Accordingly, the aim of this study was to evaluate the morphological characteristics of young adolescents on the basis of body composition, thus basic and derived anthropometric dimensions were measured to define it.

## Research methodology

### Sample of participants

The study included 1122 young male and female adolescents (Table 1), between 10 and 14 years of age. The participants were students attending three elementary schools from Križevci-Koprivnica County from both rural and urban areas (Table 2).

Table 1. Structure of the sample of respondents by age and sex

Grade	Male	Female	Total
V	137	149	286
VI	152	137	289
VII	154	136	290
VIII	147	110	257
Total	590	532	1122

Table 2. Structure of the sample of respondents according to their place of residence

	Rural	Urban	Total
Koprivnica	128	227	355
Križevci	205	231	436
Đurđevac	83	248	331
Total	416	706	1122

### Sample of Variables and measuring instruments

The variables monitored in this study refer to direct and derived anthropometric variables. Body height, body weight and waist circumference were directly measured. The body mass index (BMI) expressed in kg / m<sup>2</sup> was calculated out of the relation between body weight and height. The percentage of fat in the total body weight of the subjects was estimated by using the Omron BF 511 type scales.

### Data processing method

Data collected during the survey were processed by employing descriptive and comparative statistics using Portable IBM SPSS v.19. Of the basic descriptive statistical parameters, the following were calculated for each variable: arithmetic mean (M), standard deviation (SD), and standard error of arithmetic mean (SE). To assess the statistical significance of the differences between the arithmetic means obtained for each variable the following were applied: T-test for independent samples when analyzing in relation to sex. For the purpose of analyzing the combined effects of individual variables on the expression of differences, a univariate analysis of variance ANOVA with multiple factors was applied.

## Results

### The anthropometric dimensions of the respondents in relation to age and sex

Each of the five anthropometric variables was analyzed with an emphasis on the contribution of age and sex, explaining the significance of differences between arithmetic means obtained within specific sub-samples via two-factor variance analysis. It was supplemented by a T-test for independent samples, conducted separately for each class, for a more accurate comparative analysis of the sex averages.

### Body height

Table 3. Descriptive statistics for body height variable by subjects' grade and sex and t-test results

Grade	Sex	M	SD	SE	N
V	Male	1,47	,071	,006	137
	Female	1,48	,072	,006	149
T-test		t=-,904		Sig=,367	
VI	Male	1,53	,079	,006	152
	Female	1,53	,073	,006	137
T-test		t=-,066		Sig=,948	
VII	Male	1,61	,083	,007	154
	Female	1,59	,068	,006	136
T-test		t=1,960		Sig=,051	
VIII	Male	1,68	,082	,007	147
	Female	1,62	,056	,005	110
T-test		t=5,991*		Sig=,000	

\* Statistically significant difference. Legend: Mean (M), standard deviation (SD), number of participants (N)

The most significant factor for explaining the differences in body height of specific groups of subjects was age (Table 4). Sex was not significant until the eighth grade (Table 3). The average heights of boys and girls from 5<sup>th</sup> to 7<sup>th</sup> grade did not differ. This demonstrates current theoretical views on adolescent body height development. Males' body height gradually increases from year to year, with accelerating pace between the ages of 13 and 14 and maintaining the pace until the final height is reached.

Table 4. Indicators of the influence of grade and sex on explaining the differences between average body height values

Influence	F	p	Partial Eta Squared
Interaction of factors	9,151	,000	,024
Grade	288,752	<b>,000</b>	<b>,437 *</b>
Sex	12,713	,000	,011

\* Statistically significant influence.

### Body mass

Similar observations apply to body weight. Again, natural time of growth and development proved to be the most significant factor (Table 5), while sex showed its influence on making significant differences only in the eighth grade, that is, in the oldest students in this research.



Table 5. Descriptive statistics for body weight variable by grade and sex and t-test results

Grade	Sex	M (kg)	SD (kg)	SE	N
V	Male	<b>42,12</b>	11,87	1,01	137
	Female	<b>42,09</b>	12,77	1,05	149
T-test		t=,022		Sig=,982	
VI	Male	<b>48,51</b>	13,70	1,11	152
	Female	<b>48,19</b>	12,98	1,11	137
T-test		t=,207		Sig=,836	
VII	Male	<b>51,79</b>	13,72	1,11	154
	Female	<b>54,32</b>	12,96	1,11	136
T-test		t=-1,613		Sig=,108	
VIII	Male	<b>60,63</b>	14,15	1,17	147
	Female	<b>56,94</b>	12,65	1,21	110
T-test		t=2,165		p=,031*	

\* Statistically significant difference.

No statistically significant sex differences were observed in any of the other three grades (V, VI and VII) (Table 5). Weight gain was uniform in both boys and girls, but only up to the eighth grade. During the eighth grade, a rapid increase in body weight is observed among boys, which persists until the end of adolescence.

Table 6. Indicators of the influence of grade and sex on explaining the differences between average body weights

Influence	F	p	Partial Eta Squared
Interaction of factors	2,526	,056	,007
Grade	78,167	,000	,174*
Sex	,230	,632	,000

\* Statistically significant influence.

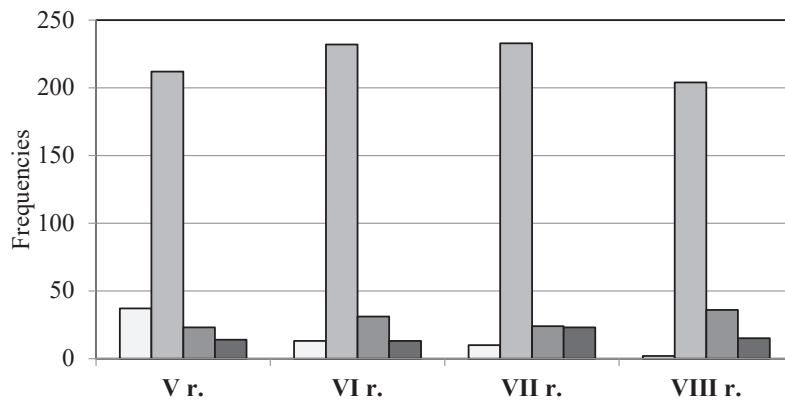
Given that body mass index is derived from body mass and height, natural growth and development are of high importance for explaining variability between individual results (Tables 6 and 7).

Table 7. Indicators of the influence of grade and sex variables on explaining differences between average body mass index values

Influence	F	p	Partial Eta Squared
Interaction of factors	2,525	,056	,007
Grade	12,312	,000	,032*
Sex	1,387	,239	,001

Both male and female younger adolescents had approximately the same BMI values until the seventh grade when, due to rapid growth in height among male participants, there is a sharp decrease in this index. As during the eighth grade, the weight gain of boys increases significantly compared to the height gain, thus, BMI approaches the values of girls' body mass index at the end of the analysed period.

Based on the subjects' physical nutrition ratings, BMI analysis was performed on the whole sample. The data obtained show that approximately the same distributions of the four nutrition categories were obtained in all grades (Graph 2). Subjects with normal body weight were the most prevalent. The number of undernourished children was mostly in the fifth grade, and this number decreased significantly with the transition to higher grades. The prevalence of overweight students (pre-treated and under-treated) has been reversed - their numbers have increased significantly with the transition to upper classes. Thus, in the fifth grade there were about 13% of overweight children (8% overweight and 4.9% obese), to about 20% of overweight adolescents in the eighth grade (14% overweight and 5.8% obese). This practically means that every fifth student leaves the primary school as overweight.



Graph 1. Distribution of physical nutrition of respondents of different grades.

### The proportion of adipose tissue in body weight

The percentage of body fat in the total body weight was the only anthropometric variable for which statistically significant differences between males and females were obtained in all grades (Table 8, graph 1). Girls in all grades had a significantly higher percentage of adipose tissue than their male peers. All values in all female age groups were above and in male groups below 20%. These values are completely consistent with the results obtained in previous studies by Erdeljac, Rakovac i Petrić (2018.) and Fidler, et al. (2016). These differences in the percentage of adipose tissue in men and women persist for the rest of their lives.

Table 8. Descriptive statistics for body fat percentage of subjects of different grade and sex and t-test results

Grade	Sex	M (%)	SD (%)	SE	N
V	Male	<b>17,18</b>	10,05	,86	137
	Female	<b>21,98</b>	12,62	1,03	149
	T-test	t=-3,542*		Sig=,000	
VI	Male	<b>17,93</b>	11,86	,962	152
	Female	<b>24,28</b>	11,09	,947	137
	T-test	t=-4,688*		Sig=,000	
VII	Male	<b>15,35</b>	9,37	,755	154
	Female	<b>25,93</b>	9,67	,829	136
	T-test	t=-9,457*		Sig=,000	
VIII	Male	<b>15,57</b>	9,80	,809	147
	Female	<b>27,38</b>	8,72	,832	110
	T-test	t=-10,014*		Sig=,000	

\* Statistically significant difference.

### Waist circumference

Although based on the level of significance ( $p < .05$ ), it could be concluded that the mean values of waist circumference of subjects of different ages and sexes differed significantly in sixth and eighth grade (Table 9), low partial eta-squared values (Table 10) do not support such a conclusion. This means that, despite the significant differences between arithmetic means in the two grades indicated, no significant influence of age and sex on the prediction of waist size of young adolescents included in this study was confirmed. The size of the waist seems to be much more dependent on the individual's genetic inheritance and the specific lifestyle of the subjects.

Table 9. Descriptive statistics for waist circumference by grade and sex of subjects

Grade	Sex	M (cm)	SD (cm)	SE	N
V	Male	<b>69,30</b>	11,44	,978	137
	Female	<b>67,43</b>	12,16	,996	149
T-test		t=1,335		Sig.=,183	
VI	Male	<b>73,44</b>	10,96	,889	152
	Female	<b>70,07</b>	10,42	,890	137
T-test		t=2,670*		Sig.=,008	
VII	Male	<b>74,31</b>	10,77	,867	154
	Female	<b>74,67</b>	11,32	,970	136
T-test		t=-,279		Sig.=,781	
VIII	Male	<b>78,61</b>	10,47	,86	147
	Female	<b>72,24</b>	11,14	1,06	110
T-test		t=4,693*		Sig.=,000	

\* Statistically significant difference.

Table 10. Indicators of the influence of grade and sex on explaining the differences between average values of waist circumference

Influence	F	Sig.	Partial Eta Squared
Interaction of factors	4,345	,005	,012
Grade	22,553	,000	,057
Sex	17,814	,000	,016

## Discussion

Generally speaking, the results obtained are consistent with those of the majority of previous anthropological studies conducted on similar samples (Knezović Svetec, Guja & Torman, 2016; Petrić et al., 2012). In this study it was confirmed that the age of the subjects had the most significant influence on the manifestation of body dimensions throughout the younger adolescent period. Furthermore, its influence was not reflected equally in all anthropometric variables. The importance of sex increased with maturation, that is, it was aligned with the specific hormonal development of boys and girls, which is more pronounced in the seventh and eighth grade. Differences, as expected, were most pronounced in the percentage of adipose tissue in the total body weight. It was also the only anthropometric variable in which girls in all classes had a statistically significantly higher proportion of adipose tissue than their male counterparts. Respondents' sex was not confirmed as a constantly significant predictor.

## Conclusion

The results obtained in this study are in correspondence with current theoretical views and previous empirical data. It is confirmed that natural processes of growth and development are the most significant predictors of morphological characteristics of younger adolescents, whereas sex had no statistically significant influence on the differences between the average anthropometric dimensions.

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## THE STATUS AND INFLUENCING FACTORS OF THE DEVELOPMENT OF UNDERGRADUATES' SELF-LEADERSHIP IN CHINESE SPORT UNIVERSITIES – A CASE STUDY OF BEIJING SPORT UNIVERSITY

Conghuan Zhao<sup>1</sup>, Chengmengxue Sun<sup>2</sup>

<sup>1</sup>Beijing Sport University, China

<sup>2</sup>Beijing Normal University, China

### Abstract

Self-leadership is about the individual's self-development and the pursuit of self-meaning. In this study, a mixed research method was used to investigate 1023 undergraduates from Beijing Sport University. The main conclusions obtained: First, the overall self-leadership development of college students is at the upper-middle level, and the overall performance is good, but there are differences in the development of seven dimensions. College students perform relatively well in interpersonal communication, positive thinking, and value choices, relatively weak in autonomous decision-making, goal management, learning motivation, and self-awareness. Second, there are significant differences in the overall self-leadership scores of college students in different disciplines, genders, student organization experience, academic performance, and family structure. Third, in terms of school experience, students have a more positive perception of the degree of support of the university environment. In comparison, they have a weaker performance in the experience of getting along with teachers and students. Fourth, the support of the campus environment, the experience of getting along with teachers and students, and the experience of clubs all have a significant positive predictive effect on the self-leadership of college students. Based on the research results, corresponding improvement suggestions were put forward: focusing on differences in student development, strengthening self-leadership education; promoting interpersonal communication, focusing on the construction of interpersonal environment; advancing curriculum reform, improving student participation mechanisms, etc.

**Key words:** *self-leadership, study experience, student development*

### Introduction

“Self-leadership” as a scientific concept was first proposed by American scholar Manz in the mid-1980s (Manz, 1986). It refers to the self-influence process of individuals through necessary self-direction and self-motivation to achieve behavioral performance. Since the concept of self-leadership was put forward, it has been widely used in various management fields. A large number of research results in academia show that self-leadership is beneficial to improve work performance (Han & Kwon, 2016; Neck et al., 2003), promote positive emotions and job satisfaction (Manz, 2015), relieve stress and anxiety (Saks et al., 1996; Wang et al., 2016), enhance self-efficacy (Prussia et al., 1998), stimulate individual and organizational innovation, improve their competitive awareness, and set goals and values (Ghosh, 2015), bring greater professional success to individuals and organizations (Kim et al., 2016). For college students, the development of self-leadership is related to the individual's level of development and the pursuit of self-meaning. Emphasizing and training college students' self-leadership development is conducive to promoting the growth of college students in sports colleges, improving the quality of higher education personnel training, and contributing to the cultivation of national innovative sports talents.

In the academic field, the current research on the self-leadership of college students is becoming more and more abundant. In China, the research is shifting from theory to practice. However, the scope of investigation is still very limited. Research on the development of college students in physical education colleges is very rare. This research is not only conducive to broadening and deepening the theory of self-leadership and student development, but also provides basic data for research on the quality of talent training in sports colleges. From the perspective of individual students and schools, this research is conducive to improving the comprehensive ability of Beijing Sport University students, and it can also provide inspiration for the reform of talent training in other sports colleges.

## Methods

The research adopts questionnaire survey method and interview method, and the survey objects are 1023 undergraduates from Beijing Sport University. This research uses the “College Student Self-Leadership Evaluation Tool” developed by the author in 2018 to revise it according to the characteristics of college students in sports colleges. The revised “College Student Self-Leadership Evaluation Tool” is divided into three parts. The first part is The background information of the students, a total of 11 questions. The second part is the investigation of students’ self-leadership, including five dimensions of self-cognition, value choice, positive thinking, learning motivation, goal management, autonomous decision-making, and interpersonal communication, with a total of 32 questions. The options of the question are divided into 7 levels from 1 (completely non-conforming) to 7 (completely conforming). The third part is a survey of students’ study experience. The test questions in this part are composed of three aspects: the support of the campus environment, the experience of getting along with teachers and students, and the experience of clubs. Among them, the degree of support of the campus environment mainly refers to the students’ perception of the school environment related to learning and personal development. There are 12 questions in total. The options of the question are divided into 7 levels from 1 (very little attention) to 7 (very important). In addition, there are 3 questions in this part to measure students’ satisfaction with their relationships with others (classmates, managers, teachers). The experience of getting along with teachers and students mainly includes 7 questions about the experience of getting along with teachers and the experience of getting along with classmates, and 3 questions about the experience of participation in community organizations. There are four options for these questions: 1 (never), 2 (occasionally), 3 (sometime), 4 (often).

## Results

### The overall characteristics of college students’ self-leadership development

From an overall point of view, the self-leadership scale score (5.37) is in the upper-middle level, indicating that the overall development level of college students’ self-leadership is good. The order of scores in each dimension from high to low is: positive thinking, interpersonal communication, value choice, self-awareness, learning motivation, goal management, and autonomous decision-making. There are differences in the development of seven dimensions. College students perform relatively well in the dimensions of interpersonal communication, positive thinking and value choice, relatively weak in the dimensions of autonomous decision-making, goal management, learning motivation, and self-awareness.

### The group characteristics of college students’ self-leadership development

There are significant differences in the overall self-leadership scores of college students in different disciplines, genders, student organization experience, academic performance and family structure. The specific conclusions are as follows: The overall score of self-leadership of physical education students is significantly higher than that of academic students, male students are significantly higher than female students, and students who act as club organizers or leaders are significantly higher than those who do not. There are significant differences in self-leadership among college students with different academic performance. There is a significant difference in self-leadership between the only-child and non-only-child college students. In the sub-dimensions of self-leadership, freshman students are significantly higher than sophomores in the dimension of value choice, and senior students are significantly higher than juniors in the dimension of autonomous decision-making. Freshman students are more motivated to participate in activities, have a strong sense of dedication and social responsibility, and the ability of autonomous decision-making of college students also changes with the change of grade. The higher the grade, the stronger the ability of autonomous decision-making. CCP members are also significantly higher than other groups of non-CCP members in the dimension of value selection.

### Analysis of the impact of campus environment support, teacher-student relationship experience, and community experience on self-leadership

The support of the campus environment, the experience of getting along with teachers and students, and the experience of clubs all have a significant positive predictive effect on the self-leadership of college students, and can explain 56.2% of the variation of self-leadership. In the dimension of campus environment support, interpersonal environment, academic support, and life support all have significant positive predictive effects on self-leadership. Among them, students’ perception of the interpersonal environment has the greatest predictive effect on self-leadership. Among the two factors of teacher-student experience, the experience of getting along with classmates also has a significant impact on self-leadership. The study also found that the influence of peer groups on the self-leadership of students even exceeds that of teachers. In addition, club experience also has a significant impact on the development of students’ self-leadership.



## Discussion

First, we should pay attention to differences in student development and strengthen self-leadership education. It is necessary to pay attention to the differences in self-leadership development and training focus of different groups of students in different disciplines, different grades, different genders, and different family backgrounds. For example, to strengthen the physical education curriculum for subject students, in the teaching arrangement, we should make full use of the school's superior resources to enable students to strengthen physical exercise, especially to ensure sufficient physical exercise for subject students, improve their perseverance and self-confidence, and let students have a good Self-awareness, state of mind and body. Second, promote interpersonal communication and pay attention to the construction of the interpersonal environment. Schools should pay special attention to the support from peers, teachers and administrators, create a good campus interpersonal environment for the development of students, pay attention to the construction of interpersonal interaction mechanism and environment, improve the quality of interpersonal interaction, so that peers and teachers can play a positive role. effect. Third, promote the reform of curriculum teaching and improve the student participation mechanism. Pay attention to the specific teaching process, pay attention to the observation and evaluation of the students' learning process, strive to stimulate students' learning initiative, pay attention to the experience and feelings of students participating in various university activities, pay attention to the overall coordination of various school activities, and constantly improve students Participation mechanism. According to the university's own talent training goals, implement classified guidance, focus on differentiated and diversified development, improve the comprehensive quality of students, at the same time strengthen the development of practical courses, and focus on the importance of practical teaching in cultivating students' social practical ability and innovation.

## Conclusion

First, the overall self-leadership development of students is at the upper-middle level and the overall performance is good, but there are differences in the development of seven dimensions. College students perform relatively well in the dimensions of interpersonal communication, positive thinking and value choice. Second, the self-leadership of physical education students is significantly higher than that of subject students; boys are significantly higher than girls; students who act as club organizers or leaders are higher than those who do not; students with higher average scores have more self-leadership scores high. Third, the support of the campus environment, the experience of getting along with teachers and students, and the experience of community groups all have a significant positive predictive effect on the development of self-leadership. Among them, students' perception of the interpersonal environment has the greatest predictive effect on self-leadership, and peer groups have a significant influence on students' self-leadership. In the future, we should pay attention to the differences in student development and strengthen self-leadership education, to promote interpersonal communication and the construction of the interpersonal environment, to promote the reform of curriculum teaching and improve the student participation mechanism.

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## DIFFERENCES BETWEEN FIFTH AND SIXTH GRADERS SOCCER PLAYERS, HANDBALL PLAYERS AND STUDENTS WHO DO NOT DO SPORTS IN INDICATORS OF CONDITION PREPAREDNESS

Katarina Žigman, Antonio Martinko, Luka Milanović

*University of Zagreb Faculty of Kinesiology, Croatia*

### Introduction

Physical activity has the potential to improve the quality of life in areas of physical and mental health, social interaction and presumably help students in improving their academic achievements. The aim of the present study was to examine differences between indicators of condition preparedness in elementary school students.

### Methods

The sample consisted of seventy-five students of the fifth and sixth grades of elementary school. Students were divided into three groups while each group consisted of twenty-five students. The first group was comprised of students who practiced soccer, the second group of students practiced handball while the third, respectively the last group was comprised of students who do not do sports. Eight tests were conducted for the assessment of indicators of condition preparedness. Four of them referred to assessment of morphological characteristics, three tests assessed motor skills and one test was used for the assessment of functional abilities.

### Results

Statistically significant differences were found in all variables. Students who do not do sports were significantly higher than students who practiced soccer, while in terms of all other tests used for the assessment of morphological characteristics, motor skills and functional abilities students who do not do sports had significantly lower results than students who practiced soccer and students who practiced handball. Statistically significant difference was found in only one variable which measured body weight, between students who practiced soccer and students who practiced handball.

### Conclusions

By improving their physical fitness children could lead healthier lives all while promoting physical activity in adulthood.

*Key words: distinction, school, activity level, characteristics, abilities*



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## SPORT, GENDER, AND AUDIENCE ENGAGEMENT: AN ANALYSIS OF BROADCASTERS' SOCIAL MEDIA PAGES

Dunja Antunovic<sup>1</sup>, Sunčica Bartoluci<sup>2</sup>

<sup>1</sup>University of Minnesota, USA

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

**Introduction/Purpose:** Previous research found that women's sports are underrepresented in routine media coverage, but receive more equitable coverage during international competition (e.g., the Olympics) and on some social media platforms (Bruce, 2016). In the Central and Southeastern European region, sports media primarily cover men's football and feature women only when they compete in sports associated with national pride and win medals (e.g., Jakubowska & Ličen, 2019). More research is needed on this region on the role of media and social media specifically in relation to the social aspect of sport.

**Methods:** This study examines gender representations on broadcasters' sports-focused Facebook pages in Hungary (M4 Sport), Croatia (HRT Sport) and Slovenia (RTV SLO Šport). The study employs a quantitative content analysis of a "routine" two-week period without Olympic competition and a one two-week period aligned with the dates of the 2021 Tokyo Olympic Games.

**Results:** Preliminary results based on a sample one-week analysis ( $N = 386$ ) indicate that during a non-Olympic week, women's sports receive less than 8% of social media coverage. Women's sports represented 7.41% of posts (0 to 21.21% per day) on the Hungarian page, 4.99% of posts (0 to 15.3% per day) on the Croatian page, and 7.14% of posts (0 to 25% per day) on the Slovenian page. Consistent with previous findings, content about men's football dominates. In Hungary and Croatia, the success of the national women's handball team had significantly higher audience engagement numbers than the men's football posts.

**Conclusion:** The data analysis will be completed before the conference. Theoretical and practical implications will be discussed.

**Key words:** *sports media, women's sports, social media, Olympics*

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## FEMALE FANS WITHIN THE ULTRAS SUBCULTURE

Sunčica Bartoluci<sup>1</sup>, Benjamin Perasović<sup>2</sup>, Vanja Dergić<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Institute of Social Sciences Ivo Pilar, Croatia

### Abstract

In modern society, football draws broad public attention, both from consumers and supporters who attend football matches and those who follow it through the mass media. Modern football has become commodified throughout the past thirty years; some authors also claim it has become feminized. This analysis will focus on “traditional hot supporters”—women as members of the ultras subculture on the Croatian supporter scene. Although they are becoming more and more numerous, female supporters must accept the “male rules of the game” to be accepted in the group. This research will focus on the status of women in the ultras subculture and the ways in which they accept masculinist patterns of behaviour typical of the football supporter scene.

*Key words: female fans, ultras subculture, Croatian society*

### Introduction

In modern society, football draws broad public attention, both from consumers and supporters who attend football matches and those who follow it through the mass media. Once a working-class sport, football became appealing to the middle class after the advent of televised matches. In this sense, the context of modern football is also one of rapid commodification. Within the past thirty years, the share of women in the stands has increased (Jakubowska, Antonowicz & Kossakowski, 2020; Mintert & Pfister, 2014); in some European countries, women make up 30% of all supporters at matches (Pope, 2017). Some authors claim that modern football became feminised as a result of women’s emancipation and the commercialisation of sport (Antonowicz, Kossakowski & Jakubowska, 2021; Dixon, 2015), which resulted in the feminisation of football audiences. The “feminisation of sport fandom” includes not only a larger presence of women in the stands, but also more open and tolerant attitudes towards their presence (Antonowicz et al., 2021)—but is the same true in the Croatian context?

As noted by Giulianotti (2002), a new typology is emerging of people interested in football in various ways; this typology can be described by differentiating traditional from modern and hot from cold. There thus exist traditional hot (supporters), traditional cold (fans), modern hot (followers), and (post-)modern (*flâneurs*). This research focuses on traditional hot supporters—members of the ultras subculture, those who actively support their club and whose lifestyle and identity is crucially tied to this.

In Croatia, research on the issue of female supporters is essentially non-existent. Some research deals indirectly with issues of women and sport, displaying the deep rootedness of patriarchal culture in Croatian society (Bartoluci & Baršić, 2020). For example, research on the gender stereotyping of sports on a sample of university students by Bosnar and Žugaj (2008) shows that even youth and educated people in Croatian society see football as a male sport. It is usually characterised by strength, power, and aggressiveness, which are considered incompatible with social expectations of women. Perasović and Mustapić (2013; 2018; 2020) describe the marginalisation of women within the ultras subculture and the barriers they face to entry into the core of supporter groups. Although they are becoming more and more numerous, female supporters must accept the “male rules of the game” to be accepted in the group (Hodges, 2019). This research will focus on the position of women in the ultras subculture and the ways in which they accept masculinist patterns of behaviour typical of the football supporter scene in Croatian society.

### Methods

Broad research on women in the ultras subculture intended to encompass the majority of Croatian ultras groups is being undertaken at the Faculty of Kinesiology in Zagreb. So far, female members of two ultras groups have been interviewed. Considering the rarity of women in these groups and resultant difficulties in anonymisation, we will not identify which groups are being discussed.

Thirteen in-depth interviews were conducted with female ultras members during May and June 2021. We will focus on data describing the connections between the actors’ private lives and identities, as well as the significance they place

on their participation in the ultras subculture. The goal is to affirm and analyse the opinions of research participants on the status of women in Croatian society and in the football stands, on women's rights, and on male-female relations in the stands. Research participants were located through acquaintances and the snowball method, in which actors themselves directed researchers towards new respondents. The participants were between the ages of 23 and 38; 11 had university degrees, one was a university student near the end of her master's degree programme, and one had completed secondary school. Twelve participants were employed and one was unemployed.

### Female supporters in patriarchal society

Research has shown that Croatian society is significantly patriarchal and is characterised by sexism. Galić (2004; 2012) notes that sexism in Croatia is especially common amongst the older population, those with lower education, and the male parts of the Croatian population, amongst whom patriarchal, neo-sexist models of thinking and prejudices regarding gender identities and gender groups still dominate. Changes are apparent in youth, who are more supportive of egalitarian partner relationships and division of labour within the family (Leinert Novosel, 1999; Galić, 2012; Klasnić, 2017). Simultaneously, the institution of the family has also proven the most significant area of gender inequality. Research participants note significant changes in the institution of the family from the times of their mothers, who accepted a subordinate role within the family and society in general, while women today are much more aware of themselves and their capabilities. Rose says:

***I think women are becoming more and more equal. Maybe not as much as they should be, but we're on the right track. Maybe I haven't even experienced any kind of discrimination. There's always the opinion that women aren't for business, women aren't for football matches, that we're the 'fairer sex', that we should stay home and cook lunch. I think the new generations are increasingly aware that it isn't so.***

Women enter the world of football supporting with their family members as children, most often with their older brothers, fathers, etc. Those who fall in love with the world of supporting and become an active part of it face disapproval within their families as "it is not a world for women": *He thinks it's not for me, that women have no place there... (Black).*

The status of supporters changes, especially when they marry and have children; their activities in the stands become less frequent, especially attendance at away matches. They are mothers first and foremost, and only then everything else. If their spouses are active on the stands, they tend to fall into the background:

*(...) now that I'm married, I'm honestly not involved in anymore because I have two young children and I have to deal with them, but it was totally different before, when I was single (...) Honestly, it's been six years since I gave birth. **I don't go to away matches because no one in my family will take care of the kids, but if someone could take care of them I would still go, and before I always went with the same people to away matches. There would always be two vans plus one car.** (Black)*

They do not give up on attending matches despite their family obligations. The intensity of their activities in the stands changes, but not their passion. Purple says:

*when you have kids your priorities in life really change, and you subordinate everything to them first, but I think you always need to find time for yourself, and my time for myself is xx (club). I think everyone can go once every two weeks, at least to home matches, you don't have to go to away matches anymore. **I wouldn't think it normal for me, a mother of two children, to go to every away match; it's one thing for fathers, that's the difference, men are men.** He can, but for me to lose both Saturday and Sunday every weekend, the only free time I have for them because we're busy all week with obligations, work, school, this, that. I couldn't do that, but for me to go to xx, watch xx and later hang out with my friends a bit, that's my time for myself, and I think everyone who wants to and who really loves it can find those 90 minutes every two weeks to actually go to a match.*

Despite having become part of a male group with whom they socialise before the match and go to the stadium, female supporters have an inferior status in the group. They can take part in a large number of activities, but the 'main' ones are exclusively reserved for men. Men do not include women in planning and decision-making. Brown notes:

*I wish the men from xxx did more to include women. They always say: **women don't want to help, and what are they good for.** They always ask that question. I guarantee that if any of those people offered women to do something useful, they would benefit (...) **I think women can contribute much more than they are allowed to.** They are not allowed to participate in some things at all, but they should be.*

The patriarchal environment is "dictated" by the male members of the group, while women are usually not asked for their opinion. A subculture always refers to a specific social group and the symbolic structure surrounding it, regardless of whether this refers to a broader or more specific common denominator such as punk, metal, dub, rap, psy-trance, or in this case, ultras. This means that individuals can attend matches alone (as they can concerts or other places where subculture actors gather) and participate in singing, chanting, and other rituals. However, within the ultras subculture, belonging to a specific, small group is very important due both to numerous risks and feelings of acceptedness and protection. Considering the dominance of male values and rules in the ultras subculture, women are lucky to be able to be a part of the group whatsoever, so they share the fate and rhythm of the group despite the fact that some of it does not suit them



whatsoever. Brown describes the rituals of her primary supporter group on the day of a match, when they drink, eat, and socialise until the last minute before entering the stadium, or are even late to the match.

*We always get together a few hours before because the men have to drink a beer or two, or five. I don't drink alcohol. It often happens that there is a barbecue or some socialising in the neighborhood, people get ready to go to the match from early morning, and then they leave at the last minute of course, because why not miss the first ten minutes of the match. There's always a rush, there's never enough time, and no one ever asks my opinion. If I could, I would always go alone and wait for them to come. (Brown)*

## Masculinism as part of the supporter subculture

Our research participants are not offended by chanting and the use of derogatory terms. The use of words such as “pussy” etc. arise from Croatian culture, which research has shown to be deeply patriarchal and marked with gender inequality, sexism, and discrimination (Bartoluci i Baršić, 2020); this is not reserved exclusively to the supporter culture, but is typical of the society as a whole. Purple says that this kind of chanting is not something that “humiliates women or diminishes their value, it’s simply a part of that”, a supporter ritual. Azure affirms this:

*As for the term ‘pussy’, it’s not an exclusive issue, it’s tied to the supporter culture, it’s simply an expression used in all parts of society because **society is still sexist and women are still perceived as the weaker sex**, then that results in “you’re playing like pussies” or play like men, because **men symbolise strength, capability**, and so on, while pussies are feminine, that’s the weaker sex, it’s something timid, it’s this, it’s that. (...)*

Male-female relationships in the stands are highly complex. Regardless of how long they have been involved, hardly any woman is fully accepted amongst the core of supporters. Orange states the general belief of our research participants that men “aren’t really happy to have women in the stands. Some guys. Not all, but some.”

Despite this, many girls have won a certain degree of acceptance and fully live their identities as members of the ultras subculture. While Giulianotti’s four-member typology of forms of inclusion in the world of football is in accordance with the changes in this world, the prior differentiation between carnival fans and hooligans no longer holds in many cases (Hughson, 2002; Perasović & Mustapić, 2013). This is especially evident in the Croatian context, in which the modern ultras subculture is a kind of crossover between the tradition of radical organised supporting (which gave rise to the ultras concept in Italy) and the subculture style of English casuals. This also means that violence is a part of the carnival; along with police repression, this puts our participants in many dangerous situations.

*I was in a car with the group and an opposing group of supporters was following us. We got away from them at one point, because we planned to call our friends to help, to prepare an ambush for those who were following us. We left our car in a special spot and the male members went to get help and some kind of weapons (bats) while they left me in the car. I was shaking, but nothing happened because my group came back before anyone found me. (Gold)*

The final, impenetrable border preventing the complete acceptance of females in the core of the ultras group is physical violence. The majority of participants avoid conflict with opposing supporters and/or police. Blue states:

*the older I got, the more afraid I was, because I became aware that **I couldn’t put myself on the same level as men. Men can defend themselves, they are much stronger than I am. If shit happens, I’ll get crushed.***

The experience of conflict with police contributes to feelings of group connectedness; women may be treated more mildly than men, but the consequences are the same as for male group members:

*I have been (arrested), I was interrogated once, and detained once. Look, the police, even though we were outside Croatia, they were terrible. **I was arrested as if I were a man**, but when I was in custody, they remembered I was a woman and they took off the handcuffs, and I was treated a bit more mildly, quite a bit more mildly than the men, **but my punishment was exactly the same as if I were male**, regardless of the fact it was completely clear I hadn’t participated in anything. (Blue)*

Aside from some rival ultras groups, the police is often labelled as the main enemy in the ultras subculture, and women’s statements on this topic are no different from those of men:

*There’s a limited number of tickets, so women can rarely get tickets, and those who do get screwed more than they should. I was stripped naked a few times for no reason at all. Sometimes shit happens in the stands so they start beating everyone with nightsticks, and I once really asked the police officer why he was beating everyone he saw. I mean, you see there are kids here. It didn’t matter if it was a woman, child, or old man, that’s his job. I mean, if it’s your job to beat people, then OK. (Brown)*

All these examples show how women in the Croatian ultras scene, despite some differences, share all (or nearly all) of the dimensions of belonging to the ultras subculture as men, accepting their patterns of behaviour in order to be accepted. While Italian girls on the ultras scene (Pitti, 2018) say that men do not entrust them with important tasks like sneaking fireworks into the stadium, this is not the case in Croatia. A significant number of girls have been banned from matches for sneaking fireworks into stadiums and other offenses; they are also obliged to report to police and are subject to other measures and penalties.

Women in the Croatian ultras subculture can fight for and gain important roles, however men from the core of the group may accept one or two girls into the hard core, but no more, both because of their own masculinity and because of the majority of girls in the ultras subculture are unwilling to plan and participate in violence and violent attempts to gain reputation, such as one of the most important tasks in the ultras world—stealing banners from rival ultras groups.

## Conclusion

In Bourdieu's terms, Mintert & Pfister (2014:1641) note that the football stadium can be described as an arena where masculinity is staged and where men compete in 'serious' games for dominant positions—on the football field and in the fan's stands. Women who follow football, are passionate supporters, and build their identity in the world of supporters breach social boundaries between the male and female sex, thus becoming a kind of threat to gender ideals and myths. They will be accepted if they subjugate themselves to masculinist patterns of behaviour and the 'unwritten' rules of the ultras scene. As the number of women in the stands increases, the number of women at away matches increases as well, regardless of the dangers they include. According to current data, women in the Croatian ultras subculture take up as much space as the dominant masculinity allows, drawing the final line at physical violence.

Women usually accommodate their attendance at matches and active participation in the stands to their private lives. Family and family obligations come first; this reduces many women's participation in supporting, but they will "always" go to the stands:

*Until I die. I'll never change stands. There's one woman who's surely 50 or 60 and she's in the supporter stands at every match, that's how I see myself in the future. (Purple)*

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## SPORT DIPLOMACY: FLN FOOTBALL TEAM IN YUGOSLAVIA

Stipica Grgić<sup>1</sup>, Dora Tot<sup>2</sup>

<sup>1</sup>University of Zagreb, Faculty of Croatian Studies, Croatia

<sup>2</sup>Università di Bologna, PhD School in Global Histories, Cultures and Politics, Italy

### Abstract

In March 1961 football team of the Algerian nationalist movement, 'Front de libération nationale' (FLN) played a total of five matches in Yugoslavia. In the paper, the event is studied as a tool of sports diplomacy, where both sides aimed at creating a positive image of the Algerian fight for independence among the public of the host country. For the FLN it meant gaining international support, while Yugoslav side tried to explain and justify its vast diplomatic and material aid provided to the Algerians. Yugoslav side also tried to impress the Algerian football delegation in an attempt to influence the leadership of the FLN, which they were convinced would soon lead the independent Algerian state.

**Key words:** Yugoslavia, Algeria, Front de libération nationale, Football, Public diplomacy

### Introduction

During the 20<sup>th</sup> century football became more than just a game. International football competitions, among other things, became expressions of imagined communities of nations, not just the pastime for those on the pitch. Governments began looking at football not only as a means to showcase their nation but also as a *public diplomacy* tool. *Sports diplomacy*, as a part of public diplomacy, can be defined as a series of formal and informal actions of a particular state, its politicians, athletes and other actors to implement certain foreign policies goals through sport (Bilandžić & Leško, 2019, p. 61).

Books and articles on the topic of the *Front de Libération Nationale* (FLN) football team focused mainly on its role in the Algerian War of Independence (1954-1962) and relations with France (e.g. Alegi, 2010; Hawkey, 2012). However, emphasis in this article will be placed not on the results of five games held during the March of 1961, but on the diplomatic goals that the Algerian and Yugoslav side sought to achieve by organizing these matches. In that capacity, the article looks into the FLN football team's 1961 'Tour of Yugoslavia' as part of diplomatic efforts from both sides. We argue that the tour aimed to shape public opinion in the host country. While the FLN team was propagating Algerian independence through football, in front of the same audience Yugoslav side was trying to justify their aid to the 'Algerian cause'.

### Yugoslavia, Algeria, France and football

In the early 1950s Yugoslavia became aware of the need to legitimize its independent position on the international political scene. It was seeking the affirmation of the policy of non-alignment by increasing its influence among the newly independent Afro-Asian countries. These efforts led to a strong Yugoslav involvement in the Algerian War of Independence. Although the extent of humanitarian and especially secret military assistance to the FLN cannot be accurately determined, its public diplomatic support for the 'Algerian cause' was a way for Yugoslavia to gain respect and admiration in Algeria and the rest of the 'Third World' (Byrne, 2015, p. 7).

After the First World War football quickly became one of the most widespread leisure activities in Algeria, both among the people of European origin (*colones, Pieds-Noirs*) and local Muslim population. As the Algerian War of Independence broke out, FLN leaders previously involved with football recognized its national mobilization and diplomatic potential. For instance, Ahmed Ben Bella, one of the nine founders of the FLN, later Prime Minister and President of Algeria, in his youth was an active footballer that even played a match for the Olympique de Marseille (Mishra, 2016). The leading movement fighting for Algerian independence in 1958 decided to form its football team, which would mostly include professional footballers from France who were ready to contribute to their nation's struggle. The FLN team would serve as a propaganda tool for the 'Algerian cause'. From mid-1958 to mid-1961, the FLN football team played a total of 86 matches in 14 countries of the Eastern Europe, Middle East and Asia. On various tours in the period 1958-1961 FLN team won 60 games, lost 14, and 12 had draws. They were received very cordially by countries where the Muslim or socialist anti-colonial character of the Algerian team was largely important. Algeria - Equipe ALN and Equipe FLN - History and Matches (n.d.). Retrieved from <http://www.rsssf.com/tablesa/alg-fln-intres.html>

Under the French diplomatic influence FIFA, which in principle advocated the policy of non-political interference in football, contemplated suspension of all members of the FLN team, as well as ejection from all footballing competitions of teams that decide to play against unrecognised Algerian squad (Hawkey, 2010, p. 98). Yugoslav politicians and the Football Association of Yugoslavia were cautious. Their national football team won consecutive Olympic silver medals in London (1948), Helsinki (1952) and Melbourne (1956), while gold was won in Rome (1960). They were well aware of the extent to which their earlier sporting achievements had served both as a means of reinforcing inner cohesion and building positive image about Yugoslavia in the rest of the world (Mills, 2018, p. 113). Although fearful of FIFA sanctions, Yugoslav side found a way to invite the football team of the Algerian liberation movement in which their government had invested a lot in terms of material and diplomatic support over the previous years.

In order to create an appearance of impartiality, the formal invitation to host the FLN team was sent by the supreme trade union body of Yugoslavia. The Federation of Trade Unions of Yugoslavia (FTUY; *Savez sindikata Jugoslavije*) was an organization often misused by the ruling League of Communists of Yugoslavia to express their views on internal and foreign policy problems under the cloak of trade union impartiality. FTUY previously wrote public protests to the UN and French authorities, demanding an end to the killings in Algeria, while at the same time highlighting the fight for freedom as the supreme ideal of all workers of the world (Savić & Lukić, 1962, p. 13).

## FLN vs Yugoslavia

In early March 1961, without prior notice, newspapers in Yugoslavia briefly informed the public that Algerian footballers arrived in their country as guests of the FTUY and that in the upcoming weeks they plan to play matches against several trade union football teams assembled exclusively for that purpose. Upon landing in Zagreb, Algerian football delegation was greeted by representatives of the FTUY and the Football Association of Yugoslavia. Algerian football delegation was escorted to Opatija shortly after their arrival, immediately visiting wounded FLN fighters that were treated at a hospital in nearby Lovran (“Alžirski fudbaleri doputovali u Opatiju,” 1961).

As Algerian football players had matches scheduled in Rijeka (March 12), Zagreb (March 15), Maribor (March 19), Tuzla (March 22) and Belgrade (March 29), they were under the direct care of trade union organizations in each town. Trade unions organized their visit as a standard hosting of a foreign country’s trade union delegation. To become familiar with the socio-political system, economy and culture of socialist Yugoslavia, Algerians were presented with meals at reputable hotels, meetings with trade union and local football representatives, theatre plays, visits to various factories, museums and day trips to national parks. Although showing they were honoured, much to the dismay of Yugoslav union leaders that accompanied them, they were grumbling because of the inability to devote themselves to training and match preparation (“Izvještaj,” 1961).

Furthermore, the opponents and stadiums in Rijeka, Zagreb, Maribor and Tuzla were far from respectable. This was justified by the fact that the main city stadiums in Rijeka and Maribor were incomplete and by the fact that main city teams, e.g. Dinamo Zagreb, had other league duties. Therefore, players from other Zagreb clubs, such as Trešnjevka, Lokomotiva and NK Zagreb, which competed in the Second Federal League, were gathered to oppose them as “Union Team of Zagreb”. Two weeks later, players of the best Belgrade clubs such as Crvena Zvezda, Partizan, Radnički and OFK Belgrade appeared as “Union Team of Belgrade”. The Algerian side describes this match as a victory for the FLN football team against the Yugoslavian Olympic football team, while all the press from Yugoslavia refers to them as “Union Team of Belgrade”. By the names of the players who were on the pitch, we are definitely more inclined towards the last description (comp. Algeria - Equipe ALN and Equipe FLN - History and Matches and “Naši gosti iz Alžira,” 1961). Although the number of spectators varied, from 2,000 in Maribor to 20,000 in Belgrade, which was a good figure, members of the FLN football delegation pointed out to their Yugoslav counterparts that in 1959 they played “matches in Bulgaria etc in the biggest stadiums, in front of 70,000 people“. Algerians also brought the tape of the Algerian national anthem. Although some local football officials were inclined to play the *Kassaman* prior to every game, Yugoslav union representatives stated “that the anthems could be played only for recognized national teams”. This, along with other explanations, was reportedly reluctantly accepted by the Algerian football delegation (“Izvještaj,” 1961).

In terms of results, game against the “Union Team of Rijeka” played on March 12, 1961, ended in a win for ‘Free Algeria’ (4:1). Match in Zagreb played three days afterwards, ended with a 3:0 defeat. On March 19, 1961, they had drawn with Maribor (1:1) but demolished Tuzla’s union team on March 22 with 9:0. All games were played in front of several thousand supporters. Journalists reporting from stadiums were a bit surprised by the quality of football they witnessed. Newspaper articles wrote about the “beautiful, efficient and dynamic” style of play of Algerians, “with enviable technical knowledge” (“Reprezentacija Alžira-Rijeka 4:1,” 1961).

Although newspaper articles on the Algerian footballers and their matches were written in a positive tone, describing positive impressions of spectators, they were nevertheless usually short, with only a handful of photos. There was no major reportage or interview with the players. Between the lines, ideas about the fraternity of the people of Yugoslavia and Algeria as well as the Algerian just struggle for freedom were present through the press. France was described rather neutral, as a country in which part of the FLN players had previously made their careers and attained a considerable



profit, mentioning in this context well-known players and former French internationals like Abdelaziz Bentifour, Rachid Mekhloufi and Mustapha Zitouni (“Stigli su fudbaleri Slobodnog Alžira”, 1961).

The focal point of the Yugoslav tour was the game FLN team played in Belgrade on March 28, 1961. This match was organized together with another one, held the same day at the same JNA stadium. The Algerians made their appearance only after a football match between Crvena Zvezda and Bangu from Rio de Janeiro, one of the best South American football teams at that time, maybe to attract as many spectators as possible on a Tuesday afternoon. Ultimately, both matches turned out to be a real sporting treat for football fans. In front of 20,000 spectators, Bangu defeated Crvena Zvezda 3:0, and then the FLN team demolished “Union Team of Belgrade” with 6:1. Reporters that attended the game were competing over who would praise the FLN team more: “It looks as if the footballers from friendly Algeria [...] showed everything they knew only in Belgrade because the class of their game exceeded what was expected after the results they achieved in previous matches in Yugoslavia. Maybe the guests, who received sympathies from Belgrade crowd for the struggle of their people for freedom, haven’t shown modern ways of playing football, but in any case, they gave our young footballers a lesson in both individual technique and many others elements of football skill” (“Dve lekcije,” 1961).

After that match, the Algerian football delegation left Yugoslavia. By the middle of the year, they continued their tours, playing matches in Bulgaria, Romania, Hungary and Czechoslovakia. Ultimately FLN football team was dissolved in June 1962 (Alegi, 2010, p. 50), a few months after the Évian Accords which ended the war. Algeria was declared as an independent country and FLN was transformed from a revolutionary movement into a political party that led the process of Algerian state-building (Byrne, 2010, p. 10).

## Conclusion

In all likelihood, the FLN team’s “Yugoslav tour” of 1961 was not overly successful for both sides involved. Members of the FLN football delegation had high expectations but were presented with the lack of publicity, playing at smaller stadiums, with “weaker” opponents. They also had a lot of extracurricular commitments organized in their honour by the Yugoslav trade union delegations before every game. On the other hand, the Yugoslav side was not satisfied with the lack of interest among the Algerian football delegation in the presentations of Yugoslav socialism and economic progress, which were probably aimed to bring the leadership of the FLN and the Yugoslavian government even closer.

Five matches played in Yugoslavia did have an impact on citizens, objects of public diplomacy. Since there has been a positive public opinion about Algeria’s struggle for independence which was built for years in Yugoslavian public space, it is difficult to conclude how influential the stay of the FLN team in Yugoslavia was. However, it can be undoubtedly said that good performances of the FLN team, and even more the positive journalist descriptions of their style of play were in the service of provoking additional sympathy for Algeria’s independence efforts with the Yugoslav general audience.

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## THE PEER VIOLENCE IN YOUTH SPORT: COACHES AND YOUTH PERSPECTIVES IN TWO SOUTHEASTERN COUNTRIES

Tea Gutović<sup>1</sup>, Doris Matošić<sup>2</sup>, Dejan Madić<sup>3</sup>, Goran Kuvačić<sup>4</sup>, Borislav Obradović<sup>3</sup>, Dragan Marinković<sup>3</sup>

<sup>1</sup>Faculty of Kinesiology, Split, Croatia; Faculty of Humanities and Social Sciences, Department of Sociology, Split, Croatia; Faculty of Economics, Split, Croatia

<sup>2</sup>Faculty of Kinesiology, Split, Croatia; HNK Hajduk, Split, Croatia

<sup>3</sup>Faculty of Sport and Physical Education, Novi Sad, Serbia

<sup>4</sup>Faculty of Kinesiology, Split, Croatia

**Purpose:** The peer violence occurs as daily issue in Southeastern countries. Even though sport is a social phenomenon with dominantly positive impact on children' and youth development, there are cases of peer violence in youth sport. That was the reason for implementation of Erasmus + Sport founded project named "Sport Against Violence and Exclusion (SAVE)".

**Methods:** The field research is based on two focus groups discussions implemented with coaches from Croatia and Serbia, who are working with children aged 6 to 16. Additionally, authors implemented field research with primarily school aged children, in order to determine the frequency of aggressive and prosocial behavior and social exclusion through questionnaires in the sport environment.

**Results:** Interviewed coaches (N=26) reported verbal violence – name calling (Croatia) and pushing, teasing, mockery (Serbia) – as the most frequent forms of violence during the training sessions, competitions and sport camps. On the other hand, data gathered in children sample showed that physical aggression in sport clubs on the estimating scale from 1 to 5 is at average estimation of 1.39 (SD=0,47) in Serbia and 1.63 (SD=0.68) in Croatia. Additionally, prosocial behavior scale in sport clubs varies from high in Serbia (3.82) up to very high in Croatia (4.13), while prosocial behavior scale in school varies from 3.79 in Serbia to 3.87. Named differences show that sport club is somewhat more desirable social environment for their members than the school class is for its students.

**Conclusions:** The research shows the verbal violence as dominant form of peer violence in youth sport in Croatia and Serbia, but it does not show high level of violence at daily basis. Coaches reported that violence is more an exception than a permanently present issue. Those results are compatible with field research implemented on primary school aged children, which showed that children identify themselves more with sport club environment. Those results are compatible with researches and applied projects, which point out the positive social nature of youth sport.

**Key words:** athletes; coaches; social exclusion; violence; youth sport

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## SPORT AND THE EMIGRANT IDENTITY: AN ANALYSIS OF MEDIA DISCOURSE REGARDING NEW ZEALANDERS OF CROATIAN ORIGIN PLAYING FOR THE CROATIAN NATIONAL RUGBY TEAM

Ivan Hrستیć, Marko Mustapić

*Institute of Social Sciences Ivo Pilar, Croatia*

### Abstract

Rugby in Croatia is a non-elite sport with no significant results on the international level. Since the 1990s, efforts have been invested to establish a stronger connection with athletes in the emigrant community, mainly in New Zealand. Through a media discourse analysis of these athletes within the broader historical context, we attempt to establish the dominant attitude of the Croatian public towards this phenomenon. This also contributes to an understanding of the processes by which the identity of this emigrant community is transmitted and constructed, as well as its relationship with its mother country.

**Key words:** *sport, rugby, Croatia, diaspora, New Zealand, media*

### Introduction

In Croatia, rugby is an amateur sport that does not draw broad public attention. Croatia's first rugby club, HARK Mladost, was founded in Zagreb in 1954. Despite this relatively long tradition, Croatia's clubs and national team have enjoyed no significant success on the international level. The greatest success came in the late 1990s (a step from ranking into the 1999 World Cup and a noteworthy performance at the prestigious *Hong Kong Sevens* tournament in the same year), at which point the national team was ranked 22<sup>nd</sup> in the world (Žukina, 2000). This success was primarily due to the involvement of players from the Croatian expatriate community, mostly from New Zealand. The 2000s saw decreased cooperation with expatriate players, which negatively affected sporting results. The idea to re-intensify this cooperation appeared once again in the 2010s, albeit to a lesser extent than in the 1990s. In 2020, Croatia is competing in the third tier of the European rugby union.

The goal of this paper is to perform an analysis of media discourse regarding Croatian national rugby team players from New Zealand in order to affirm the Croatian public's dominant attitude towards them. This will also contribute to an understanding of the processes by which the identity of this emigrant community is transmitted and constructed, as well as its relationship with Croatia. Much has been written about sport as a key element in the everyday process of (re-)constructing national identity; a few authors have also attempted to analyse the role of sport in creating the identity of Croatian emigrants (See: Bairner, 2001; Jarvie 1993; Hay, 1994, 2001; Hughson, 1996, 1997; Mosely, 1994, 1995; Danforth, 2001). However, this research has generally focused on the role of sport within the framework of emigrant communities, and their basic focus is on football as an elite sport and the most popular sport worldwide. The current research shall focus on the role of rugby as a non-elite sport in Croatia about which very little has been written in the Croatian scientific literature. Additionally, we will examine the media interpretation of the role of the Croatian state, which undertook institutional attempts to influence the process of (re-)constructing the national identity of its emigrant population. Through this process, the emigrant identity is approached as a process and a fluid phenomenon subject to change throughout its development as the result of intense triangular interaction between the coordinates Croatia-New Zealand-emigrants. However, given spatial limitations, this research will not deeply analyse the identity characteristics of the emigrant population in New Zealand in the long term regarding three closely interwoven identities that are expressed: Dalmatian, Yugoslavian, and Croatian. This research focuses on the period after Croatia's independence, which will be briefly contextualised *en longue durée*.

### Croats in New Zealand and rugby

Croatia is a country with a large emigrant population. According to official estimates, around 3 million Croats and their descendants live throughout the world, while the population of Croatia in 2011 amounted to 4,285,000 (Central State Office for Croats Abroad). Croats began emigrating to New Zealand in the late 19th century. Estimates of the number of Croatian emigrants and their descendants in New Zealand today range between 20,000 and 60,000, although only 2,673 declared themselves as such in the 2013 census (Stats NZ). The majority of Croatian emigrants came prior to World War

I, so their descendants primarily identify as New Zealanders. However, they nurture a positive relationship towards their ancestral home through participation in the work of emigrant organisations. Sport has played an important role in this context, not only in maintaining cultural connections with Croatia, but also in the process of integration into New Zealand society. This is clearly apparent in the spread of rugby's popularity amongst Croatian emigrants. Prior to arriving in New Zealand, Croatian emigrants were unfamiliar with this sport, which is of exceptional importance to New Zealand's national identity (Nauright, 2007). However, Croats founded their first rugby club in New Zealand in Waiharara already in 1910; rugby sections were also active in the majority of Croatian/Yugoslavian associations in New Zealand in the 20th century. It is thus unsurprising that many of New Zealand's rugby players of Croatian descent have enjoyed remarkable sporting careers. Thirteen of them have played for New Zealand's senior national rugby union team (the 'All Blacks'); of these, Frano Botica and Matthew Cooper also played for Croatia in the 1990s (Radica, 2011).

Rugby also opened a new channel of interaction between emigrants and their country of origin. Rugby players who played for clubs throughout New Zealand during the 1970s and 1980s came together three times a year within the framework of the Yugoslav Sports Club; they also played a series of games in four tours of Yugoslavia between 1978 and 1990 (Puhovski, 1986; B. V., 1990; Jelich, 2008). In addition to this, eminent New Zealanders of Croatian origin sponsored tours abroad for Croatian rugby clubs and the Yugoslav national team (Vujina, 1988). The relationship intensified further during the 1990s as a result of the intense efforts of the new Croatian government and its institutions regarding emigrant populations. Sport was considered a highly important tool to promote and affirm Croatia internationally; the strongly homogenising character of sport was at the same time seen as important to the process of (re-)constructing the Croatian national identity (Bartoluci, 2013; Brentin, 2013). As early as February of 1991, the Croatian Rugby Federation had already started an initiative to contact Croatian emigrant rugby players (Vujina, 1991). This initiative did not enjoy significant success. The leadership of the rugby federation received fresh support for the idea to establish strong contacts with emigrants from the Croatian Olympic Committee in 1995. The plan was to hire a coach of Croatian descent to improve rugby in Croatia, as well as to organise tours for the Croatian national team in New Zealand (Tartaglia, 1995). However, the initiative of Antony Sumich and the national team's leadership in 1996 proved key (Birtić, 1998). Sumich later also became both a player and the selector for the Croatian national rugby team. The players who answered his invitation agreed to play without pay. Significant support was offered to the rugby federation by the Croatian Ministry of Immigration, which financed the majority of players' travel expenses and accommodation. The entire process was also financed by a handful of New Zealand entrepreneurs of Croatian heritage (Grubišić, 1997). During the 2000s, cooperation with players from New Zealand declined. This cooperation re-intensified in the 2010s, albeit not to the same extent as in the 1990s (Ledinski, 2009).

## The Croatian media and rugby players from New Zealand

This paper is based on the qualitative analysis of the content of media coverage. As it was impossible to systematically analyse print, TV, and online sources through multiple decades, we decided to use Vjesnik newspaper's documentation, a commercial media research agency, and the Google search engine. Vjesnik's newspaper documentation is a themed collection of newspaper texts written between 1962 and 2006; it consists of a total of 6,105 binders and 26 drawers. The media research agency included all Croatian print media articles and national television news segments since 2005, as well as web content from the past three months. In addition to this, we used the Google search engine to establish a broad search string constructed according to the key terms "Croatia, rugby, New Zealand". We defined the unit of analysis as a single media item relating to Croatian national rugby team members from New Zealand; a relevant conclusion can be drawn on the subject of research on the basis of this content.

According to these criteria, we identified a total of 8 articles in Vjesnik's newspaper documentation about national rugby team members from emigrant populations, mostly from New Zealand in the late 1990s. The Google search and the results of media agency research provided 39 additional newspaper items from the later period, mostly after 2010, as well as two TV reports. The low number of news items makes it apparent that rugby did not arouse particular attention in the Croatian media. Weak media coverage was a result of the status of rugby in Croatia as a 'small' or 'non-elite' sport. Rugby's marginalised status despite the successes of the 1990s was the dominant subject of newspaper articles on the sport at the time. Within this context, the relationship towards national team members from New Zealand was exceptionally positive, and their nearly exclusive credit for rugby's rise in Croatia was regularly noted. It was also heavily emphasised that they enjoyed no financial gain from playing. Only two articles included a critical relationship towards cooperation with players from New Zealand. In the first, the author claims that some players from New Zealand were no better than those from Croatia, and that the use of emigrant players was both damaging to the growth of young Croatian players and represented an unnecessary expense (Buškulić, 1997). This comment was refuted in an explanation from the Croatian national team's leadership, who noted that the goal of bringing players from New Zealand was to popularise rugby in Croatia and to develop young players (Grubišić, 1997; Birtić 1998). However, there was an apparent difference in opinion within the rugby federation as well, which is apparent in the reduction of cooperation with players from New Zealand during the 2000s. The media did not report significantly on this discussion. In accordance with this, in discussing the issue of hiring expatriate athletes, the author of the 2002 article primarily focuses on criticism of this practice in football,

while this type of cooperation in rugby is partially justified by the low level of the sport in Croatia: “*This helped the Croatian national rugby team – although it was called many things in the world out of veneration, but never Croatian. For the national football team, this would have been a step backward – communicating in English and losing identity*” (A. B., 2002).

On the other hand, the national team leadership in the 1990s saw the basic barrier to rugby’s further development in Croatia in its inadequate media and sponsor support. Accusations were particularly harshly directed at the Croatian national television station and the Croatian Olympic Committee (Žukina, 2000). Arguing for the need for stronger support, in the spirit of the broader context of Croatia’s social development, representatives of the rugby federation emphasised the importance of improving relationships with the expatriate community. In doing so, they predominantly interpreted national identity in the primordialist spirit, as an inborn individual trait. Velimir Juričko, secretary general of the federation in 1998, compared the national rugby team to the women’s national volleyball team, whose successes at the time were greatly thanks to naturalised Russian-born players: “...*these are our boys! They aren’t foreigners who need to be given citizenship, but Croats who have a right to it! (...) The national rugby team can certainly bear the mark of genuine Croatian quality, because we haven’t turned anyone into a Croat*” (Birtić, 1998). In a similar spirit, coach and Croatian national team selector Drago Lulić stated in 2000 that Croats were forced to relocate to New Zealand before World War I due to a blight on grapevines, the foundation of the Dalmatian economy at the time, but that “*rugby is bringing them back to their homeland*” (Žukina, 2000). However, the athletes’ multicultural background could not be ignored. On the contrary – the connection with New Zealand, one of the most successful countries in the world in this sport, was especially important, and was emphasised accordingly. Frano Botica, the biggest name to play for Croatia in terms of his career success, was of mixed Croatian and Maori origin. Botica was also the first non-white athlete to compete for a Croatian national team. Of particular interest to the media was the performance of the haka, which players from New Zealand also performed in their Croatian jerseys. This overlap in the ethnic and civil form of nationalism, as interpreted by Anthony D. Smith (1991), is in accordance with observations that these phenomena do not exist in reality in their ‘pure’ form (Bartoluci & Doupona, 2019).

In the period from 2001 to 2010, the only news items located were one concerning a notable performance by Mark Ozich in 2002, a brief interview with Antony Sumich, and an announcement of reintensified cooperation with emigrants in 2009 (Mikulek, 2002; Grubišić, 2005; Ledinski 2009). In accordance with this, media interest increased after 2010. However, in this context, a change in media discourse about the national rugby team is apparent as compared to that in the 1990s. The articles analysed that were published after 2000 did not discuss the status of rugby within the framework of Croatian sport; the dominant thematic focus shifted from emigrant rugby players’ contributions to the national team’s results to the personal, individual level of the rugby player. This is in accordance with the observations of Bartoluci & Doupona (2019), according to whom the role of sport in Croatia in the 1990s was primarily important in creating ethnic nationalism and promoting the new state; after this, the contribution of sport was more pronounced in the creation of the civil type of nationalism.

## Conclusion

The global battle for talent and changes in athletes’ citizenship in order to compete for countries they were not born in have greatly marked the development of modern sport. This results in the commodification of citizenship, which itself is the result of the paradoxical policies of nation-states that found the promotion of their nation upon sport, but without their own nationals. This type of elite sport migration has already drawn great attention from the scientific community. However, much less interest has been shown in research on members of expatriate communities who decide to compete for their country of origin. This topic has been further neglected within amateur and/or non-elite sport, in which the interests of athletes cannot simply be reduced to career advancement or financial gain. Additionally, as concerns Croatian national rugby team members from New Zealand, an additional idiosyncrasy as compared to research on elite athlete migration is that they cannot be viewed as migrants. As a rule, they are returning to their homeland immediately after the games.

The practice of drawing talented athletes from expatriate communities has been present in Croatia for decades now, and is strongly supported by the general public. This is the consequence of a long history of emigration and strong ties between the social development of the emigrant community and Croatia as the country of origin. The discourse analysis of Croatian media also makes this apparent in the case of rugby, in which political institutions also became actively involved in the process of attracting expatriate athletes. The Croatian media space dedicated to this topic was quite modest, however it treated the rugby players from New Zealand positively. The interest of the Croatian public is, however, focused on football and sports that are perceived as the ‘pride of the nation’. This is a consequence of rugby’s status in Croatia as an amateur, non-elite sport. The rugby players from New Zealand undoubtedly play for the Croatian national team due to their emotional ties to the homeland of their ancestors. In this context, they become active participants in the process of (re-)constructing national identity within the Croatian emigrant community in New Zealand, as well as an actor in interaction along the triangular coordinate system of country of origin, emigrants, and immigrant country. In this process, rugby has and continues to play an important role as a social actor that catalyses cooperation and establishes new areas in which to deepen relationships.

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## INTEGRATION INTO SOCIETY THROUGH SPORT: A CASE STUDY OF HESTIA FC, THE FIRST REFUGEE AND MIGRANT WOMEN'S FOOTBALL TEAM IN GREECE

Rahela Jurković

*Independent scholar, Croatia*

### Abstract

This paper investigates the integration of refugee women in a host society through football. It is based on a case study of the first refugee and migrant women's football team in Greece: Hestia FC. The research is based on qualitative methods: semi-structured interviews and participant observation. The results of the study show that playing football, when approached appropriately, brings many benefits to refugees. The right approach to football as a tool for refugee integration is to be found in dedicated people who manage such football programmes, in creating a football pitch as a safe space, and in listening to the needs, desires and thoughts of refugees. In this way, the broadly spread idea in contemporary migration theory and policies of integration as a mutual process can be successfully materialised and may bring benefits to both refugees and the local community.

**Key words:** *integration, refugees, refugee women, sport, football*

### Introduction

A single definition or theory of integration acceptable to everyone simply does not exist (cf. Castles et al. 2002). Many scholars have adopted working definitions of integration in line with their particular research. Penninx (2007, p. 10) defines integration as “the process of becoming an accepted part of society”. This elementary definition, as he calls it, is also relevant for the research on which this paper is based. Integration in the European context is currently a concept that mainly refers to refugees. Based on the author's previous research in the area of contemporary refugees (Jurković 2018a, Jurković 2018b), “becoming an accepted part of society” is not only defined by the society in which a refugee has arrived (host society), but it also, and much more, depends on the refugee, and how he or she feels to be accepted (or not) by the host society. These feelings are the result of everything that the refugee has experienced in the society since his or her arrival. When considering the integration of refugees, Ager & Strang (2004) developed an integration framework that consists of ten key domains important for the integration of refugees, grouped around four indicators of integration: means and markers (employment, housing, education, and health), social connections (social bridges, social bonds, and social links), facilitators (language and cultural knowledge, and safety and stability), and foundations (rights and citizenship). Leisure, which includes sport, has recently been added to the group of “means and markers”, in an updated version of the integration framework (Ndofor-Tah et al., 2019), reflecting the importance of such activities (sports included) for the integration of refugees. In explaining the importance of leisure for integration, the authors claim that “[l]eisure activities can help individuals learn more about the culture of a country or local area, and can provide opportunities to establish social connections, practice language skills and improve overall individual health and wellbeing” (Ndofor-Tah et al., 2019, p. 38).

This paper investigates this domain of integration, and, more precisely, football played by refugee women. It is based on a case study of the first refugee and migrant women's football team in Greece: Hestia Football Club (FC), run by the International Olympic Truce Centre (IOTC) in Athens. The name Hestia originates from Ancient Greek mythology: it was the name of the goddess of “the hearth, architecture, and the right ordering of domesticity, the family, the home, and the state” (Hestia FC, 2019). In modern Greek, as Katerina Salta, the Sport for Protection Programme Manager of the IOTC and manager of Hestia FC, explained, Hestia also means the goalkeeping area on the football pitch.

Hestia FC was founded in 2019 as a programme of the IOTC, in collaboration with the international non-governmental organisation Eir. The aim of the programme is the “protection, the psychological well-being, the empowerment and the social integration of refugee and migrant women, as well as the promotion of the Olympic values and the United Nations Sustainable Development Goals through sport” (Hestia FC, 2019).

## Methodology

This paper is based on qualitative research conducted in October 2019, consisting of semi-structured interviews and participant observation. The semi-structured interviews were held with Katerina Salta and six refugee women who are members of Hestia FC. The researcher also gathered with them before and after the individual interviews. Participant observation was done during a workshop and at a football game held during the event “A Ball against Discrimination” on 19 October 2019 in Athens, as part of the *#FootballPeople Weeks* in Greece, an international campaign organised by the Fare network. This event took place the day after the interviews with the research participants. Participation in the mentioned event, as well as befriending sessions during and also after the interviews, helped the researcher to “grasp what they experience as meaningful and important” (Emerson et al. 1995, p. 2). The six interviewed refugee women originate from Afghanistan and Iran, and their age was between 22 and 40 years. As regards the period of their stay in Greece, when the research was conducted it ranged from six months to four years. Although their legal status in Greece was not the subject matter of the research, during the interview it was discovered that some of them were still in the process of obtaining asylum, while others had already gained asylum or humanitarian protection in Greece. Some interviews were held in English, while four interviews with refugees were conducted with the assistance of an interpreter for Farsi and Dari.

## Results

Since the foundation of Hestia FC and the first training of the team in March 2019 until October 2019, thirty women had passed through the team: some left Greece and some found a job and therefore could not continue playing football. The team had training sessions twice a week (on Mondays and Wednesdays); on Fridays they had workshops on different subjects of interest; and during the weekends they occasionally played friendly matches with other local football teams. Although at the time of the interviews Hestia FC had been active for only about eight months, the team had already attracted international interest and its members were invited to conferences and football competitions abroad. However, Hestia FC players – refugee women – could not attend the events outside Greece because they were either still in the procedure of gaining asylum or had refugee protection that did not allow them to obtain documents necessary for traveling outside Greece.

The reason football was chosen as a tool for the integration of refugee women is explained by Katerina Salta: “it is easy to implement, apply everywhere; it is so popular with everyone; you don’t need a specific language in order to communicate: even with body language or by drawing and painting you can communicate. For me, it is the most popular and the easiest one and it can unite people, bring them together, find common cause, common dreams... And at the same time, it is not only about uniting people, it is about empowering them, it is about integrating them”. She added that the football pitch is considered a safe space, where, in this case, women “can develop friendships, where they can open up and express themselves”. Empowerment through football is reflected in the fact that participating in Hestia FC gives refugee women the desire and strength to engage in other activities of everyday life in Greece: enrolling in Greek and English language lessons, and searching for a job. Friendly football matches, but also the conferences they are invited to attend, offer them opportunities to meet local people and befriend them.

The interviews with six women refugees who played football in Hestia FC confirmed the benefits that football brought them. All interviewees considered the football team an important part of their life in Athens since joining the Club. For half of the interviewed refugee women, becoming part of Hestia FC was a trigger for health improvement. In their own words, they had had psychological problems and suffered from depression, and, after joining the team, their health improved, and they no longer felt such problems. Hestia FC also gave them hope, energy and it marked a new beginning in their life. Their families (mostly children) noticed this as well, and encouraged them to continue playing. One of the interviewees said: “For me, I didn’t know exactly what rights I have, because I grew up in a country where they didn’t accept refugees at all. You say here it’s better than before, and there it is worse. But here, inside football I know my rights, it’s full of energy this football, really. It has changed my life... It’s freedom”.

Based on the changes that playing football with Hestia FC brought to their lives, the majority of the interviewees said that they were trying or would try to encourage other women in a position similar to the one they previously had (mainly meaning isolated from society and depressed) to start playing football. They wanted to demonstrate through their own example that a positive change in the life of refugees was possible. Some of them started to play football for the first time with Hestia FC at the age of 35 and 40, and they planned to continue playing football. In this way, their example indicates that everyone, not only refugees or women in general, can start playing football at any age, and that playing football is not only meant for young people or for men only.

However, the benefits achieved in Hestia FC using football as a tool for integration into society did not happen just because of football. The benefits occurred because football has the potential to serve as a social bridge (cf. Ager & Strang 2004), but only when the approach is right. For instance, quoting integration as one of the goals of a football club or waving a banner with the inscription “refugees welcome” during football matches are, as deeds, not enough to actually help refugees integrate into society through football (cf. Jurković, 2018b). The reasons behind Hestia’s success are to be



found elsewhere. Katerina Salta, manager of the team and a Greek humanitarian worker since the outbreak of the so-called migrant crisis in 2015, has poured love, devotion, passion and persistence into Hestia. Her efforts also enjoy the organisational support of the International Olympic Truce Centre. What is most important for the team as a whole is the way Hestia FC is run. This is best explained in Salta's words: "It is essential to take into account their desires and their [the refugee women's] needs. So they know from day one that, okay, I do have experience, and I'm more mature, older, and also that the coach in matters of football knows better, but at the same time, they know that some, if not most, of the decisions are taken after discussion. We always take into account their ideas; we brainstorm together and that's really important. During all these procedures they open up, they express themselves and we become one. I said from the beginning: this is a family; this is not just a team".

The second important element of Hestia FC's approach to working on the integration of refugees through football is again explained by Salta in the following way: "Balance in everything. Balance between humanitarian aid and the football aspect. I cannot check only the humanitarian or the solidarity view and forget the football one. At the same time, I cannot apply the same rules, have the same behaviour to vulnerable people that I would have with *normal* football players, so there has to be a balance. You have to give them some space, some time to adjust. At the same time, you cannot be 'Aah, refugees, they can do whatever they want, they're traumatised' – NO... This is balance and it's not easy".

## Discussion and conclusion

In the area of the integration of migrants through sport, many scholars have been critical of the efficiency of the approaches taken by different institutions and organisations in countries receiving migrants, including refugees (cf. Dukic, McDonald & Spaaij, 2017). For instance, Spracklen, Long & Hylton (2015) have critically examined the positive role that sport is usually assigned when considering the integration of migrants in general. In an empirical study of new migrant communities in the United Kingdom, these authors questioned the role that organised sport has on the inclusion of new migrant communities in the local community. They argue that "Sports, like other social forms, do the work of hegemony by Othering and excluding subaltern groups, especially where sports are part of an uncritical offer of leisure activities [...] We are not suggesting that potential does not exist, just that, contrary to the aspirations of its advocates, sport is more likely to reaffirm Otherness and elitist distinction" (Spracklen, Long & Hylton, 2015, p. 126).

On the other hand, in a recently published critical review of the literature on sport, refugees and forced migration, a surprising "relative lack of sports-focused refugee and forced migration studies" is noticed (Spaaij et al. 2019, p. 2), although publications on the topic in recent years have been increasing. The fact that leisure activities have only recently been added to the ten domains of the integration framework (Ndofor-Tah et al., 2019) gives evidence of the lack of understanding that sport is not only a leisure but is also an important field that needs to receive greater research interest.

However, most recent scholarly work finds sport has a positive impact on refugee integration, which this paper also demonstrates. Doidge, Keech and Sandri (2020) reveal three significant areas of the impact of sport on refugee integration: an active approach from coaches; the creation of a safe, enjoyable and welcoming sport environment; and the focus of an activity centred on fun and social interaction, rather than just sporting skills.

The fieldwork that underlies the research that this paper focuses on, which is broader than the presented case study, has observed an evident lack of support for refugees playing football in Southeast Europe. This study provides empirical evidence on the potential of football for refugee integration in the host society, and how football can be successfully used to create positive changes in society, not only for refugees but also for the local society. The fact that Hestia FC is a women's football team, established only recently, in a country with around 80,000 refugees, speaks for itself: football for refugee women is yet to be developed. In this sense, the case presented in this paper is an example of good practice and an initiative to be supported by European Union (EU) public funds and other donors. Integration at work, as presented through Hestia FC, indicates that the process should start from the refugees, and demands the participation of members of the local community who should be able to listen to refugees and reply appropriately to their needs. Mutual confidence, trust and respect are of paramount importance in this process. In such a way, both "sides" win and are able to develop social bridges in other aspects too. Essentially, they can successfully bridge the gap which, at the beginning of the arrival of refugees in the host society, evidently exists between the local community and refugees. How the integration of refugees through a women's football club can be successfully achieved is clearly explained by Katerina Salta: "Many times many people in this world start something in order to support others. But if you don't take into account their desires, their needs, and you just apply what you think is better... If you think that you are superior, that you know better than a refugee because you went to university, and she didn't, or you have been working for the last 20 years and she has only been a mother, we are doing something wrong. And in this way, you begin to support, but in the end, maybe, just maybe, you end up harming them. So, do not harm! And in order not to do harm, you also have to protect yourself. To put boundaries, to have balance, protect yourself in order to be able afterwards to support another human being. Do not harm".

However, an open question arising from the research, to which further study should provide an answer, is the following: will Hestia FC find necessary support from the local community, from wider society, from national and European programmes, from national and international football associations, and from all other relevant stakeholders, in order to continue and broaden its activities?

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## CROATIAN POLICE OFFICERS' SATISFACTION WITH RUNNING WORKOUT PROGRAM AS IMPROVEMENT TOOL FOR POLICE PERFORMANCE

Ruža Karlović<sup>1</sup>, Ivana Glavina Jelaš<sup>1</sup>, Jurica Pačelat<sup>1</sup>, Krešimir Šimić<sup>2</sup>

<sup>1</sup>Police College, Zagreb, Croatia

<sup>2</sup>Brodsko-posavska County Police Administration, Croatia

**Introduction:** Running as well as exercise in general beside physical improves mental health (Skead & Rogers, 2016) and cognitive abilities (Rassovsky & Alfassi, 2019; Cotman, Christie & Brechtold, 2007) which are very important for police work. The aim of this study was to analyze police officers' satisfaction and perceived benefit of running workout program regarding their mental health and performance.

**Method:** First, the whole group participated in an assessment of the 1000-meter run, and participants were assigned to experimental or active control group based on their score. Participants were divided into groups in such a way that it was possible and practical to implement training program, while two groups were similar in most measured characteristics. Former sport experience was also taken into account (measured at baseline by questionnaire created for the purpose of this research). The study was conducted on 31 subjects (14 experimental, 17 control group). After the completion of the 8-week program the respondents completed evaluation questionnaire. It was consisted of 9 questions (satisfaction with program; satisfaction with the organization; satisfaction with the trainer; program usefulness - psychological wellbeing; program usefulness - physical wellbeing; motivation to continue with exercise; program usefulness - job performance; program usefulness - mental health) on which respondents answered using 5 point Likert scale with the possibility of written comment to each question. 4 final questions (applying reasons; most useful segments; disappointments; group functioning) were open ended.

**Results:** All of the officers were highly satisfied with the program. Only for two questions the mean was below 4,5 (physical wellbeing; continuation with workout). On other questions mean was above 4,8. Subjects consider program very useful for police performance and mental health. Officers were highly satisfied with the program in general and its organization. They perceived that the program improved their psychological wellbeing. Man – Whitney U test showed that the only statistically significant difference between experimental and control group was the motivation to continue with the running workout in the favor of the experimental group.

**Conclusion:** Police officers were very satisfied with the conducted running program. They perceive it very useful for police work, performance and mental health. This research implicates that officers are interested in these kinds of programs which should be provided to officers as a good mean to improve their performance and mental health.

**Key words:** *police, running, workout, performance, health*

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## SPORTS ORGANIZATIONS AND COMMUNITY DEVELOPMENT: THE EXAMPLE OF FUTSAL DINAMO FOOTBALL CLUB

**Rašeljka Krnić**

*Institute of Social Sciences Ivo Pilar, Croatia*

### Abstract

When we talk about social development in general, and thus about the development of local communities, there is a significant increase in expectations towards various organizations regarding social responsibility and contribution to community development. Such expectations, in the form of a certain type of participation in development processes, apply also to sports organizations. Professional football clubs historically had a significant connection with their local communities. Projects under global “Football in The Community” program can be found within the vast majority of professional football clubs since the early 1990s, and although the FITC was originally conceived as one of the measures to combat the consequences of hooliganism back in 1975, today it has developed into initiative that has serious ambitions to address various social issues in partnership with the public and private sectors. In this paper, a part of the data obtained by the ethnographic research of the Futsal Dinamo club, conducted within the HORIZON 2020 project CHIEF (Cultural Heritage and Identities of Europe’s Future), will be presented and analyzed. We were interested in which ways the Futsal Dinamo club got involved in the global project Football in the Community, ie how this local indoor soccer club from Zagreb contributes to the development of the local community.

*Key words: sports, local community, community development, football in the community*

### Introduction

The concept of “community” in the academic literature is applied and defined in different ways, however, in most cases the definitions contain terms such as solidarity, participation, cohesion, collective action, loyalty and commitment (Gosling, 2008; Purdue et al., 2000; Taylor, 2003). Furthermore, a community is described as a network of local social relations often determined by some type of reciprocity and emotional connections among its members (Schulenkorf, 2012). Considering all these elements, Alonso and O’Shea believe that the community “can be conceptualized as an environment where individuals live, interact, build social networks, and have a sense of belonging” (2012: 657). Although within academic discourse there are unquestionable differences in understanding of the concept of community participation, the foundation of the idea of participation implies “building from below”. In other words, it implies development that is primarily initiated within the community itself, by the contribution of its members. In this sense, any type of community development project implies respect for the local context and active planning and participation of community members in the decision-making process through dialogue with various social actors (Alonso and O’Shea, 2012; Reid, 2006; Sanoff, 2000).

When we talk about social development in general, and thus about the development of local communities, there is a significant increase in expectations towards various organizations in the context of social responsibility and contribution to community development. Such expectations, in the form of a certain type of participation in development processes, apply also to sports organizations (Coalter, 2007). The role of professional sports is closely related to the entertainment industry (Knobloch-Westerwick et al., 2009), however, it is increasingly becoming a “space for community building and positive social outcomes” (Alonso and O’Shea, 2012: 657). Sport is, according to Alison (1998), an extremely important agent in the process of creating a civil society, and King (2000) emphasizes its important role in creating and nurturing local identities and social cohesion. Local sports clubs are an important component of formal and informal social networks that support the creation, development and maintenance of social capital, and those based in the local community provide an opportunity for community members to meet regularly and for club members to participate in wider social networks through various formal and informal mechanisms associated with sport (Cuskelly, 2008). While twenty years ago it was much harder to find development projects that relied on sport as a driver of social change, today the “sport for development” initiatives are significantly more present (Schulenkorf, 2016). Various development projects are increasingly relying on the “use of sport to exert a positive impact on public health, the socialization of children, youth and adults, the social inclusion of disadvantages, the economic development of regions and states, and on fostering intercultural exchange and conflict resolution” (Lyras and Peachey, 2011: 311)

Professional football clubs have historically had a significant connection with their local communities (Stone, 2018). The idea that sport, and especially football, can have a wider range of social functions dates back to the 19th century, but the formal participation of sports organizations in social development projects dates back some thirty years (Sanders et al., 2014). Projects under “Football in The Community” program can be found within the vast majority of professional football clubs since the early 1990s, and although the FITC was originally conceived as one of the measures to combat the consequences of hooliganism back in 1975, today it has developed into a program that has serious ambitions to address various social issues in partnership with the public and private sectors (Watson, 2000).

In this paper, a part of the data obtained by the ethnographic research of the Futsal Dinamo club, conducted within the HORIZON 2020 project CHIEF (Cultural Heritage and Identities of Europe’s Future), will be presented and analyzed. In this research we were interested, among other things, in which ways the Futsal Dinamo club got involved in the global project Football in the Community, ie how this indoor soccer club from Zagreb is contributing to the development of the local community through participation, creation and implementation of various projects and activities of wider social significance.

## Methods

Ethnographic research on Futsal Dinamo futsal club was carried out during the 2018/2019 season. Research began on 6 October 2018 and was concluded on 10 May 2019. The participatory observation method included thirteen Futsal Dinamo home matches, as well as three other events not directly tied to matches - these were a music event, an art exhibition, and the club’s yearly assembly. A total of 25 field diary entries were recorded, as the researcher frequently spent time with Futsal Dinamo supporters in informal situations outside the context of field research. At the end of field research, a total of twelve interviews were carried out; two were with the club’s secretary and former president, three were with club volunteers, and the rest were with supporters. The shortest interview lasted 22 minutes, while the longest lasted 1 hour and 10 minutes. The interviews were carried out in food and beverage outlets in various locations in Zagreb, Croatia. The researchers did not find themselves in any ethically questionable positions during the research. All participants in the research were guaranteed their anonymity, and each respondent has been provided with a pseudonym. Also, all respondents consented to participate in the research (they signed a consent form), and in accordance with the law, they were informed of all the conditions under which their data collected during the research would be used. Conversations were recorded using a Dictaphone, and the records were stored in the researchers’ private databases.

## Results and Discussion

Futsal Dinamo is an indoor soccer club founded on March 21, 2012, in Zagreb. In the spring of 2014, members of the GNK Dinamo fan group, the Bad Blue Boys, came up with the idea of founding their own indoor soccer club to gather Dinamo fans at its matches and to continue the tradition of cheering for Dinamo in Zagreb. It is important to emphasize that during this period repression, blacklists and a large number of bans removed many Dinamo fans, primarily ultras, from Maksimir Stadium. “Blacklists” are managed by the club and by the police without the court while “bans” usually apply to court decisions. In the background of the long-standing conflict and the generated frustration of some Dinamo fans was the disagreement with the club’s administration about the organization and management of the club. Dinamo fans persistently warned the public about the presence of criminal acts in the management of the club. Two quotes from the fans and volunteers in the club well summarize some of the elements of the repressive behavior of GNK Dinamo’s management towards their fans. They serve as an illustration of the background context of the decision to establish a new club:

*The blacklists issued by the club management, on a daily basis and in agreement with the police, forbade access to the stadium to anyone who was in any way in conflict with the management. (Sumi).*

Also, the following quote shows that the consequences of this conflict went beyond the domain of football and sports and began to affect the daily lives of fans:

*It was no longer normal, stripping you naked at the entrance to the stadium, you don’t know if you will have problems at work if someone sees you somewhere, really an abnormal situation (Nod).*

Futsal Dinamo indoor football club is conceived as the antithesis of GNK Dinamo, where fans and all those who support the club will be actively and equally involved in the organization of the club. As the Futsal Dinamo already existed, the BBB established contact and teamed up with the club’s founders. It was soon decided that Futsal Dinamo will operate according to the membership model “one member - one vote”, according to which all club members in democratic elections have the right to elect their leadership, which then has absolute autonomy in the sports and organizational segment of the club. For most of the members we spoke to, this was an extremely important dimension of organization and future functioning of the club, but not exclusively in the club context but as a principle they see as a generally desirable and



potential role model for the functioning of the wider community and society. In this sense, the role of the club in the promotion of democratic principles and values is especially important to some of its members:

*It is a problem that people do not believe in democracy anymore and that is why they need to be further educated. Our club can play a role in that. It is also one of the tasks of the club, to educate society, to teach people that they can influence some processes in society and that they can question the processes (Novinar).*

The antagonism between GNK Dinamo fans and clubs management showed an interesting transformation of the confrontational element into innovation, where one of the main aspects of fan dissatisfaction was the fact that GNK Dinamo is no longer a homogenizing factor for its fans and how, according to them, the club is fully separated from Zagreb and its fans. With the implementation of the “membership model”, the fans wanted to return the “spirit of the club to the city”, but also emphasize the importance of a sports club that contributes to its own community, and that the community, on the other hand, can identify with that club and its activities. From the very beginning, in various ways, Futsal Dinamo tried to get closer to those who follow the club, but also to other members of the community. One of the main goals behind founding the club, also stated in the club’s statute, is to gather citizens, especially young people, to play amateur and professional indoor soccer through the indoor soccer school. One of the members and volunteers points out:

*We want to be present, we want everyone who wants to be able to train to come, it's not OK for children to be prevented from participating in something like this....I mean, it's the only club that has a children's corner, where everyone can play on the field at halftime or before the game...This is the only club that gives you some kind of upbringing. We want you to have a club in you from a young age and to make you feel like part of that club. Many public figures help us with that, and we also have numerous programs, membership week, tournaments, cultural things, etc. (Novinar).*

From its establishment the club organized numerous initiatives, including the promotion of sports in the community through socializing with the club’s players and organization of few cultural events. As already mentioned, our research was not only limited to going to club matches but was also conducted in the context of informal gatherings during events organized by fans. Such events, according to some members, are of great importance for the club, because by offering various content to the community, the club increases visibility and influence in society. As an illustration of the diversity of activities organized in the wider local community, it is important to mention setting up an exhibition dedicated to the Dinamo club and its history, arranging clubs cooperation with a theater in Zagreb (where club members have a discount on tickets), organizing pub knowledge quizzes and a big music concert in one sports hall in Zagreb. Furthermore, as a form of activity for the benefit of the community, the participation of Futsal Dinamo members and players in numerous humanitarian initiatives is very important - from helping adults and children with special needs to raising funds for the reconstruction of Zagreb elementary schools and for victims of various accidents.

*We are happy when we can help in some way, it is important for us that people realize that the club and its fans are not separated from the community and that we are ready to help our fellow citizens when needed (Boki).*

With their programs and activities, management and fans want to increase the level of recognition of the club within the local community and thus gain the sympathy of people who are not necessarily passionate fans but feel a certain level of identification with symbolic aspects of Dinamo, city of Zagreb and Zagreb’s sports in general. The symbolism of the club’s return to fans is crucial, as many respondents in the research emphasize through interviews, however, their activities can be viewed through the prism of various theoretical aspects relating to sports and the local community, discussed earlier in the introduction of the paper. In clubs specific philosophy, politics and organizational approach we can recognize two concepts. The first refers to the symbolic building of the community through sport, in this case through the activities of a local football club, with the idea of creating and strengthening a collective identity rooted in the local. Building and strengthening social cohesion through joint, intergenerational participation in different activities exist as a goal of many initiatives within larger and smaller football clubs in the context of the umbrella program “Football in the Community”. Another aspect which can be recognized relates to the intention to promote sport as a possible generator of social change. Critical questioning of social processes through the promotion of democratic participation, pointing out the importance of social inclusion of the most vulnerable groups in society, demonstration of solidarity and collective action as instruments of social change all indicate an attempt to influence social processes by implementing projects that reflect recognized needs of the local community. Futsal Dinamo, as a social agent, through its activities provides a context for the interaction of various social actors and thus the creation of wider social networks, which results in the strengthening of social capital. Emphasizing the inclusion of children and youth in sports in the context of contributing to the development of the local community means encouraging the practice of healthy socialization and easier integration of young people into society at large.



## Conclusion

According to the club's statute, the Futsal Dinamo indoor football club was founded with the intention to promote, develop and advance indoor soccer in the city of Zagreb and with the intention to gather citizens, especially young people, to play amateur and professional indoor soccer through indoor soccer school. Although the club statute does not specifically mention any goals that would directly relate to the intention to influence the development of the local community, except through the promotion of sports, the analysis of collected data shows that Futsal Dinamo, following the example of many international sports clubs, is at different levels and in different ways actively involved in the life of the community. The establishment of the indoor soccer club Futsal Dinamo by the fans, as a reaction to the long-standing conflicts with the GNK Dinamo management, meant a shift towards acting in the domain of civil society and adoption of direct participation as a way of functioning, which meant opening up to the local community and wider society. Although it is clear that the reasons for founding Futsal Dinamo are primarily related to the football context and background political conflicts, the results of this research shows that some volunteers and members, actively involved in the club, are aware of the potential which sports organizations of this kind can have regarding their influence on local community development. In some future research, it would certainly be interesting to see how the wider local community perceives the activities of Futsal Dinamo, to what extent the programs by which the club demonstrates social responsibility are recognized, and what are the realistic achievements of specific initiatives.

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## THE POSITION OF WOMEN IN SPORT IN CROATIAN SOCIETY-A LITERATURE REVIEW

**Dora Medimorec**

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

In the history of the Republic of Croatia, sport has had a major status and great power in society, yet women in sport remain marginalized by the media, discriminated against and do not have the same opportunities as men. Female athletes do not have the societal support (generally) enjoyed by male athletes, and especially those women who gain the opportunity to work in the highest structures of sports organizations – these are very few in number, mostly underpaid, underappreciated and face gender inequality. Under the guidance of the International Olympic Committee and Council of Europe, implemented in Croatia by the Croatian Olympic Committee and Central State Office for Sports, there is an aspiration to slowly increase the number of women in sport organizations at all levels and in national sport federations. A global women's rights movement in Croatia has finally begun: feminism is on the rise and sportswomen are *acknowledging* their power and obligation to influence and empower a younger generation of girls and women in sport. The difficulties for women in sport is something we need to resolve and not just talk about. Finding a way to improve and upgrade girls and women's participation in sport is essential to reap the associated social, mental and physical benefits. This literature review will, unfortunately, show how little scientific research has been done and published in Croatia, and hopefully result in some changes being made in the future.

**Key words:** *women in sport, gender equality, discrimination, media, Croatian society*

### Introduction

During the antique Olympic games, only men were allowed to participate in competitions. As the creator of the modern Olympics said, "The inclusion of women at the Olympic games would be impractical, uninteresting, unaesthetic and incorrect," (Baron Pierre de Coubertin, 1912; cited in Coakley, 2016). Many changes have occurred since then. In today's Olympics we do have national teams that consist of both male and female athletes in the same sport.

The problematic area to work on here, is on considering the role of women in sport and the role of female athletes generally in Croatian sport and society, with particular reference to their presence in various hierarchical levels of management, media, and their role and position in top-level Croatian organizations like the Croatian Olympic Committee, National Olympic Sports Federations, National Non-Olympic Sports Federations, the Croatian Paralympic Committee, National Sports Federation and other high-ranked sports organizations. In addition, gender equality in sport for girls and women of all ages, regardless of sport, ranking and media presence, is important for educating young girls. This kind of inappropriate media approach to women in sport is surely responsible for the lack of interest in women in sport in general and making female role models to give women's sport a high-level of presence. Female athletes, coaches, kinesiologists, female members of sports organizations, journalists, and high-ranking sports management figures are key for education, inclusion and promoting gender equality through their example and for one day being a role model to young girls in their society or worldwide. The discrimination of women in society is not a new topic of discussion. We can refer to Simone de Beauvoir's book *The Second Sex*, originally published in France in 1949, where she said: "Enough ink has been spilled in quarreling over feminism, and perhaps we should say no more about it. It is still talked about, however, for the voluminous nonsense uttered during last century seems to have done little to eliminate the problem. After all, is there a problem? And if so, what is it?" (Beauvoir 1949). To emphasize, almost 70 years later we are still talking about an old problem but in a new way, in different fields and with different issues that women generally face in society, especially in sport. Despite the legal regulation from the Council of Europe and the government of the Republic of Croatia, women in sport are still a minority with no concrete plan for integration into the highest structures of sports organizations or levels of management of any kind. When discussing media representations of women in sport, in developing the page "Women and Media," some things are starting to change. Equal rights, payment, an increase in the share of women in the management structures of sports associations and other sporting organizations and a guarantee of female athletes' equal access to sports infrastructures, alongside professional training, development and employment in the field of sports did not yield satisfactory results as measured over the years by the Croatian Olympic Committee. Moreover, of the 116 members of the Croatian Olympic Committee Assembly, only 8 are women, while in the 60-year history of the Faculty of

Kinesiology, University of Zagreb, there have only been two female deans. Consequently, the aim of this literature review is to find literature on women in sport in Croatia from the first published paper in 1998 up until this day, by employing a content analysis of documents organized by key words.

## Methods

The research methodology is based on observations of texts, articles, scientific research, documents from international and national conferences and congresses, paper reviews and other printed or online articles on the subject.

They have all been searched with the keywords written in the abstract connected with women and sport in general and ordered by content analysis in Table 1. The main aim was to establish how much work has been published by the highest-level sports organizations in Croatia such as the Croatian Olympic Committee, the government of the Republic of Croatia, the Central State Office for Sports and the Faculty of Kinesiology. They were chosen in accordance with the criterion of their focus on women sport, female athletes, women in sport management, feminism and feminism in sport, discrimination, women's position, and other topics regardless of whether they related to sporting environments, famous athletes or sporting events. As this was preliminary research, it does not include marketing coverage, promotion videos of a certain sport or newspaper articles. I reviewed internet databases from the first published articles in 1998, up to 2020. These included: Web of Science, Merlin, Hrčak, Google Scholar, Crosbi, the Library of Croatian Olympic Committee, DOAJ, and libraries such as the National and University Library in Zagreb, the Library of the Faculty of Kinesiology, the Faculty of Humanities and Social Sciences Library, the City of Zagreb Library and local libraries.

## Results

The aim of this paper was to number the published bibliographies and complete a content analysis of papers on women in sport and female athletes' gender equality in Croatia. As seen in Table 1, there were only 20 articles published on the subject. Prior to this work, there was true evidence of a lack of articles on gender inequality, differences, discrimination and an absence of proof that women exist and work in sport. To explore this issue, 20 published articles available to the public and academia have been analyzed, as well as different sociological and human rights articles and students' research.

Table 1.

PUBLISHER	YEAR	TITLE
	1998.	Paper of Commission on Care for Women in Sport year 1. Number 2.
	1999.	Paper of Commission on Care for Women in Sport year 2. Number 3.
	2007.	International Seminar Sportswoman: From results to a career in sports: [collection of papers])
CROATIAN OLYMPIC COMMITTEE	2012	V. seminar for women coordinators in sport "Toward Olympic games London 2012.
		Both sides of medals – win to win models in sport: report
	2015.	Croatian sportswoman at the Olympic games Jurica Gizdić
	2018.	Gender Equality in Sport: Proposal for strategic action 2014.-2020.
	2019.	European Olympic Committees, EOC Gender Equality Commission Strategy 2019. -2021.
	2011.	National Policy for Gender Equality for the period 2011- 2015
		Declaration at the 10 <sup>th</sup> European Conference on Women in Sport, London. Guide for the Organization of Gender-Equal Sports Ceremonies
GOVERNMENT OF REPUBLIC CROATIA	2015.	Ministerial Committee of the Council of Europe state-members on gender-aware politics in sport
	2017.	Law on the equality of genders. Editorially cleaned text of the Law NN Gender equality in sport: accessibility of sport activities for girls and woman, Talleu C.
	2019.	Prevention and the struggle against sexism
CENTRAL STATE OFFICE FOR SPORTS	2019.	National program of sport 2019–2026
AGENCY FOR ELECTRONIC MEDIA	2019.	Recommendations for better monitoring of women's sport in electronic media
		Women in elite sport Šalaj, et al.
FACULTY OF KINESIOLOGY	2009.	Representation and perception of women athletes in the media Barbaros Tudor, P. et al.
(CONFERENCES AND CONGRESSES, COLLECTION OF PAPERS)		The attitude towards women's football in a rural environment Bosnar, K., Kovačević M.

	2013.	Differences between women and men at the level of achievement, engagement and attitude of sport, Lauš, D. et al.
	2015.	Gender equality or differences on the cover Croatian sports magazine "Sportske novosti" Penjak, A.; Karninčić, H.

The highest-level sports organization in Croatia – the Croatian Olympic committee – is aware of the current problems that women are facing in sport, so on 19 December 1996, the Commission on the Care for Women in Sport was founded and since 2015 it has worked as the Gender Equality in Sport Commission. They have published several guidance papers on the equality of sexes in sport, all recommended by the Council of Europe. These have included the following: Recommendation of the Committee of Ministers to the Member States on Preventing and Combating Sexism, and the Handbook on Good Practices of Gender Equality in Sports Croatia 2017, All in – Toward Gender Balance in Sport. These are promoting the inclusion of women in sport by raising awareness of some key indications of gender equality such as: participation, the training process, leadership in sport, gender-based violence, and media representation. Their aim is to support a policy based on evidence-based analysis and develop concrete material and activities to improve gender equality for women in sport. The Gender Equality in Sport Commission, Croatia has published a book based on the international seminar "International Seminar Sportswoman: From Results to Career in Sports: [collection of papers].(2007) All papers were written by women who succeeded in sport, from women in leading positions in sport organizations like National Sport Federations, to Olympians, sociologists and journalists. Some of the conclusions are from 2007. The seminar argued that we cannot build a democratic Republic of Croatia without women. To paraphrase a sentence from the introduction, democracy without women is not an imperfect democracy, it is not a democracy. The most interesting papers included those written by Gordana Borko, general secretary of the Gender Equality in Sport Commission, whose quantitative analysis considered all structures of women in sport: in leading roles in organizations like presidents, general secretaries, referees, coaches, doctors etc. She also analyzed the percentage of women in national sport federations in Croatia. These are the topics that appeared about 13 years later in a seminar for female coordinators to be presented with recommendations for better coverage of women's sports in the electronic media in Zagreb in 2019. The Agency for electronic media released a guidance book for reporting, publishing and posting news, videos, interviews and for covering women in sports news in general. The government of the Republic of Croatia released six publications on gender equality, the visibility of women in sport in the media, and the most important gender equality law that created a solid basis for continuing the work of the Gender Equality Office that published the recommendation for the inclusion of women in sport. Researching the webpage of the European Institute for Gender Equality in the gender statistic database of Women and men in decision-making positions in national level of sports in the 2019 base of national sports federations, based on a sample of the top ten most popular Olympic sports in each country, we find that among the members of the highest decision-making body in Croatia, men represent 90.9% and women 9.1%. This is concerning and it will take a lot of work to make the equality of men and women a reality. Papers published from Faculty of Kinesiology include papers from conferences and congresses and they are in general connected with elite female athletes, professional athletes and pointing the differences between man and women in sport; however the students are starting to do more researches on this topic in their final thesis and trying to make the change of perspective for women in sport and Faculty of Kinesiology. One of the most important paper was written on perspectives of women in top sports that can be viewed from a biomedicine and social point of view. In the training process, with the aim of optimizing competitive activity and reducing the possibility of injury, trainers must understand the specifics of the structure and function of the female organism and adapt the training to female athletes. (Šalaj et al.,2009). Bosnar and Kovačević (2012) published a paper on the female football clubs in Croatia, and attitude towards woman's football in rural environment. To point out the problems faced by women athletes when it comes to the media, Barbados Tudor et al. (2009) wrote a paper on women's sport that started to attract media attention and more space in daily news.

## Conclusion

Little has been written in Croatian society about women in sport. We need to work harder on trying to change perspectives on feminism and gender equality, on creating a better future for young girls through the education of men and women, on inspiring and empowering women through female role models, aspiring to a society where women and girls are valued, and have equal choices and opportunities to lead and participate in sport. Increasing the share of women in all societal structures, especially in sport where they are obviously discriminated and unequal, will ensure new prospects for young girls and women, so as to have an easier path to success one day. We need to educate a future gender inclusive sport culture, where major women sporting events are secured and showcased, where more women participate in leadership positions on and off field, and where we have sports facilities that meet the current and future needs of women in sport, as well as the sports fans. We have witnessed a fundamental shift in society over the last half century, and nowadays women have more options to be themselves, to use their voice and make changes in sport in Croatia and worldwide.

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## PLAYING TO OLD RULES: PROFESSIONAL SPORT OF SOCIALIST YUGOSLAVIA AND ITS TRANSITION TO CAPITALISM IN THE 1990S.

Nikola Mijatov

*Institute for Contemporary History, Serbia*

### Abstract

In the socialist Yugoslavia, by its socialist ideology everyone had to be a part of the 'working people' as it was (in idea) a 'land of the working people'. However, professional sport has different set of rules where it ideologically stands far from socialism and in fact holds within the ideology of Laissez-faire capitalism: instead of profit the only thing that matters is the (sports) result. Consequently, in order to have professional sports and attain prestigious sports achievements for the country, Yugoslavia had to compromise and allowed the emergence and the establishment of professional athletes in a socialist country. Officially, they were called 'non-amateurs', but in reality they had all the conditions as their 'capitalist' colleagues from the West. With the fall of socialism in the 1990s, new former Yugoslavian countries had to play to new capitalist rules, except for their professional sport whose transition was in fact unnecessary.

*Key words: Yugoslavia, socialism, professional sport, transition*

### Introduction

Socialist world in the 20<sup>th</sup> century was determined by its ideology. The 'vanguard' was USSR and it served as a role model for other authentic revolutions. One of such was the Yugoslav partisan revolution that emerged victorious from the WW2.

A new Yugoslavia was being built from 1945 led by the ideas of socialism. Former illegals and partisans, leaders of the Communist Party of Yugoslavia (CPY) were now leaders of the new socialist Yugoslavia. Pillars of its socialist ideology were set by the high-ranking party official Edvard Kardelj.

The essence of this ideology was that everyone was or were to be equal and contribute to the building of socialism in Yugoslavia. Everyone had to be, as Kardelj defined, a part of the 'working people' (Kardelj, 1984). On the other hand, Yugoslavia needed elite sport as an instrument for its international reputation. For elite results, professionalism in sport is necessary as the rules of competitions are ideologically far more similar to Laissez-faire capitalism than Yugoslav socialism. Clearly a compromise had to be set and professional sport within the ideology of socialism in Yugoslavia played to different rules. Consequently, its transition to capitalism in the 1990s had to be different.

### Method

By critical analysis of archival sources of the relevant fonds, as well as the relevant literature, the position of professional sport in Socialist Yugoslavia is analyzed both on its ideological perspective and in its manifestation in reality. Adding to this, its transition to capitalist rules following the breakup of Yugoslavia in the 1990s is analyzed by tracing fundamental changes within sports societies that had to adapt to new capitalist rules in its newly independent countries.

### Results

In the sphere of ideas, professional sport is opposing to the idea of socialism. For achievement in professional sport the only thing that matters is the result and everybody has the same opportunity to achieve it. Ideologically it is closest to Laissez-faire capitalism while instead of result it is the profit that only matters in this theoretically purest form of capitalism. Imperative for more profit is also very similar to Olympic motto: *citus, altius, fortius* (faster, higher, stronger) (Coubertin, 2000). As the essence of professional sport is this imperative, the philosophy of it could be characterized as 'sport Machiavellianism' (Radoš, 2010). There are some exceptions to this rule, as even in professional sports a perfect model of Capitalism could not exist. There are several 'free market' restrictions, for e.g. up until the Bosman's rule in 1995, players could not transfer to other clubs freely. Still, even as such, professional sport is ideologically closest to the theoretically purest form of Capitalism. On the other position in ideological specter, socialism emphasizes human and place him in the center of its ideology. Adding to this, in the idea of Yugoslav socialism everybody was or were to be a

part of the 'working people' (Kardelj, 1984).

Interestingly, other Olympic motto that is closer to the ideas of socialism – the importance of pure participation – was neglected by the socialist Yugoslavia. In the London Olympics in 1948, Yugoslavia sent as many athletes as possible so that everyone would have a chance to participate in the event. However, due to the catastrophic result that were reflecting the success of Yugoslav socialism, for the next Olympic games in Helsinki in 1952 the order of the general Dušan Korać was clear: there would be 'no sense' sending those that do not have a chance of winning medals, 'neither from the sports aspect as well as the financial aspect'. (Korać, 1952). Sport expert Branko Polić complied: 'We have to send those who have the highest chance of winning' (Polić, 1952). Thus, socialist Yugoslavia only embraced the most capitalist part of the Olympics ideology.

On the individual level, socialism strived to build a complete human – Homo Sovieticus, or in Yugoslav terms – Homo Yugoslovenicus (Mijatov, 2019). A new human had to be versatile unlike their narrow specialization that capitalist system produces (Engles, 1973). When it comes to sports, again professionalism is more closely to capitalist ideology minding the fact that elite athletes are highly specialized in their chosen sport but are also highly undeveloped in other areas of human development due to the demanding level of commitment that is essential for elite result (Skembler, 2007). Consequently, building of Homo Yugoslovenicus was impossible in professional sport, or as it was noted about the football player of "Hajduk" at the Unions of Croatia in 1948: "You cannot allow for them to live in socialist Yugoslavia and that their head is being turned into a football because they do not do anything else" (Kladarin, 1948).

On the I Congress of Alliance of Physical Culture of Yugoslavia in 1948, the Congress where key ideological basis for Yugoslav sport was set, Kardelj stated: "The content of the whole creative life today in Yugoslavia can not be apart of the content of our physical culture – to create a human that who will willingly join the development of new Yugoslavia and who will be capable to contribute the most this development, both physically and mentally". An athlete in socialist Yugoslavia had to be versatile, or as Kardelj defined: "The real physical culture, as our should be, do not improve humans only physically, but also mentally, culturally and professionally". This new socialist sport had to be completely different from the old capitalist sport of Kingdom of Yugoslavia where it produced, as Kardelj noted, "physically strong machines that could serve the capitalist economy" (Kardelj, 1947).

However, in 1945 for Yugoslavia it was clear that in the Cold War world a country international recognition was being build, among other factors, by sports results. In a World divided by two confronting ideologies, socialism and capitalism, each sports event was perceived as a test for the successfulness of countries ideology (Riordan, 1974).

For elite results a professional sport and professional approach to sport is necessary. Yugoslav politicians had to compromise: professionalism was a part of Yugoslav socialist sport from the very beginning in 1945. Professional athletes were defined as 'non-amateurs' while in fact they were professionals. Two models were set in order for athletes to have a quality of life which would allow them to strive for top results: food money and fictional jobs. They could not receive a salary for being elite athletes so they received money for food that was justified by their need for special diets. These diets consisted extra calories that were required because of their sports activities. In reality, this money that was given for food was more than enough and in fact was an unofficial salary for achieving top results. Officially it was called 'help for the maintenance of fitness of athletes' (Konferencija FISAJ-a, 1952). When it comes to jobs it was clear that they could not work 'normal' jobs with full employment because that would surely leave bad consequences on their fitness and results. Still, they had to be a part of the 'working people' and they had to have jobs in order to justify state's ideology. The solution was a hypocrisy: elite athletes received fake jobs in which they only be singled in but would receive salary. The money was in fact a payment method for their sportsmanship (Mijatov, 2019).

All of this produced hypocrisy on the national level and irony was that the model was set by the communist Government which promised equality but clearly singled out elite athletes as a privilege part of the society. Consequently, for e.g. there were football players of Partizan that were full employees in the Army but their only task was to set the time on army's watches (Dedijer, 1969). Other example is more illustrative: football player, Marčetić Đuro, when asked in 1949 how he lives, he stated: 'I live good, travel through Yugoslavia, eat at the best hotels and I do not do a thing' (Marčetić, 1949). In those years Yugoslavia was going through post-war scarcity and such way of life that Marčetić have had was quite exceptional. Nevertheless. In the following decades, football player were portrayed in public as modest and hard working, an role model for the people of socialist Yugoslavia while in reality elites among them were living the luxurious life (Zec, 2016).

All of this had its price. Elite athletes in order to become or to maintain that privileged status had to achieve elite results. Officially, athletes had their 'professions', in reality made up jobs, but in fact they were professional athletes who instead of 'normal' salary would receive payments in other methods. Still, all other negative effects of elite athletes' lifestyle were also present within Yugoslavia's elite sport. Versatility was the trait that suffered most and was completely opposed to principles of socialism and its aim for a new human (Homo Yugoslovenicus). For elite results a narrow specialization is necessary so athletes were masters in their chosen sport, but undeveloped in other areas of human development. Even in physical aspect, elite athletes of Yugoslavia were specialized: in 1950 it was evident that the training of basketball players was orientated on achieving as many points as possible. Consequences were physical, as leading Yugoslav expert

of physical culture Mile Čubrić noted: “So, comrades, is a goal to create some sort of humans that will really efficiently score points, to create humans that are high, bony, with hunched spine etc, or to create humans that will be perfect base for numerous diseases. Is that our goal? That is not our goal and it should not be“ (Čubrić, 1950).

It was up to politicians to set the goal and not the experts. Politicians wanted result because they reflected Yugoslavia in international terms and contributed to countries reputation in the Cold War. The government tried to tackle professionalism in sport but were warned by physical culture expert and faculty professor Nikola Kurelić who highlighted that in order to achieve elite results, elite athletes must have an ‘special’ condition of life. Kurelec said directly to high ranking party official Veljko Mićunović: ‘at each and every quality competitor there is an extraordinary physical and physiological effort’ and Yugoslavia must find a model to ‘give our athletes something that will enable them to keep their condition’ (Konferencija FISAJ-a, 1952). That ‘something’ were the same conditions that were available for elite athletes in the capitalist West, conditions that were at the same time necessary for top results.

Consequently, leaders of Yugoslav Communist Party established a category with an illustrative title: ‘non-amateurs’. It is clear that the difference between amateur athlete and a professional one is in the income. While amateur athlete does not earn his living through sport, a professional earn his livings of sport and his income depends on his sports results. For a socialist ideology and Kardelj definition of the ‘working people’ and institution of ‘non-amateurs’ was just a pale cover up of the establishment of professional athletes. Furthermore, elite athletes could even receive retirement as the assembly of Yugoslavia voted in 1977. fore regulations that had established retirement funds for the elites (Tubić, 2005).

On the other hand, amateur sport in socialist Yugoslavia was thriving. Professionalism was reserved for the elites and more precisely: for the elites of certain sports. Football was the main place of professionalism while other sports that were not so popular were dominantly based on real amateurism. Even in football, professionalism was only on top, reserved for the best player while other clubs worked on amateur level.

In, essence Yugoslav ‘socialist’ professional athletes were similar as their colleagues form the capitalist West. They were living as professionals and their quality of life depended on the sports result they would achieve. Behind them there were thousands of amateur athletes that were the core of Yugoslav socialist sport while handful of professionals represented the best among them and enjoyed numerous privileges.

## Discussion

Socialist model of professional sport was quite successful. Elite athletes had special, but unofficial, status among ‘working people’ and all necessary conditions for achieving top results. Consequently, socialist Yugoslavia was quite successful in elite sports through the Cold War (Tubić, 2005).

Still, socialist world was not everlasting: it crumbled with the fall of Berlin wall in 1989 (Hobsbaum, 2004). Yugoslavia was torn apart by civil war that was followed by transition to capitalism. New countries established in the 90-ties had to reconstruction and embark on a long and painful journey of transition to modern capitalist states. Everything had to be remodeled and reshaped in order to comply with the capitalist ideology that for its goal had profit.

However, did professional sport had its transition? Minding the fact that it played to capitalist rules from the beginning, from basically 1945, no essential transition was necessary. Capitalist rules were in the core of professional sport in socialist Yugoslavia and it was ready for capitalism. The model was similar as in the USSR where during Gorbachov’s Perestroika soviet sport gradually embraced capitalist rules, while soviet elite sport played to these rules all along (Riordan, 1990). In Yugoslavia, only changes that were necessary were on the surface: socialist ideology had to be removed from professional clubs and they had to rebrand in order to adjust to new ideologies of successor states (Mills, 2018). For e.g. football club Dinamo changed his name to Građanski because the name ‘Dinamo’ reflected socialist ideology and was in fact just a pale copy of Moscow football club that carried the same name (Riordan, 2010). Nevertheless, football club even during socialist Yugoslavia had become an ideological opposition to the state’s socialist ideology as ‘stadium nationalism’ became ever-present during the 1980 (Previšić i Mlinarić, 2020). When it comes to players of the clubs, their task was the same, no matter of the states ideology: result.

## Conclusion

Professional sport within the Yugoslav socialism had specific position that was a consequence of the rules of professional sport and imperative of achieving elite results. From the very beginning of socialism in Yugoslavia, elite athletes were privileged from the rest of the society in terms of payment and food money. Communist government made a solution that was a hypocrisy and established a model for professional sport where by all standards professional athletes were called ‘non-amateurs’. In order to achieve or to maintain that status, athletes had only one conditions: to achieve elite results that would positively impact the international recognition of Yugoslavia.

In this micro part of the Yugoslavian society these ‘non-amateurs’ competed in their chosen sports and subdued to imperative of results that is ideologically closest to Laisses-faire capitalism and quite far from the socialist ideology. It was a micro part of purest form of capitalism in socialist Yugoslavia that was not just tolerated, but also embraced by the

government for 'higher' purposes. However, there were some exceptions to this rule. Firstly, football players could not sign a contract with a foreign club before they turn 28 years of age. Secondly, in the highest Yugoslav football league, teams were chosen not by their quality but by their geography. The "key" was to have in the most important Yugoslav football league representatives from every part of the country (even Trieste) so that state unity through football could be portrayed and imposed (Mijatov, 2019). Still, when it comes to material gains and salaries of football players in Yugoslavia, the only thing that mattered was the result.

All in all, professional sport of socialist Yugoslavia was ready for the fall of Berlin Wall as it played to capitalist rules all along. For elite athletes in order to become or to maintain the status of 'elite' only thing that mattered was the result, as in Yugoslavia as well as in successor states.

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## SOME FORMS OF EXPRESSING PEER VIOLENCE IN YOUTH SPORT: THE CASES OF ITALY AND SERBIA

Ivana Milovanović<sup>1</sup>, Ambra Gentile<sup>2</sup>, Antonio Bianco<sup>2</sup>, Stefano Boca<sup>2</sup>

<sup>1</sup>*Faculty of Sport and Physical Education, University of Novi Sad, Serbia*

<sup>2</sup>*Department of Psychological, Pedagogical and Educational Sciences, University of Palermo, Italy*

**Purpose:** The research is a part of the project Sport against violence and exclusion, founded by Erasmus + Sport 2017 Program. The main purpose of the project is to define, recognize peer violence in youth sport environment, as well as to teach coaches to prevent and react on peer violence episodes.

**Methods:** The paper presents results of desk research, based on analysis of laws which deal with social exclusion and peer violence in youth sport, as well as focus-group discussions conducted with coaches in relation to recognition and prevention of peer violence among children in grass-roots sport clubs. The research was conducted in Palermo (Italy) and Novi Sad (Serbia), during 2018 and 2019.

**Results:** Italian Government and Parliament recognized the need to govern the social exclusion and peer violence among children/youth, which is visible through The National Sport Strategy, as well as Guidelines for sport activity and physical education in primary and secondary schools and several compatible laws. In Serbia there are the Law on Youth in 2011, the National Youth Strategy and Action Plans for the implementation of the strategy. In case of both countries, it is obvious that policymakers recognized the named issue as important in wider social context. When it comes to focus/groups discussion with coaches (N=23), the main result is predominance of verbal violence among youth in sports (teasing and mockery, name calling, disregard and inflicting the feeling of guilt).

**Conclusions:** The laws and strategies in both countries are in place, but they address peer violence in sport context as minor social issue, comparing with peer violence in some other environment (i.e. schools). However, coaches believe that Faculties/Universities of Sports should somehow find a way and organize education of coaches, parents and children in order to recognize and prevent violence. The education would be useful starting point in solving this raising social issue.

**Key words:** *peer violence, youth sport, coaches, Italy, Serbia*

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## TRANSITION OF SPORTS JOURNALISM STUDIES IN THE COUNTRIES OF THE FORMER YUGOSLAVIA

**Marina Mučalo, Marin Galić**

*University of Zagreb Faculty of Political Science*

### Abstract

The political transition that affected the countries of the former Yugoslavia in the early 1990s brought about a transition of its journalism in general as well as of its sports journalism in specific. This transition has not yet been completed, and the future education of sports journalists constitutes an important element in terms of steering this process in the right direction. Despite a long sporting tradition and, moreover, great sports achievements, there is no tradition of studying sports journalism in the countries of the former Yugoslavia. The number of study programmes in journalism and communication science has increased significantly, yet few of them offer sports studies through teaching journalistic skills. Our research conducted through a case study finds that there are only three undergraduate courses whose purpose is to train sports journalists. Some universities offer independent modules of Sports Journalism, usually among other elective modules within undergraduate study programmes. A survey conducted among undergraduate students of Journalism at the Faculty of Political Science in Zagreb shows that there is a strong interest in sports journalism. As sport is increasingly coming into focus within numerous scientific disciplines, this paper points to the value of studying this content within communication sciences, especially from the points of view of journalism and media.

**Key words:** *sports journalism, university degree study programmes in Journalism, Sports Journalism module, interest in sport*

### Introduction

Numerous studies show that sport is more than playing and more than a match. Because of its massive attendance and immense popularity, sport is considered to be perhaps the most important cultural and political phenomenon of our era (Harrison, 1988, according to Bartoluci, 2013: 35). Throughout history it has been used as an 'extended arm of politics', especially in times when it was used to construct the national identity of an individual or society as a whole. There are numerous examples of countries trying to establish and consolidate their political affirmation on the international scene through sports and sporting success (Bartoluci, 2013). This was the case in Southeastern Europe as well, namely in the former Yugoslavia, where sport was used for the purpose of promoting the State, and sports journalists and the media played their part. When it comes to the media, they are often used as an instrument of party and political propaganda. The usual method is: party or state media have the task of activating, informing and organizing the audience (McQuail, 1994: 15).

The role of athletes and their positioning in the public media space evolved over years much in the same fashion the media themselves did. At the time of the Socialist Federal Republic of Yugoslavia, media control, as well as technological limitations, restricted, to a certain extent, public appearances of athletes, but also the freedom of journalistic expression. After gaining its independence, Croatia tried to use sport as a kind of window into the world in order to become as 'visible' in the world as possible (Bartoluci, 2013). Along with political and technological transition, there has also been a transition of sports journalism, a process yet to be completed. In particular, education is emphasized as a key prerequisite for training young people for the profession of sports journalists, reporters and commentators. Today, the situation in terms of offer is much different. Yet, given a great interest in this profession, present-day offer is not sufficient.

Undoubtedly, this is a large and interdisciplinary topic that is in constant transition, changing in line with social change. According to Malović (2003: 147), sports journalists deal with top phenomena, top athletes, top results, events that capture the attention of hundreds of millions of people. It was this epithet of 'top quality' to have attracted names, such as Ernest Hemingway, Norman Mailer or, in Croatia, Veselko Tenžera.

### Methods

This research was conducted through a case study and a survey. The aim of this research is investigate the opportunities of education for the profession of sports journalist within university and polytechnic studies in the region, with a prominent role of journalism students at the University of Zagreb's Faculty of Political Science.

The case study represents a type of qualitative research methods. It differs from other types in that it involves intensive analysis and a description of an individual or system connected by space and time (Hancock, & Algozzine, 2006: 26). ‘The study of a type of case study is based on the argument that understanding of human activity implies both people’s development over time and the environment and context in which a particular activity occurs (Jones, & Gratton, 2004: 114).

For this case study, Sports Journalism modules and Sports Journalism study programmes were selected as the unit of analysis. Consequently, the research and data collection by means of Google and on the official websites of universities and colleges was aimed at establishing which countries of the former Yugoslavia provide these modules and study programmes.

The method of survey is a special form of non-experimental research that uses as a basic data source personal statements of opinion, beliefs, attitudes and behaviour, obtained by means of appropriate standardized questions. (Milas, 2009: 395)

The survey aimed to examine the views of respondents, undergraduate students of Journalism at the University of Zagreb’s Faculty of Political Science on their interest in sports journalism. It was conducted during March 2019 by means of the survey questionnaire method. 170 participants (n = 170) or 45.8% of the total number of undergraduate students (375) in the 2018/2019 academic year participated. The average age of the respondents was between 20 and 21 years. The respondents were mainly female (83%).

## Results

There is no real tradition of training sports journalists in Croatia. Thus, *Sports Journalism* was introduced as an elective module at the undergraduate study of Journalism at the Faculty of Political Science in academic year 2018/2019. At the same Faculty, the original course at the undergraduate level titled *Political and Social Aspects of Sport* has been carried out from earlier on. This module provides students with a basic reflection on sports.

There is a *Sports Journalism* module among the elective modules at the graduate level of Journalism studies at the University North in Koprivnica. As part of the undergraduate study programme of Communication Studies at the University of Zagreb’s Faculty of Croatian Studies at the undergraduate study there is an elective module titled *Sports Journalism*

Libertas International University based both in Dubrovnik and Zagreb offers a complete professional undergraduate course called *Management of Sports and Sports Activities* that educates experts in managing various types of sports activities and accompanying economic service activities related to sports, recreation and tourism. The study programme focuses on management and marketing.

The Private Polytechnic VERN offers an elective module *Sports Journalism* within its professional undergraduate Journalism course. The Polytechnic of Međimurje in Čakovec offers both an undergraduate professional study programme and a specialist graduate professional study programme in *Tourism and Sport Management*. The Aspira College of Management and Design based in Split has a comprehensive specialist professional study programme of *Sports Management*.

There are two examples of the countries in the region with accredited comprehensive Sports Journalism study programmes. One such example is found in Nikšić, Montenegro and another one in Belgrade, Serbia.

The University of Montenegro, within the Faculty of Sport and Physical Education in Nikšić, offers a comprehensive undergraduate course *Sports Journalism* which comprises 41 modules. Learning outcomes include, but are not limited to, basic knowledge of sports and sports disciplines. Since 2019, there has also been an undergraduate course called *Sports Journalists and Trainers* which also offers 41 modules.

The private university *Union - Nikola Tesla* in Belgrade, within the Faculty of Sport offers an undergraduate study programme *Sport Journalism* with 32 modules. Students are educated to work in sports newsrooms in various media,

An independent module titled *Sports Journalism* is offered as elective within the undergraduate study programme of *Journalism* at the Faculty of Humanities and Social Sciences, University of Mostar, Bosnia-Herzegovina. The Faculty of Philosophy in Novi Sad, Serbia offers *Sport and Media* within the undergraduate study programme of Journalism. The Faculty of Social Sciences of the University of Ljubljana, Slovenia offers, within the undergraduate study programme of Journalism, a module called *Specialized Journalism* focused on sports journalism and understanding of sport. Similar courses can be found at some colleges in the region.

The results of the research on the interest in sports journalism among students of the Faculty of Political Science are presented in Table 1.

Table 1. Interest in the job of sports journalist

Yes		No	
m= 20 (11,7%)	f= 38 (22,3%)	m= 9 (5,2%)	f=103 (60,5%)
58 (34,1%)		112 (65,8%)	

(n=170)

Although these data are seemingly indicative of the lack of interest among female students, it should be noted that the majority of students of Journalism at the Faculty of Political Science in Zagreb are women. That is why a score of one-third of those interested confirms the supposed transition: sport is no longer solely a ‘male’ topic.

A particularly interesting question in the questionnaire questioned the views of respondents who stated that they would like to be sports journalists (58 respondents) in the context of the type of jobs in the field of sports journalism. The answers included the most common and well-known formats of sports journalism, namely (a) reporting from sports events; (b) one’s own programme, section or column; (c) interviews with athletes; (d) I do not mind at all, I just wish to get the opportunity to work in sports journalism, and (e) write your own answer. Table 2. provides the findings.

Table 2. *Desired job type in sports journalism*

Reporting	Sports programme	Interviews	I do not mind
23 (39,6%)	12 (20,6%)	14 (24,1)	9 (15,5%)

(n=58)

There is a clear interest in reporting, which is somewhat expected. Reporting is the most prominent and the most popular type of sports journalism business. The relative lack of interest in one’s own sports programme indicates the reluctance of young people to stay indoors (radio or TV studio), that is, emphasizes the need to stay on sports fields and enjoy sports competitions and atmosphere.

## Discussion

“There is no other area in which there are so many specialized editions, ranging from daily newspapers, radio and television stations to special channels, shows, magazines, and a huge number of sections and journalists who specialize in that particular field” (Malović, 2005: 305).

However, Sports Journalism modules are still a rarity at Croatian Universities, where they are elective in various forms at three universities, while Libertas University is the only one offering a complete professional undergraduate study programme. The Faculty of Kinesiology does not have a module directly related to sports journalism. In other countries of the former Yugoslavia, comprehensive undergraduate study programmes are offered in Nikšić and Belgrade, while in Slovenia and Bosnia-Herzegovina, there are only modules dealing with this topic.

One third of the respondents (about 34%) are interested in the job of sports journalist. This finding is especially surprising because it is a study that has been dominated by female students for years, this survey being no exception (the proportion of female respondents amounts to 83%). According to gender stereotypes, men tend to be more interested in sports than women, so these findings clearly indicate changes that could take place in this, so far, convincingly masculine, profession. Reporting obviously attracts the most attention (about 40%). Such a finding is not unexpected because reportage itself is a kind of ‘trademark’ of sports journalism. Another attention-grabbing format is interview (about 24%) that allows journalists to communicate with athletes and gain a different, more personal, impression of athletes. There are similar findings regarding one’s own programmes (sections, columns). A small portion of the respondents (about 16%) do not mind at all what formats they would opt for as long as they can take part in sports journalism. Only one respondent opted for “write your own answer” option, and his choice of the desired type of job in sports journalism is statistics and analysis.

## Conclusions

The sociology of sport has been systematically addressing the issue of the impact of sport on society for years (Perasović, & Bartoluci, 2007), and sport has also been a topic in public relations, marketing and management. So far, these topics have been tackled by Kinesiology studies or, at the secondary level, by the so-called sports gymnasiums. Sport is much less commonly found in communication science, media studies and journalism. Despite its continuous presence in the media and its undeniable impact on society as a whole, this case study found that only a few tertiary-level Communication and Journalism study programmes engage in a deeper analysis of the phenomenology of sport and its social role. Ignoring the popularity of sport and its effect on society, seems like missing out on a good opportunity. It is more so due to the fact that there is a high motivation among students. A particularly important question is how to educate them – by means of which methods and tools. For this purpose, collaboration between established scientific disciplines will be unavoidably required.

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## BASKETBALL'S 'MEMORY BOX': A DISCOURSE ANALYSIS OF DRAŽEN PETROVIĆ BIOGRAPHIES

Marko Mustapić

*Institute of Social Sciences Ivo Pilar, Zagreb, Croatia*

### Abstract

Collective memory represents a synthesis of various individual and group memories. The media play an exceptionally important role in interpreting and mediating the meaning of the past. Assmann sees the memory construction process as the fluid process of filling a 'memory box'. Dražen Petrović (1964-1993) is a mythical figure in European basketball. This paper analyses the discourse of biographies of Dražen Petrović published in the Croatian language. The goal of this paper is to affirm the key social functions of these books. The discourse surrounding Petrović's biographies represents a special basketball 'discourse community' and affirms the thesis on the fluidity of collective memory.

*Key words: sports star, collective memory, biography, basketball, national identity*

### Introduction

Football was the most popular sport in Yugoslavia. However, starting in the 1970s, the popularity of basketball nearly reached the level of football. Basketball was an important part of popular culture, especially amongst younger generations. Sadly, in the 21<sup>st</sup> century, Croatian basketball is far from this level of popularity. Various experiences in the history of sport tell us that all forms of sport are integrated into the social context. Social and cultural changes, as well as changes in centres of social power, influence the meaning, purpose, and organisation of sport. In the 'Yugoslav school of basketball', Perica (2001) sees a fascinating story of the successes enjoyed from the 1970s to the 1990s, as well as proof that a 'small country' could symbolically compete with the geopolitical giants of the Cold War – the US and the USSR – through sport. Thus, elite athletes played a significant role in promoting Yugoslavia. Similarly, in the 1990s, they played an important role in constructing the Croatian national identity and promoting the new state (Bartoluci, 2013). Dražen Petrović (1964-1993) was the most popular Yugoslav athlete of the 1980s; following Croatia's independence, he became the most popular Croatian athlete in the 1990s. Throughout his impressive career (Šibenka, Cibona Zagreb, Real Madrid, Portland Trail Blazers, New Jersey Nets; Yugoslavia and Croatia), he won numerous team and individual awards. Dražen's contemporaries (basketball players, coaches, and journalists) considered him a pioneer in the breakthrough of European players in the NBA in the late 1980s and early 1990s. Many of them also consider him the best European basketball player of the time. After his tragic death, he was inducted into the Naismith Memorial Basketball Hall of Fame (2002). This is the greatest individual recognition in basketball. Dražen has been the subject of numerous media pieces, documentary films, books, and museums; squares, streets, sports halls, tournaments, and trophies have been named after him. Collective memory is founded on the selective interpretation of the meaning of the past from the perspective of the present. It represents a synthesis of various individual and group memories in a continuous process of (re)construction and accommodating to changes on the macro- and micro-levels of society. Collective memory is the result of a relationship between the cultural memory and everyday forms of communication on the individual level. The cultural memory thus manifests in how long events from the past last in cultural forms. The communities that surround particular actors in sport, both collective and individual, express a referential framework for a shared worldview rooted in a set of values and norms, especially in collective memory. Sport builds unique cultural communities, primarily founded on the specificities of particular sports and sporting disciplines. Brockmeier (2002) emphasises the importance of the popularity and massiveness of sport, because collective memories in the framework of a particular sport are more complex if they are filled with famous athletes and the mass interest of supporters and the media. This especially holds for national sports stars of global significance. Pyota (2015:3) notes that one must distinguish between two basic structural elements of collective memory in sport: the *narrative or qualitative element* (such as a story about a heroic performance by a team and its players) and *quantitative elements* (statistics and results). Throughout this process of constantly (re)constructing memory, the media play an exceptionally important role in interpreting and mediating the significance of the past. Coakley (2009:80) says the following on the role of the media in the commodification of sport in light of the enormous growth in media and sponsor interest in professional sport: "With the dramatic growth of media coverage during the 1970s, entertainment became an increasingly important purpose of sports. As this occurred, the styles and personas of athletes took on new meanings, and teams built public



relations profiles around values and identities that resonated with current and potential spectators. Entertainment and winning came to be closely linked during this time; winning teams filled stadiums and generated revenue for sponsors and owners.” Numerous papers have been written on the important role of the print media in the 1990s (magazines, monographs, textbooks) in reconstructing collective memory in Croatian sport and the connection with the modern national identity (Sindbæk, 2013; Perasović and Mustapić, 2014; Hrštic and Mustapić, 2015). Assmann (2011) sees the process of constructing memory as the process of filling a ‘memory box’. This process is not unidirectional or exclusively positive – in addition to a strong feeling of collective belonging and identity determinants, it can also include particular traumas. Assmann (2011) thus concludes that memory is an amalgam of forgetting, choosing, and processing what is recorded. He emphasises the fluidity of this process. This is a true challenge for both individuals and society as a result of the development of the internet. The ability to remember and forget is more dynamic than ever before. As collective memory can also be observed as a narrative practice regarding famous athletes, discourse holds special importance in the filling of the ‘memory box’. Middleton and Edwards (1990) researched memory as a discursive practice, concluding that the media and the ways in which they represent events form what can be said, written, or remembered. They thus have an enormous influence on the (re)construction of memory. Biographies, as a special media format, are of particular importance. In light of the aforementioned, we have chosen to analyse biographies of Dražen Petrović.

## Aim and Method

Biographies are an exceptionally popular genre in modern society. Numerous public figures with commercial potential are the subject of various biographies, especially sports stars. Through their interpretations, the authors of biographies influence the image and the construction of memories about the subjects of their books. If authors idolise their subjects and remove traces of their faults, they affirm myths and legends to further solidify their image. Discourse always offers a competitive way by which to give life meaning, as well as a way to view ourselves and the society we live in. Foucault (1979) attempts to use the concept of discourse to explain the relationship between socially constructed forms of truth, power, and knowledge. Discourse analysis always focuses on the way in which members of a particular linguistic community communicate. It deals in the description and analysis of the spoken or written word, the understanding of which is influenced by numerous social and cultural factors. Lemke (1995) explains how the analysis of the meaning of a text serves to affirm the clear social functions of the text, especially what kind of value system the authors support. Van Dijk (2009) argues that the link between society and discourse is often indirect and depends on how language users themselves define the genre or communicative event in which they are engaged. Paltridge (2012:15) defines a discourse community as a group that share special interpersonal communication methods and that generally share common goals, but may also share same values and beliefs. This research will analyse biographies of Dražen Petrović published in the Croatian language (Zorko, 2003; Crnogaj and Radičević, 2015; Sphere, 2016). The general aim of the paper is to affirm what the key social functions of this biography are, or rather which values and beliefs its authors advocate.

## Discourse analysis of biographies of Dražen Petrović

The discourse in these biographies is constructed on the basis of key facts related to Dražen’s career and his image as a pop icon in the former Yugoslavia. The first book included in the analysis (Zorko, 2003) is actually the second edition of a book first published in 1997; it was released in a hard-back edition with 9 chapters across 224 pages. It is full of both colour and black and white photographs, 224 of which are related to Dražen and 61 of which focus on his trophies, diplomas, medals, etc. Of the 224 pictures of Dražen, 181 are from his time playing with various teams (Cibona 65, NJ Nets 43, Croatia 34, Real Madrid 15, Portland TB 9, Šibenka 8, Yugoslavia 7; other 43). The second book (Crnogaj and Radičević, 2015) was published in a paperback edition with 21 chapters across 488 pages. It contains 51 colour and black and white pictures, 29 of which are photographs of Dražen playing for various teams (Cibona 9; Yugoslavia 5; NJ Nets 4; Šibenka and Yugoslav Army, 3 each; Croatia and Portland TB, 2 each; Real Madrid 1). The third book (Sphere, 2016) is a translation of a book published in English two years earlier, printed in a paperback edition with 24 chapters across 279 pages. It contains only 23 photographs, all of which are black and white; seven of these are from a family album, while the rest are of his appearances in various teams (NJ Nets and Yugoslavia, 5 each; Šibenka and Portland TB, 2 each; Cibona and Croatia, 1 each). Pictorial material dominates the first biography, while the other two are textual. The biographies share some characteristics in their content and discourse, while differing in others. Their foremost commonality is in their emphasis of the character of a champion, his work ethic, his high motivation to succeed, and his personal enthusiasm. There is a wealth of data on his successes and the development of his career from his first steps in basketball. They especially emphasise the fact that Dražen was the first European to become an elite NBA player, and that he had never played in the NCAA league prior to this. All authors see the basic reason for his success in his dedication to work and practice. Zorko (2003:38) notes Dražen’s famous quote that he considered missing practice a “deadly sin”. After the death of great athletes, memories remain of their great matches and accomplishments. However, in the case of Petrović, there is another special item held in his collective memory – “myths about his working habits” (Crnogaj and Radičević, 2015:12). The cult of work and sacrifice for the sake of sporting success is a synonym for Dražen’s career. He was

exceptionally ambitious: “It was an attitude that made him stand out from the other Europeans who considered transferring to the NBA in the late 1980s” (Sphere, 2016:102). In accordance with this statement, his teammate Danny Ainge from the Portland Trail Blazers said he had never seen anyone with a greater drive to succeed in the NBA than Dražen (Sphere, 2016:132). An athlete with this kind of character and ascetic working habits was a leader and a man with charisma that was not hard to follow (Crnogaj and Radičević, 2015:12). Zorko (2003:44) notes that, at the age of 17 in Šibenik, Dražen had already become a leader and “someone everyone listened to”. A leader must know how to bear the burden of defeat and failure. Crnogaj and Radičević (2015:74) quote Dražen after defeat in the finals while he played for Cibona: “No one has ever won every game. The sooner you realise that, the easier it will be for you. Crying over one defeat, however painful, will only slow down your career. If you’re on good terms with yourself, if you know you gave your all to win, it’s best to forget the game right away”. Sphere (2016:124) explains why he was loved by supporters of all the teams he played for, something that made him stand out from the great majority of other professionals – “everyone could see his unusual enthusiasm, the infectious kind you usually find in children”. His obvious passion and the joy he drew from being on the court was constantly apparent. Dražen believed that money brought potential distractions that could lead him off the path to his goals (Sphere, 2016:120). Zorko (2003:190) quotes Brad Greenberg, vice president of the Portland Trail Blazers, who portrayed the general unfamiliarity with European basketball in the United States, and Dražen’s charisma and image in Europe in the 1980s: “People here haven’t realized how big Dražen is in Europe. He didn’t have to come to America for financial reasons. He wanted to stay here and be the best player on the court every night. He wanted that more than any amount of money. “His patriotism during the war in Croatia is emphasised in all of the biographies analysed. However, it is significantly more pronounced in the oldest biography (Zorko, 2003). One of the key features of this biography is its avoidance of the terms ‘Yugoslavia’ (national team), Yugoslavian (champion), etc. The author explicitly mentions Yugoslavia for the first time on page 92, but in a negative context. Dražen was in no way an athlete who could have been considered a nationalist or a chauvinist. His statements on this topic were always measured. Despite this, Zorko (2003) strongly accentuates Petrović’s expressions of belonging to the Croatian nation, noting his impressions from his first official game for Croatia on 20 May 1992 against Slovenia: “New uniforms, the Croatian coat of arms, our national anthem, it all seemed unreal to me. I can’t explain it. I’ve played it all, even the NBA finals, but this is a special feeling” (Zorko, 2003:172). Similarly, he recounts a number of Dražen’s impressions of the destruction of the war, explaining misunderstandings with his former teammate Vlade Divac in Yugoslavian national team: “His story is about how much the Serbs suffered in WWII, how they are at risk in Croatia today, and that this was the main reason for the war. On CNN, I told him that the war isn’t being fought around Belgrade and Serbia, but on Croatian soil, and that it isn’t a civil war, but pure Serbian aggression against Croatia. The war will end when the Serbs withdraw from all occupied areas” (Zorko, 2003:174). The method and approach of the other two biographies (Crnogaj and Radičević, 2015; Sphere, 2016) differ significantly from the older biography (Zorko, 2003). The key difference is in their source of information as compared to Zorko (2003), who mainly founds his narrative on quotations of media items and his own interpretations, as well as numerous photographs. The two significantly more recent biographies draw on a large sample of interviews with Dražen Petrović’s contemporaries. This type of sample is referred to in sociology as a ‘deliberate sample’ or ‘expert sample’. Crnogaj and Radičević (2015) have a total of 65 interviewees of whom 26 are from Croatia and 39 are foreign; Sphere (2016) has a total of 54 interviewees, 15 of whom are from Croatia and 39 of whom are foreign. The diversity of sources and collected data make their discourse significantly more complex and measured, especially as regards topics with political connotations. Furthermore, both biographies attempt to familiarise the public with Petrović’s personality and lesser known details of his career and private life. Both biographies also analyse key moments in Dražen’s career in Yugoslavia in the 1980s objectively and with factual support, free of politicisation, with a special focus on his work with coaches and performances in youth teams in Yugoslavia. As concerns novelties in the discourse about Dražen, Sphere (2016) places the greatest emphasis on his enormous competitive character and his ambition and decisiveness to succeed amongst the best basketball players in the world. This biography has a frame that is understandable to international basketball audiences. In terms of novelties, Crnogaj and Radičević (2015) offer a frame that is clearer to the basketball audience from the former Yugoslav republics. This is particularly true in that they describe Dražen’s development in youth teams, when he looked up to Yugoslav basketball stars of the time such as Dragan Kićanović, Mirza Delibašić, and Zoran Slavnić (Crnogaj and Radičević, 2015:31). Another exceptional novelty is the extensive description of privileged conditions provided to Dražen during his mandatory military service in Pula, where he had excellent conditions for training and scrimmage games (Crnogaj and Radičević, 2015).

## Concluding remarks

The analysed biographies of Dražen Petrović published in Croatian represent only a small part of Dražen’s ‘memory box’. His biographies are a part of the communications channels that mediate between the author and the audience in the process of building collective memories of this unique sporting figure. The authors of the biography have shared goals, foremost to promote Dražen and preserve memories of the sports star, whose life ended tragically. However, there are discrepancies in narrative regarding the value connotations and social function of the texts. The ethnocentric perspective of the role of sport is typical of late 20th century Croatia. However, this perspective is still present today in the relationship

between sport and Croatian society. The biographies published in recent years, as opposed to the first biography from the late 1990s, have taken a clear step away from ethnocentrism. The first biography insists on Dražen as a primarily national icon, or refers to him as ‘our Dražen’. The later biographies published in the mid-2010s also include various interpretations of his career and determinants of collective memory, with numerous details from his private life. His Yugoslav phase is not considered a taboo to be erased from memory. They revitalise the global significance of Dražen’s career, not just for basketball, but for modern sport in general. They focus on universal sporting values that breach national and local frameworks. In conclusion, the analysed biographies of Dražen Petrović represent a unique basketball ‘memory box’, affirm how collective memory is fluid and subject to (re)construction from the perspective of the present, and represent a special basketball ‘discourse community’.

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## 30 YEARS OF CULTURAL TRAUMA - FRAMING OF THE EVENTS OF 1 OF MAY 1990 IN MASS MEDIA

Andrej Ivan Nuredinović<sup>1</sup>, Dino Vukušić<sup>2</sup>

<sup>1</sup>Faculty of Humanities and Social Sciences, Croatia

<sup>2</sup>Institute of Social Sciences Ivo Pilar, Croatia

### Abstract

Fan riots on Maksimir stadium that took place on 1 of May 1990 became a myth rooted in the daily discourse of Dinamos' fans as well as in the general public. The aim of this paper is to analyze the elements of media discourse related to the event and its social adaptation in the last thirty years by using cultural trauma as theoretical starting point.

*Key words: cultural trauma, mass media, Dinamo Zagreb, Red Star Belgrade*

### Introduction

It's been three decades since never-played game between Dinamo Zagreb and Red Star Belgrade. Instead of a football match violent clashes took place between members of two groups of fans and the police. The final balance of injured people was 138, luckily no one was killed (Milinović, 2014). This kind of description can serve as an introduction to numerous events related to violence surrounding football, but rarely do any of these events carry the burden of context and echoes that go back to the present day, as is in this case. In his work, Mills (2018) historically contextualises the emergence of organized fan groups in Yugoslavia during 1980s, pointing to the continuity of deviant football-related behavior. Tense situation in the country and a football league that rarely gave the impression of a regular competition, shows that deviance in the Yugoslav stadiums did not "arise overnight" but tensions existed long before the organization and later the process of subculturalization of football fans. Perasović and Mustapić (2013:262) mention different sociological studies of this phenomenon, emphasizing that the research conducted in 1989 by Buzov et al. shows that the government encouraged such research referring to the existence of nationalist and other "anti-state" elements within fan groups. We can say that the position within which we analyze this event contains two aspects that are often not evenly distributed in media interpretations. There is a process of subculturalisation of football fans who, taking over some aspects of the fan subculture contained in the English and Italian fan traditions, primarily relying on the notion of ultras (Spaaij and Vinas, 2005), form a specific subcultural style in which there is also an aspect of violent behavior and confrontation with other fan groups. On the other hand, government saw fan groups as carriers of "anti-regime" ideas, and thus gave fans a certain stereotypical designation of "nationalistic fighters". Once there are such two positions it is possible within thirty years after the event to construct different narratives through media, using different levels of stereotyping and selective representation of actors and events. This paper aims to analyze media discourse related to a specific event and to show the turns and changes that have taken the discourse in the direction that today's generations recognize as Maksimir 5/13 1990.

### Methods

According to Gamson et. al. (1992) media discourse contains a "struggle" over meaning. Guided by such an understanding of discourse, we can say that media texts, through their repeated discourse, can create a dominant narrative in a society related to a specific topic. Often this narrative, under the aegis of media discourse, is altered by the passage of time or the entry of new "players" into the media, social or political arena.

In total, 214 newspaper articles published in three daily newspapers were analyzed. We have based our analysis on the dates 12, 13 and 14.5. every year since 1990. Selected newspapers are Sportske novosti, as the most read and circulated daily sports press in Croatia, Večernji list and Jutarnji list, the leading daily newspapers in Croatia. The coding of the collected empirical material was done inductively, although several basic nodes were created even before the empirical reading, since the researchers are well aware of the phenomenon under study.



## Articulating cultural trauma

A concept of cultural trauma is connected with a social change that causes “a dramatic loss of identity and meaning” as it hits some cohesive group of people (Eyerman, 2004:61). While observing cultural system, we ascribe an invasive and overwhelming event that is believed to be undermining one or several essential ingredients of a culture (values, norms, beliefs, etc.) or the culture as a whole to cultural trauma (Smelser, 2004:37-38). The trauma does not exist if it isn't properly culturally classified and articulated as a trauma (Alexander, 2004:10). This process starts with symbolic representation of *carrier groups* via claims about the shape of social reality. Carrier groups are the collective agents of the trauma process who, via discourses, articulate the situation for the audience to acknowledge their claims (Alexander 2004:11-12). “It is a claim to some fundamental injury, [...] a narrative about a horribly destructive social process, and a demand for emotional, institutional, and symbolic reparation.” (ibid. 2004:11). The cultural classification of trauma consists of four critical representations. The *carrier groups* must provide compelling answer to questions of *the nature of the pain* (what actually happened?); *the nature of the victim* (what group of persons was affected?); *the relation of the trauma victim to the wider audience*; *attribution of responsibility* (who is to blame?). The process of classification is conducted inside one of the *institutional arenas* (i. e. mass media or state bureaucracy) and it depends on stratificational hierarchy in this arenas (i. e. who owns the newspapers?) (ibid. 2004:13-22). In this paper we focus on *mass media arena* because of its consistent popularity and highly dramatized narrative that is not prevalent in other arenas. If the trauma accurately actualize inside some society, then some of its instances become “sacred” to collective, actors are often characterized as victims or heroes of that society and elements for bonding with in collective identity. But, identities are often negotiated and mutate through time. Once the collective identity has been reconstructed and trauma begins to fade, the period of “calming down” emerge and charisma of the event becomes routinized. “As the heightened and powerfully affecting discourse of trauma disappears, the “lessons” of trauma become objectified in monuments” (ibid. 2004:23). While exploring the cultural trauma in the football fans subculture, Spaaij and Hughson (2011:9) extract something very useful - a localized cultural trauma of Hillsborough tragedy that has failed to fade away.

## The events of 1 of May 1990

In 1990, Yugoslavia entered a period that we can mark as the beginning of the end of the state and social system. Due to the conciseness of the text, we will not go into a deeper analysis of all the processes that have taken place since the mid-1980s and in a way indicated the tectonic changes that were about to come (Galurđić, 2011). However, we will point out that the incident at the Maksimir stadium happened shortly after the first multi-party elections in Croatia, in Yugoslavia the atmosphere was stimulated by changes in the constitution, shifts in Party leaderships, the emergence of various nationalist rallies in Serbia and rallies influenced by Serbian nationalism in other Yugoslav republics (Jović, 2017). Fans' conflicts in the former Yugoslavia, especially in the 1980s, were not something new to the police, the media and the general public, but the context in which the conflict at the Maksimir Stadium took place is a novelty in several aspects of the violent behavior of the football audience. The incident, which culminated on the pitch and on the stands of Maksimir stadium started earlier that same Sunday, May 1, 1990. News reports show that the problem started even before the arrival of fans at the Dinamo stadium. Sportske novosti quotes official notes by Zagreb police that Red Star fans (Delije) stopped the train before the Zagreb station by pulling the emergency brake, and started making problems around the city. This was followed by demolishon of shop windows and clashes with smaller groups of Dinamos' fans (Luncer, 1990). After 'warming up', they headed to Maksimir Stadium, where the first incident was recorded an hour before the start of the match. Delije demolished billboards in the South stand and then, shortly afterwards, clashed with Dinamo fans who were located in the upper part of the South stand. 'Die-hard' Dinamo fans, the Bad Blue Boys, were located on the opposite side of the stadium (North stand). Revolted by the situation, they broke the fence, directly confronted the police and invaded the pitch. One of the most striking images recorded that day is certainly a physical confrontation of a police officer and, at that time, Dinamos' player Zvonimir Boban later a well-known player of AC Milan. It was described in the newspaper as the “biggest incident ever” on stadiums in Yugoslavia (Stipković, 1990). The next day, a “media analysis” of what had happened began, and with the report on the injuries and material damage, there were numerous headlines and articles trying to identify who was responsible. It is important to highlight the dominant narratives that went in three directions immediately after the traumatic event. The first direction was about the general condemnation of the rampage, appeal for 'hatred to stop', but also clear statement that blame was on away fans. The second discursive direction was the lack of response by the police and also poor organization of the match. A special section, mostly covered through the articles in Sportske novosti, was related to the role of Zvonimir Boban as a prominent player in Yugoslavia, as well as an analysis of the situation in Yugoslavian football and thus burdened with various problems.

## Framing of the traumatic event

The most important characteristic of the trauma process is that it has to be put inside recognisable cultural codes that come from already known set of values of our culture (cultural pool). If it doesn't happen, we cannot say that cultural trauma has emerged. In this research we recognize four unique phases of embedding the cultural trauma by *carrier groups*.



*Immediately after the event (1990)* A claim that bears a fundamental endangerment of sacred values of the society in this case is believed to be a matter of discrimination of Dinamo fans because they are Croats and is described as Serbian chauvinism. The insertion from one article of Večernji list concludes just that: “On the one side, demolition and fight is allowed, whilst on the other, a severe reaction, without a pardon or mercy, to the extent that it can be called - a discrimination!” (Rede, 1990). The majority of photos shown have a role of making the scene look more realistic to the public but its symbolic meanings are yet to be put into play because the negotiations on the significance of the events are still ongoing (Filić, 1990). *The carrier group* can be described as Dinamo fans, footballers and staff, members of ultras subculture and then political and media elite that transfer informations framed, amongst else, in their own interests. *What really happened* is brought to wide public firstly by media coverage on hooligan violence in general. This narrative quickly changes as with more facts are coming to the sun. There is a prevalent discourse that recognizes the “bad side” of the story in a triangle Delije, police and Serbian politics. Few times a supposition of pre-planned political incident emerged in the articles. Nationalist songs and paroles such as “we will kill Tuđman”, “this is Serbia” and reminiscence on Serbian Chetniks and their leader Draža Mihajlović could be heard during Delije quest on Zagreb. *The nature of the pain* is therefore based in a perception of a “sirius injustice” (the discourse depends on “cultural pool” that at the time differs on the ground of the social/ethnic group) that happened to Dinamo fans and players. The audience is wounded by the dominant “story” – violence and repression against fans and players (“Croatian youth”). The connection between the victim and the audience is drawn from mutual history - historic traumas recalled from troublesome events in Serb-Croatian historic relations (f. e. Chetnik war crimes in WW2). Another factor is the perceived territory of the collective identity that has been desecrated. Football fan becomes a “collective victim” while the wrongful acts begin to be perceived as something typical for Serbs (Alexander 2012:38). This era closes by event entering the legal arena: committees have been established, sanctions have been dispersed between the players, clubs and the police officials. Also, placement of new, war traumas, began.

*Homeland war and struggle for the name “Dinamo” (1991-1999)* A narrative of a “victim” is, in the times of the war, even more underlined with new cultural traumas emerging. The continuity of the „victim“ narrative changes in the narrative of a “hero”. The fans became the “army”, the “fighters for freedom”. The fate of the people is now intertwined with those of the football fans who were perceived as delinquents a few months ago (Alexander, 2012:42). The main *antagonists* of the event are “them”. “Them” is not longer seen as innocent instrumentalized youth. “Them” is now an “ontological evil” (ibid. 2012:36). The very *event* and the latter aggression on the “homeland” is looked upon as equal (R.J., 1984). Behaviour of “our fans and players (Boban in particular)” was seen as an uprising against the regime of the wild east: “[...] there was a physical clash, between the barehanded fans (Croatian people) and Belgrade thugs with the help of the hated police (the embodiment of communist regime)” (Židak, 1995).

The problem that emerges is a change of club name “Dinamo” to “Croatia”. The system now sees “Dinamo” as a reminiscence of the “old regime”. The ideological base of this “new state” is grounded on the harsh negation of everything that once was. Bad Blue Boys, based on their experience in the former regime, defend the name as for them it symbolizes patriotism (Vrcan, 2003). The conflict escalates with the ruling party and club officials publicly derogate Bad Blue Boys as agents of Belgrade, thugs and even Chetniks. This divide is followed by mixed feelings from the audience even though the majority still supports „Dinamo“. The battle for meanings and identity was strongly based on the events of 1 of May which BBB tried to connect with their current situation: “[...] They say that we are destroyers of Croatia, opponents of democracy and communists... When it is known how much of BBB were in the war, that we were the first to start it on the stadium...” (Prnjak, 1997:105).

The unique moment of this struggle for meanings was erecting a monument, “that the rulers were never comfortable with” before the West tribune of the Maksimir stadium on the 1 of September 1994 for the “fallen fans of Dinamo” (TŽ, 1999). In this period, the media arena is under pressure from the politics whose interests in sports builds on the success of Croatia Zagreb. Despite this, ruling party leadership of the club (president Canjuga) comes to pay respects towards 1 of May and proclaim it a “Fans day” - this way the date itself becomes legitimized by the club structures and, indirectly by the state. The period ends with Tuđmans death and subsequently name “Dinamo” was restored.

*Ritualization of trauma (2000-2009)*. It begins with the calming down of turbulent events in the 90-ties. Nevertheless, the carrier group remains strongly based in Bad Blue Boys with only a few journalists reinventing “the story”. The reporting on the event now bares new findings or new views (JL, 2010), the “Arkan story” - instructed and planned event in which even Serbian special militia were involved inside Delije who were led by notorious war criminal, attempt to capture our attention while articulating responsibility for suffering and injustices done to all instances of society with a shock (Meek, 2016). They keep the mythic story “alive”. The event itself is now inseparable from war. This connection explains the involvement of Dinamo and its fans in collecting funds for generals on the Hague trials (Nezirović i Krasnec, 2006). BBB organize tournaments named “For all those who are gone”, they also organize concert events and every year they massively commemorate the event before the monument. Also the image of “heroes” is constantly shown and the memory is kept by conducting choreographies and other performances. The cohesion of the club and fans in this period results in positive ritualization of the event that is no longer seen as trauma, but more like proud history of Bad Blue Boys. This period, however, ends, with another conflict with club structures for a democratization of the club.

*Wounds that are still open (2010-now)*. The final period reflects on the conflict not only amongst fans and club structures but between fans themselves (AL, 2011). The democratization struggle that officially started in 2010 brought back the delegitimization tendency from club structures and the media towards the younger generation of Bad Blue Boys (Jurišić, 2010). The symbolic power of the monument is again shown during battle when some Bad Blue Boys (inclining to Mamić) organized their own Fan club. They did it by standing on the monument, wanting to show their direct linkage with the fallen heroes. Bad Blue Boys (the majority) organized separate manifestations of the date, often linking it with three historical stages of “resistance to the system”. Bad Blue Boys created narrative of three stages of rebellion against the repressive systems: for Croatia; for “Dinamo” and for democratization of the club. Despite this, the *victim* narrative of the event was to be connected with the “older” (Mamić inclined) part of the Bad Blue Boys. The *relation to the victim* from the audience is twofold - on the one side, the majority started to ignore Dinamo matches and in the same time, some were supporting Mamić. The main *antagonists* were kept to the previously described triangle, although the battle for democratization was such that Bad Blue Boys recognized Mamić as a “Serbian”, “Chetnik” and a war profiteer (Krušelj, 2017). The cultural trauma of the event, in such a period, haven’t been able to end. The ritualization process that started at the beginning of the century was never able to heal the wounds as the pain for the majority of Dinamo fans is only transformed ever so often.

### Conclusion: overcoming trauma?

This analysis determined that the media discourse related to this event shifted through the last 30 years. Although, in all four phases that we have established, a localized cultural trauma is consistent. In the first phase, a certain discrepancy in the roles of Dinamo and Zvezda fans is seen. The media outrage is centered around Delije and the police, while home fans are victimized. In the second phase, a period of a high social cohesion during the war for independence, a discourse towards Dinamo fans shifted from a victim to a hero and the event is integrated in the story of war. At the same time, we see a battle for meanings between life-experience meaning sphere of the fans and the meanings named by the system (Vrcan 2003). Whereas, the system through delegitimization of the fan tribe moves towards ritualization of trauma according to its own measures, fans create their own meaning of traumatic event as a basis of the suppressed club’s and group’s collective identities. In the third phase, a promotion of traumatic event through new “shocking” findings is dominant. Its purpose is final reconstruction of the collective identity. This phase is characterized by “calming down” in a process of routinization while mutual relations between club, group and politics are peaceful. The trauma charism flattens out and can now be seen as a stimulus of a benign social change (Sztompka 2000). The last stage, however, reveals the depth of trauma that reemerges through a series of delegitimization processes with which the fans become marginalized and pushed away from the club. Those acts issue a fans’ call for understanding towards the public while embedding and recollecting memories of what is now perceived as a bonding historical traumatic event – the event of a lasting trauma that pictures a fan as a hero of society.

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## ATHLETE'S BODY AS A "MEAN OF PRODUCTION" AND EMBODIED CULTURAL CAPITAL

Saša Pišot<sup>1</sup>, Ivana Milovanović<sup>2</sup>

<sup>1</sup>Science and Research Centre Koper, Slovenia

<sup>2</sup>Faculty of Sport and Physical Education, University of Novi Sad, Serbia

**Introduction:** The body has become a subject of both social and cultural importance; therefore, this paper is related to discourse of athlete's body from the point of Bourdieu's Forms of capital and Marx's theory of conflict. Cultural capital, beside economic and social capital, can exist in three forms: the objectified state, as cultural goods, the institutionalized state and the embodied state (ECC). The accumulation of ECC reflects through culture, cultivation, ("Bildung"), in process of embodiment, incorporation, which implies an acquisition like physical muscles or capabilities what costs time invested personally by the investor. Additionally, according to Marx's theory of conflict, in every society conflict lies between people with money and power, who are owners of "means of production" (MP) and people without those resources.

**Methods:** Theoretical application of athletes' body as an MP and sport training as accumulation of incorporated CC was made by some examples on sports field.

**Results:** Athlete's body can be seen as a tool for accumulation of ECC through time dedicated to training, sport participation and MP, which enable athlete to (acquire financial remuneration and power for his/her sport performance done with a body. Being an owner of a body (MP), s/he generates money and power in non-conflict relation.

**Discussion:** We need to put attention on the following facts: i) that the conflict occurs when athlete becomes alienated from his/her body and is willing to risk injury or compete injured to obtain results (money and power); ii) who is the "owner of MP" in the relation of sponsors, club owners and athletes and iii) the accumulation of ECC cannot be accumulated beyond the appropriating capacities of an athlete; it declines and dies with its bearer (age, injury).

**Key words:** *forms of cultural capital, acquisition of embodied capital, means' of production ownership*

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## REBRANDING OF RED STAR AND DYNAMO SPORTS SOCIETIES – A CONSEQUENCE OF TRANSITION AND/OR POSTMODERN CHAOS?

Sandra Radenović

University of Belgrade, Faculty of Sport and Physical Education, Serbia

### Abstract

The paper will consider the process of rebranding of sports societies Red Star (Serbia) and Dynamo (Croatia) during the 1990s in a post-socialist context. This process follows the breakup of the Socialist Federal Republic of Yugoslavia (SFRY) and the transition and it is reflected not only in official rebranding such as the removal of the five-pointed star (example of Dynamo), but also in the merging of incompatible symbols such as the five-pointed star and Chetnik movement symbols within the groups of the fans (example of Red Star supporters group). Is the rebranding of sports societies a consequence of transition, or is there some kind of postmodern chaos? Do these sports societies recognize the importance of branding and do they consider fan groups as a brand carriers? – these are some of the questions that will be discussed in the paper.

*Key words: rebranding, transition, sport, postmodern chaos*

### Introduction

The bloody disintegration of the SFRY during the 1990s, the transition, privatization and pauperization of the majority of the population of the newly created states are the processes that marked the mentioned period. At the same time, the states and societies of the newly emerging countries did not avoid the influence of postmodernity as a feature of contemporary global societies characterized by the so-called 'pastiche' – a mixture, a conglomerate of numerous morals whose more or less shapeless colors spill and diffuse and/or overlap with each other (Turza, 2009). Newly emerging states and societies intersected with their socialist past, including socialist morality – manifestly, by removing socialist symbols, primarily the five-pointed star. Breaking up with the socialist past by erasing the five-pointed star in the context of transition can be interpreted not only as a symbolic cut, but also as a kind of rebranding process for social organizations, state institutions, and certainly professional sport. Through professional sport, as a segment of the physical culture system, all those processes that are present in the belonging society are reflected, in this case the transition and influence of the postmodernity. Let us note that professional sport in both socialism and post-socialism and capitalism has the function of "opium of the people" (Marx), "valve" (Fukuyama) or "exhaust valve" (Vrcan), therefore it has a compensatory role (Mijatov, 2019), and it is superfluous to speak about professional sport in the period of transition as a specific phenomenon. That is why we will return to the notion of rebranding of social organizations, state institutions and even professional sport. Contemporary marketing theory insists on the fact that branding, more precisely, forming of the brand as a recognizable, visual identity of a particular product encompasses all aspects of life and is therefore present not only as branding of products, services, organizations, but also as branding of personalities, events, occupations, objects, cities, nations (Ožegović, 2014), including sports societies, clubs, certain sports. In this paper we will talk about the process of (re) branding in the sphere of professional sport in the context of post-socialism, more precisely in the context of breaking with the socialist past.

### Methods

The method of theoretical analysis, historical method and the method of content analysis were applied in the paper. The content of the official sites and official documents of the sports societies Crvena Zvezda and Dinamo, the visual identity of these societies, the official coat of arms and flag, as well as the elements of the scenography of the supporters of these sports societies were analyzed.

### Results

The Sport Society Red Star was founded in 1945 as the Youth Physical Education Society with the aim of being made up of numerous sports sections. The idea originated from the members of the United Federation of Anti-Fascist Youth of Serbia, relying on the idea of versatility present in the Soviet model of sport (Priča o SD, 2016). The example of the Yugoslav socialist sport showed that football, as definitely the most popular sport regarding the representation and number



of clubs, won all the other sports, including the mentioned idea of versatility (Mijatov, 2019). As the official colors and symbol of The Sport Society Red Star were defined red-blue-white with a white five-pointed star on a red jersey (Priča o SD, 2016), which later became the recognizing red five-pointed star. Besides Red Star, which was founded on the model of the military club from the Soviet Union also other sports societies had the Soviet example of sports societies as the model. The most important Soviet sport society was Dinamo, so the Croatian Dinamo was created in the same way as the Soviet Dinamo. GNK Dinamo was founded

in 1911 as Prvi Hrvatski Građanski Športski Klub, and in 1945 it was transformed into Dinamo by the decision of new authorities with a new administration loyal to the communist regime. Until 1991, it was named Dinamo, and then changed to HAŠK Građanski, Croatia, NK Dinamo and finally since 2011 the club's official name is GNK Dinamo (Povijest, 2013). The club retains the recognizing blue color and the basic elements of the coat of arms appearance after World War II, although throughout the history the coat of arms of the club has changed sixteen times since its founding in 1911 (Dinamovi grbovi kroz povijest, 2013). In 1991 Dinamo removed the five-pointed star which has been added to the coat of arms after World War II, in that way Dinamo has intersected with the socialist part of the past and at the same time has begun the process of its rebranding in the context of the transition of society. Regarding the historical aspect of the phenomenon of football fans, while the cheering for Partizan as a physical education club of the Yugoslav Army, founded in 1945, certainly had a clear Yugoslav dimension, for the way of forming the Serbian dimension around FC Red Star – there are no traces in the historical sources. It is possible that Red Star, perceived and formed as a serious opponent of Partizan in Belgrade as such, more from anti-identity, has become a factor of Serbian identity (Mijatov, 2019). During the 1950s, Red Star was accompanied by nationalist riots during football matches with Dinamo and Hajduk with the shouting such as “Chetniks” when the car with Belgrade registration has been overturned. In Belgrade, on the other hand, Hajduk supporters have been called “Ustashe, fascists, and killers of Serbs.” (Mijatov, 2019; Previšić & Mlinarić, 2020). Today, Red Star has a separate section on its fans at official site (Navijači, 2016) with detailed history of organizing into a fan group in 1948, the formation of Delije in 1989, the creation of songs, flags, banners, red and white scarves and hats, choreography, in a word – the forming a profile of a “real Red Star supporter” as well as developing marketing of the supporters’ group (Navijači, 2016). The club rules of FC Red Star are clear regarding the importance of fans for FC Red Star because they are very well known throughout the history of the club, and therefore their contribution to the creation and spread of Red Star ideals and brand (Pravilnik o uređenju zvaničnih klubova navijača, 2011). Regarding the value system, the rulebook states that the mission of the fan clubs is to spread and promote the values of the Red Star, civic pride, social integration, sporting spirit, solidarity, democracy, national and other values that reflect the club's commitment to the whole society (Pravilnik o uređenju zvaničnih klubova navijača, 2011). The Statute of FC Red Star underlines the most important goals and tasks such as: gathering youth and adults for the purpose of playing football and creating conditions for professional sports achievements; the revitalization and strengthening of the spirit of Olympism and fair play as well as the elimination from the sport of all deviations such as doping and violence in sport; adapting to contemporary business conditions and developing their business, respecting the legality and principles of fair business and market relations; promoting ecological ideas by developing activities that contribute to environmental protection and improvement (Statut FK „Crvena Zvezda“, 2017). On its official site, GNK Dinamo has a special section on fans with detailed information on the history from the formation of Bad Blue Boys fan group in 1986, organized trips through the former state, proving love for a club in that manner that sometimes it was inevitable to have fight for the club, until the participation of members of the supporters group in the homeland war (Navijači. Povijest, 2013). According to the available information, beside the Statute of GNK Dinamo, no rulebook like the Rulebook on the organization of official fan clubs of FC Crvena Zvezda can be found (Redovna Skupština Dinama: Usvojen novi Statut, 2018). The Statute of GNK Dinamo underlines as one of the goals the gathering of citizens, children and youth in the implementation of physical and health education programs through football schools (Statut GNK „Dinamo“, 2018). Regarding the membership, the GNK Dinamo Statute states that a member cannot be a person who, through his or her behaviour and actions, inflicts material and non material damage to the club and which inhibit the club from accomplishing its goals and performing its activities because of the violent, discriminatory and racist behavior and actions (Statut GNK „Dinamo“, 2018). The official website of FC Red Star and GNK Dinamo in the sections dedicated to the fan groups does not contain information about the penalties for these football clubs for the incidents and violence of fan groups, both Delija and Bad Blue Boys. Numerous photographs of these fan groups’ incidents and texts are available in the electronic media (Zvezda ponovo na tapetu UEFA, 2018; UEFA bez milosti, 2019; UEFA drastično kaznila Dinamo, 2009; Ustaške poruke sa Maksimira, 2008). Let us also mention that a large number of papers from the field of sociology of sport are devoted to the phenomena of fan violence, nationalism of fan groups, racism in stadiums and instrumentalization of fan groups for political purposes, which will not be discussed in this paper. (Previšić & Mlinarić, 2020; Mills, 2019; Vrcan, 1990; Marjanović, 2013; Koković, 2010). To illustrate the elements of the scenography of the fan groups of these football clubs, we remind of the following two examples. The first example is the Manchester Stadium riots caused by the Bad Blue Boys clashing with British regulars, breaking 150 chairs in stadium while one member of this fan group was saluting with a Nazi salute (Neredi i nacistički pozdrav navijača Dinama na „Etihadu“, 2019). Another example is the merging of incompatible symbols on a banner such as the five-pointed star and Chetnik movement symbols within the Red Star fan group Delije in the stadium as the element of scenography of the supporters’ group.



Figure 1. Connection of incompatible symbols: Five-pointed star and Draža Mihajlović

## Discussion

According to the mentioned data, Red Star has kept its visual identity since its formation, despite the trend of removing the five-pointed star from state institutions, from the coat of arms and from the state flag, which is clear because of the name itself. Regarding that, Red Star has maintained its recognizing brand in the region and the world. As it is mentioned, very soon after the founding of the sport society, a Serbian national dimension is formed, which very easily transforms into nationalism, followed by nationalist incidents during matches. Therefore, the merge of the incompatible symbols of the five-pointed star and the Chetnik movement is not surprising because these are the elements that officially and unofficially form the identity of the sport society: officially and manifestly, it is a five-pointed star, unofficially and latently in the value system and scenography of Red Star supporting group - it is a national element which is able to slip very easily into nationalism but also chauvinism, thus causing direct material damage to its club, which is punished in accordance with FIFA and UEFA rules. The Statute of FC Red Star clearly underlines the basic value system of the club, which is contrary to the frequent unambiguous nationalism of the Red Star supporter group. On the other hand, the FC Red Star Club Rules clearly emphasizes the importance of the fans as well as their contribution to the creation and dissemination of the Red Star ideals and brand in the context of the Red Star value system. According to mentioned data, since its forming until nowadays GNK Dynamo has clearly established its visual identity, blue color and basic elements of the coat of arms as a recognizing brand in the region and the world. The five-pointed star added after the World War II has been removed in 1991 when it has been intersected with the socialist part of the past and started with rebranding its visual identity in the context of society's transition. The GNK Dinamo Statute clearly emphasizes the basic value system of a club that is in direct opposition to the behavior of Dinamo supporters group whose members are often cause riots in stadiums with nationalist and Nazi scenography, thereby causing direct material damage to their club, which is punished in accordance with FIFA and UEFA rules. Although the official documents of GNK Dinamo do not explicitly state that fans are spreading the ideals and brand of the club as it is stated in the official documents of FC Red Star, it is clear that Dinamo fans are significant element in the expansion of the Dinamo brand in the region and beyond. An excellent illustration of the aforementioned is the monument to Dinamo fans participating in the Homeland War. Regarding the value system of Red Star and Dinamo connected to the importance of fans in expanding the brand of football clubs, it is indicative that at the official sites there are no information about the positive activity of fan groups such as organizing and participating in humanitarian campaigns. This type of supporters group activity has not been studied much, but it is certainly a form of positive action (Stojković, 2018) that would contribute to a better image and brand of fan groups in the context of the rebranding process, bearing in mind the fact that the fan groups in the general public are mostly known for riots in stadiums, nationalism and racism, which is the reason why their own clubs, they claim to be something 'holy' for them, suffer direct material damage and contribute to creating a negative image in the public in the region and the world. According to the official documents, it remains unclear why club management does not seriously sanction the incidents of its fans and does not work with its fans to promote a sports culture, for example, through marketing and promoting humanitarian actions organized by fan groups.

## Conclusion

The rebranding of the sports societies Red Star and Dynamo is a consequence of the transition, regarding the fact of breaking up with the socialist past and reaffirming the visual identity in the professional sport market in the region and the world. The aforementioned sports societies manifestly and latently consider their fan groups to be the main carriers of the recognizable brand of the club through the development of group marketing in order to form a loyal fan profile. Postmodern chaos can be recognized not only in the merging of incompatible symbols in the example of Red Star, but also in the discrepancy between the value systems of the sports clubs Red Star and Dynamo officially prescribed by the Statute and the value system of fan groups Delije and Bad Blue Boys, which is unambiguously reflected in causing a violence in stadiums, as well as nationalistic, Nazi and racist incidents that directly cause the material damage and penalties for their clubs in accordance with FIFA and UEFA rules.

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## WHAT MAKES THE SPORT A VALUABLE HUMAN ACTIVITY? A SPORT-PHILOSOPHICAL PERSPECTIVE

**Matija Mato Škerbić**

*Faculty of Croatian Studies, Croatia*

**Introduction:** In this paper, I will approach the question of why people are getting engaged in sport and/or what makes the sport a valuable human activity - from the sport-philosophical perspective. In order to do that, I will turn to the conception of internalism and internal values of sport (IVS), which has produced several answers to the question that are considered as the essential.

**Methods:** Research was conducted by the application of the critical analysis as well as a critical review method.

**Results:** Three conceptions of internalism were developed: 1) historicistic conventionalist internalism, introduced by W. J. Morgan; 2) interpretivism, brought by J. S. Russell; and 3) broad internalism or interpretive formalism, by R. Simon, J. S. Russell and N. Dixon, as well as two recent attempts to develop them further - pluralistic (broad) internalism presented by S. Kretchmar and shallow interpretivism by S. MacRae. In them, several internal values of sport were pointed out such as striving for excellence (Morgan, Russell, Simon), fair play (Russell, Simon), gratuitous logic of sport (Morgan), and human flourishing (Simon).

However, I find them unsatisfactory, mostly because they are depicted in a universalistic abstract manner. In my view, they should be expressed and explained in a much more concrete and realistic way strongly connected to the sports practice. Thus, I will present my eightfold model of IVS or eight areas of human sporting life in which IVS become obvious in a concrete and explicit manner: 1) intersubjective; 2) emotional; 3) spiritual; 4) sensual; 5) epistemological; 6) aesthetic; 7) ethical; 8) anthropological.

**Conclusions:** Internal values of sport are the ultimate answer to the question why sport is a valuable human activity, but also why it gives opportunities for human flourishing and a good purposeful life. However, because of the universalistic and abstract depiction of IVS in the literature thus far, I developed a new model which answers what are they concretely and where and how they can be detected.

**Key words:** *philosophy of sport, the conception of internalism, internal values of sport, definition of sport*

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## TWITTER AS AN ORGANIZATIONAL MECHANISM IN PROFESSIONAL SPORT - EXAMPLE OF EUROLEAGUE PLAYERS SYNDICAL ORGANIZING

Marija Todorović<sup>1</sup>, Branka Matijević<sup>2</sup>

<sup>1</sup>*Faculty of Sport, University of "Union -Nikola Tesla" Belgrade, Serbia*

<sup>2</sup>*Institute of Social Sciences Belgrade, Serbia*

### Abstract

With their rapid growth rates over the last few decades, Information and Communication Technology became integrated in almost every aspect of our social life. Technological and social structure of digital platforms enables gathering social capital through social networking. With no space and time limitations, Internet communication increases the development of online platforms for social networking. For users, this type of platform represents universal communication tool for keeping old contacts and getting new ones. This paper aims to understand digital communication among EuroLeague basketball players, which led to their self-organizing into the union of professional basketball players EuroLeague Players Association (ELPA). We applied qualitative content analysis on Twitter communication. Confirmed as strongest virtual organizational mechanism, in this case, Twitter also happened to be a unique virtual network for self-organizing in the sports area.

**Key words:** *Twitter, self-organizing, basketball players, EuroLeague, ELPA*

### Introduction

Groups of interconnected persons who share particular characteristics form, what we call, a social network (Golubović, 2008). Belonging to a certain network enables support, better access to information and plays the important role for one individual in the process of accumulating the social capital (Golubović, 2008). This capital represents a social relationship within the system of exchange and refers to all goods, whether they are material or symbolic, appearing to be rare and valuable (Bourdieu, 1990b: 178). Accordingly, Bourdieu (1990b) distinguishes three interrelated forms in capital occurrence: economic, cultural, and social. In our work we focus on the **social capital of the particular group of people: basketball players**. Our standpoint is based on viewing social capital as the collection of cultural properties which create and maintain mutual trust and cooperation among members of particular social network. (Štulhofer, 2013).

Relaying on the social network capital theory, the topic of this paper is self-organizing of EuroLeague basketball players through Online Platform for Social Networking (OPSN), primarily on Twitter. The goal of this paper is to understand the Twitter role and impact of this type of network capital on self-organization of the first European basketball players union named EuroLeague Players Association (ELPA).

In the past few years the Internet becomes the channel for overcoming the space-time distance and serves to connect structurally isolated individuals with like-minded ones, thus creating a virtual social capital (Petrović, 2013). Virtual capital is seen as a type of network capital, but with the one main difference, it cannot exist without the Internet. Its character can be observed as both connecting and bridging: virtual connecting capital is rooted in relationships established on the Internet, while bridging virtual capital is rooted in virtual personal networks established thanks to the Internet (Petrović, 2013).

Among existing OPSN platforms one of the most interesting is Twitter. The main reason for that is due to digital networking mechanism of Twitter that under certain conditions establishes itself as an organizing agent (In the spirit of Latour (2005) actor-network theory where technology can be presented as actor), while communication via Twitter becomes the base for collective organizing, removing hierarchical structure, the role of professional leaders and organizations (Bennett & Segerberg, 2011; Bennett, 2012; Bimber, Flanagan & Stohl, 2012 acc. to Petrović & Petrović, 2017). This type of social networking is focused on exchanging information and opinions via so called tweets, which are textual messages no longer than 280 characters. Tweet is delivered with three micro-blogging options to its users: like, retweet (copy/share the tweet, mostly with a comment) or just a comment. These micro tools enable easy and efficient communication among users by emitting and exchanging information and opinions on their activities (Gardašević et al., 2018).

We distinguish three ideal-types of network organization through OPSN, according to Bennett and Segerberg: self-organizing/crowd-enabled, organizationally-enabled and organizationally-brokered (Bennett & Segerberg, 2013). In



this paper, we focus on self-organizing networks, which the mentioned authors point up to represent the purest form of connective sharing. Also, these networks are primarily technology-enabled (Bennett & Segerberg, 2013). Consequently, we start from the point where Twitter is the basic organizing agent and coordination mechanism in the players self-organizing. In other words, we could say that this type of self-organizing was possible primarily due to the organizational potential of Twitter.

Additional reason for choosing Twitter, beside its potential, is that professional athletes mostly use this online platform, because it allows them to communicate with each other as well as to connect directly to their fans (but also to a wider public) (Pegoraro, 2010).

## Methodology

Qualitative content analysis is used to analyze tweets of EuroLeague basketball players. Qualitative analysis is applied on the whole content of experiential material in order to determine the important categories of analysis, this way insuring the understanding of studied material including its origin context (Manić, 2017).

It is necessary to emphasize that the online portals contain the original published tweets of players during the period from June 12, 2017 to September 27, 2018 which referred to the studied issues. Because the content of the observing data is incomplete, the construction of categories in advance is omitted. For that reason categories are based on the material itself by reading material repeatedly (Manić, 2017).

Ordinarily, qualitative analysis doesn't insist on a representative sample (Manić, 2017), so, in this paper we used online portals as a purposeful unit sample. The samples for qualitative research are generally assumed to be selected purposefully (non-probabilistic sampling) to yield cases that are "information rich" (Patton, 2001).

Online portals were the source of basketball players twitter posts in the form of news that enabled spotting the main problems of the analyzed phenomena. Twitter as OPSN was not taken as the unit sample, because of its complexity, huge number of users, our limited resources and type of the applied analysis (Manić, 2017). Two internet portals that post basketball daily events were used as source of data: Eurohoops.net and TalkBasket.net. These two portals were chosen both for their agility in publishing basketball news from all over the world (daily) and for being EuroLeague's official partners, which make their information reliable and relevant.

The next unit sample is news published on the mentioned portals that fulfil the criteria to have content considering some type of organizing or union occurrence. Total of 18 news that met the criteria mentioned above were identified.

In this paper we use the news text as the unit of analysis to answer the following research questions:

- In which way Twitter enabled EuroLeague basketball players to organize a Union?
- Is it possible to spot the key motives for players to use Twitter?
- Do the players, after organizing a union still use a Twitter as a communication channel?

## Results and Discussion

After the end of EuroLeague season 2016/17, few players announced problems bothering them during that season on Twitter, thus making them public. During this season, already present conflict between EuroLeague and FIBA exacerbated, which resulted in big changes in competitions format. The number of competing clubs decreased (from 24 to 16) and the number of matches for players in the regular part tripled. This change of competition format didn't influence the national leagues which remained unchanged, with average number of matches from 20-40 in regular part. This way, players beside their already "tight" EuroLeague schedule, where they have to travel across the Europe every two weeks, had additional match in national competition every week. Consequently, the summer has become reserved for fulfilling obligations towards representation, which includes additional matches for national teams in FIBA international competitions. For the majority of players this brought the huge problem of not being able to have a necessary vacation for the recovery after exhausting season.

Twitter can be considered a suitable channel for the self-organization of EuroLeague basketball players into a union, primarily because there was no formal institution that would enable that. In its capabilities, Twitter can be a good channel because it enables direct communication with the public, where players can freely express their personal opinion without any intermediaries from the club. We can say that this way reduces the risk of their statements being misrepresented and misinterpreted by journalists.

The question is whether the existence of a formal institution would prevent their advertising on Twitter, given the impression that there is dissatisfaction with "how far their voice is heard". That can be seen in the following tweets of players:

- *Nobody listens to players – Bobby Dixon (Fenerbahce)*
- *Nobody listens to players in the right way, whatever we say just goes in one ear and out from other – Keith Langford (Panatinaikos)*
- *Players need to have a role in making decisions and organization of competitions – Nemanja Nedović (Unicaja)*
- *It is urgent to organize Union of players – Ekpe Udoh (Fenerbahce)*
- *Basketball belongs to players and to no one else – Ekpe Udoh (Fenerbahce)*

The key motive for players to use Twitter as a platform is because they don't have much opportunity to communicate face-to-face among themselves. This is not surprising given the fact that the competition in EuroLeague implies clubs from different European countries. As clubs are in the constant rivalry, it is not rare to see rivalry transferring to the players. Most of the players made their first contacts on the playground, which decrease their chances for some sort of cooperation. This phenomenon particularly presents establishment of connecting character of virtual social capital that contributes to cohesion. Eurohoops.net conveyed following communication on Twitter in the observed period:

- *Some judges in Spain do not want to look at you when you speak to them politely or ask questions during sports trials – Nemanja Nedović (Unicaja)*
- *Union of players – answer from Nikola Kalinić (Fenerbahce)*
- *It seems to be the only solution – adds to the previous answer Nemanja Nedović*
- *It would be good to have the All-star competition in EuroLeague like in NBA – Gigi Datome (Fenerbahce)*
- *If we have a Union, maybe that would be possible to organize – Tornike Shengelia (Baskonia)*

However, the most frequent communication, as expected, is the one between players from the same club or between ex-teammates, considering they are mostly in everyday contact in the "offline" world. Because they have face-to-face communication they are interconnected with strong relations of social capital.

It is observable from the above that the players need to network and organize into union, to establish better communication and cooperation, as well as to let the public know about their situation. Players gathered virtual social capital through Twitter, which opened possibilities to deal not only with their local problems, but to act on the higher level- to create united goal-organize union of basketball players that will serve as their "united voice".

After intensive, mutual digital communication, 19.05.2018, on the closing Final four tournament in Belgrade, the EuroLeague players union, ELPA, was created. Although the original idea on self-organizing came from the active players, the main initiator for union creation was ex- NBA and EuroLeague player Bostjan Nachbar, who has been following players' posts and communicating with players in both online and "offline" world. Eurohoops.net conveyed that players gave him full support and agreement for union creation. Later, the Twitter account was opened and the first news on union creation was posted. Today, beside the players, the union is followed by around 5800 basketball fans.

Following are few comments from players regarding union creation:

- *If you are EuroLeague player than you should follow ELPA Union of players and everything related to it. This is the first step in the right way for our future- Mike James (Panatinsikos).*
- *It is necessary for all of you to follow (on Twitter) the first union of EuroLeague basketball players- Nikola Kalinić*
- *Huge step for basketball! I am looking forward to our cooperation and with great expectations. Great job!- Vladimir Štimac (Anadolu Efes)*
- *I am very excited. This organization will help players to unite and become as one- Alex Tyus (Maccabi)*
- *Huge step for EuroLeague, especially for players to unite!- Matt Janning (Baskonia)*

It was assumed that players would not continue with their Twitter communication, after establishing the union, and that they will communicate with the ELPA through their representatives (as each club has a representative). However, **players continue to use a Twitter as a communication channel**. Although there is a formal institution now, players continued to "tweet" posts addressing ELPA. Eurohoops.net conveyed a tweet from Nikola Kalinić, on 24.08. 2018, addressed to ELPA, FIBA and EuroLeague: *It is necessary to use the same ball for all competitions*. His post was retweeted by three players with supporting comments to this requirement:

- *I agree with you 100 percent- Jeremy Pargo*
- *Please do it for us, it is a small thing but it means a lot to us.- Michael Roll*
- *Man, I have just mentioned it on today's training. Change of the ball in the middle of the week is awful.- Mike James*

As an answer to the presented problem ELPA's vice president, Kyle Hines, posted a following tweet:

- Please, make a list of problems which need to be discussed on the next ELPA meeting.

This comment suggests that ELPA representatives don't want communication to be public as it was before creating the Union and would rather like players to address their actual problems directly to the Union. From one point this attitude it is understandable as public really doesn't have to be involved in every single problem considering players and basketball. Also, avoiding discussion on every single problem separately will save a lot of time and effort. On the other hand – could it be the sign of coming lower transparency?

## Conclusion

Basketball players networking enabled by Twitter was the big step for both sports and relationships among players (especially because of rivalry presence). Presented analysis showed that this OPSN has an underlying potential not only for social networking but also for (self) organizing. Our impression is that the players recognized that potential, based on analysis of their tweets that are expressing clearly the need for using communication without any intermediaries in the form of club managers or employees. The main reasons that turned Twitter into the platform for self-organizing EuroLeague players could be the opportunity to communicate directly, to publicly express personal opinions and also to social network.

Posted tweets spread information to relevant people who engaged accordingly and succeeded to organize players in ELPA Union. Consequently, digital communication on Twitter gathered significant virtual social capital, which led to forming Union in the offline world.

The present example is one of many illustrating the way of organizing on Twitter, but unique in the sports area and, as far as we know, unique in the outcome: forming the **institution in the real world!** In our future works we plan to pay more attention to this topic, given that this is a unique example of self-organization on Twitter in the field of sports and thus require more complex research that involves the complementary use of quantitative and qualitative data.

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## BMX AT THE 2020 OLYMPICS: THE COMMERCIALIZATION OF A SUBCULTURE

**Marita Ukić**

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

Over the past few decades, lifestyle sports have evolved. Changes have been particularly evident through the visible inclusion of lifestyle sports such as BMX, snowboarding, surfing and skateboarding in the Olympic Games.

Focusing on the Croatian context, this paper investigates the impact of this sport's commercialization on the BMX subculture. Qualitative research, i.e., ethnography, was carried out. Through participant observation and semi-structured in-depth interviews, this research examines participants' attitudes toward incorporating their sport into the Olympics.

Although the participants believe that any kind of promotion of BMX is good for the sport's progress, they believe that the Olympic Games exclude the most important part of the sport, which is the BMX subculture's background and lifestyle.

*Key words: BMX, subcultures, sport, commercialization, Olympic Games*

### Introduction

The emergence of lifestyle sports such as skateboarding, mountain biking, snowboarding and this paper's focus – BMX (bicycle motocross), and these sports' rapid development are some of the most significant events in the world of sport in recent years. Although these sports have experienced a great increase in popularity and media coverage over the last twenty years, a debate remains in the scientific literature over such sports as a phenomenon – even over the terminology used to describe them. Terms are vaguely defined and often misused. In this paper, we have chosen the term “lifestyle” sports, not only because it is the most commonly used in similar research in the world, but also because the participants themselves call it a lifestyle sport. Wheaton (2013) was the first to refer to the term “lifestyle sports,” opting for it because it was accepted by the subcultural members themselves and was a term that embraces that culture and identity, signaling the importance of the “socio-historical context in which these activities emerged, shaped and existed.” There are three central concepts related to sports such as BMX, skateboarding, snowboarding etc. They are conceived as “alternative” – i.e. as practices differentiated from conventional sporting forms, “lifestyle” – a term related to personal factors beyond success in competition, and “extreme” – a label given to aspects of sporting practice associated with risk-taking and extreme skills, and also associated with branding and commodifying some aspects of the sport's practice (Tomlinson et al., 2005). The dominant characteristics of these sports include a lack of competition, resistance to external regulation, a high risk in performance and the personal freedom of athletes (Wheaton, 2013). Sport – in this case freestyle BMX – can serve as a basis for creating a youth subcultural style and identity.

Despite lifestyle sports having different histories, they all tend to exhibit a kind of subcultural style (Thorpe and Wheaton, 2011). While sports such as BMX have been around for over thirty years, they have only recently become an area of interest for sponsors and advertising companies. As their popularity grows, changes are occurring among the athletes themselves, that is, among their groups and subgroups. While some advocate original, antitraditional values, others see the potential benefits of popularization and have thus become part of the “mainstream” (Jarvie, 2013). Today, it is certainly difficult to draw the exact line between mainstream and marginal culture. In the sociological sense, “lifestyle” sports are “activities that, either ideologically or in practical terms, offer an alternative to mainstream sports and mainstream sports values” (Wheaton, 2013). Lifestyle sports evolved in a different social context to modern organized sport, and their informal structure has influenced the position and status of participants in the scene (Sisjord, 2009).

The aging demographics of Olympic viewers is one of the International Olympic Committee's main concerns. The inclusion of action sports in the Olympic programs has been a key strategy in trying to connect with youth consumers, most recently through the inclusion of lifestyle sports such as freestyle BMX, skateboarding, surfing, and sport climbing in the Tokyo 2020 Summer Games (Wheaton and Thorpe, 2019). As Thorpe and Wheaton (2011) highlight, the inclusion of action sports in the Olympic program is a highly complex process interwoven with various context-specific social, cultural, political, and economic factors. With heightened competition from other mega-sports events and changing leisure trends, the drive to explore new, small-scale markets and new media has become fundamental to the survival of the Olympic Games. Given that 2020 is the year when freestyle BMX will enter the Olympics for the first time, with Croatia having a potential representative, we have used this research to further explain the differences between lifestyle and mainstream



sports. Reflecting the “counter-cultural” heritage of lifestyle sports, many participants still consider these sports to be an alternative way of life rather than a sport (Wheaton, 2004) and they celebrate value systems that are often inconsistent with the disciplinary, hierarchical, and strict Olympic regimes (Thorpe and Wheaton, 2011).

The main goal of this paper is to examine the development and impact of commercialization on a unique local BMX. The analysis also explains the views of this BMX subculture regarding their sport’s inclusion in the 2020 Olympics, and the challenges that their sport faces as a result of commercialization.

## Methods

Qualitative research methods were used to gain an in-depth understanding of the freestyle BMX scene in Zagreb, Croatia. The local scene is made up of males in the 17–26 age range, who ride freestyle BMX at least three times a week. This paper is grounded in ethnographic methods, including semi-structured interviews and participant observation. These methods were used to allow participants to freely express their experiences of BMX. The ethnography was conducted using participant observation. As a researcher, I observed and participated in the local BMX scene and kept a research diary. Ethnographic fieldwork took place over eight months (from March 2019 to October 2019). During that period, I participated in over 10 BMX events or competitions and made 26 research diary entries. Extensive field diary also contain quotations of respondents and serve as a source of data in this paper.

Given that I have known most of the riders for several years already, entry to the scene was neither strange nor problematic. In addition to the Zagreb Skate Park at Jarun, socializing with participants took place during various “street jams” and competitions throughout Croatia, as well as in bars, coffee shops and other places where the participants socialize. This paper is part of a larger research project and only two interviews with members of the BMX scene have been conducted so far. The interviews included various questions about the Croatian BMX scene, the impact of commercialization and the increasing popularity of the sport, as well the challenges that arise relating to the inclusion of BMX in the 2020 Olympics.

## Results and discussion

While each lifestyle sport has its own specificity, history, identity, and development patterns, they all share many characteristics, including anti-establishment, individualistic and do-it-yourself philosophies and subcultural styles. Core members saw their culture as different to rule-bound, competitive, regulated, Western, traditional, and institutionalized sport cultures (Wheaton, 2004). Our interviewee, a Croatian BMX biker agreed with this. In his words: *“BMX is the same as skateboarding or snowboarding, only the props are different. They all came from the same place, the people are the same, it’s the same ‘vibe,’ the same lifestyle.”*

Subculture implies a recognizable hierarchical social structure, a unique set of shared beliefs and values, unique jargon, rituals and modes of symbolic expression (Hebdige, 1979). The group identity of participants in the freestyle BMX subculture is marked by a series of symbols, which range from the special equipment and clothing used, to musical taste. Beal and Wilson (2004) say that participants in any kind of lifestyle sport demonstrate a stable, shared and equal understanding of their subcultures and forms of status and identity. As one of the bikers explained: *“You can’t describe our vibe in words. You have to see it. I remember you once told us you couldn’t believe what kind of support, we give each other, even in competitions. If someone lands “flare” for the first time we’re all happy. If people saw it, that is what would impress them.”* It is interesting to note that due to commercialization, the scene has split into those who are more focused on success and competition, and those who prioritize the “good times” and the “core” values, regardless of success level or number of sponsors: *“When you look at the whole BMX scene, the BMX thrashy people will split up and they will form their own scene of thrashy BMX riders who just want to show off. They love their glittery bike frame. On the other hand, there are others, who also have sponsors, but so many people respect them for giving back to BMX scene. To sum up, we appreciate you for being a good person and that’s it.”*

There is no doubt that lifestyle sports grow rapidly as the interest of large media and marketing firms increases. While some within the BMX subculture criticize corporate involvement and decry its influence, others emphasize the direct benefits of commercialization to the subculture, both as a whole and to individuals (Edwards and Corte, 2010). Within the sport, there have been factions arguing for and against commercialization’s inclusion, with changes in attitude over time (Thorpe & Wheaton, 2011). Early practitioners were particularly careful about incorporation into these forms of competition organized by traditional sports organizations, seeing it as a form of “selling out” their “alternative” values and ideologies (Humphreys, 2003). Younger contemporary generations of lifestyle sport athletes seem more willing to embrace such opportunities, with events such as the X Games and athlete-organized competitions continuing to hold more cultural authenticity than the Olympics (Beal & Wilson, 2004; Wheaton, 2004). The same can be seen in the Croatian BMX scene: *“The X Games, however strict they are, does not take away the freestyle and freedom that the Olympics do. The X Games doesn’t take that away. Before the X Games there is no doping test because 90% of the riders smoke weed. The X Games took all that into consideration, while the IOC takes that away. And that’s why they’re losing this*



true population. This competitive population in BMX, they go to the Olympics, and they should go. These true bikers, they are BMX, these others are not, they are like some puppets, people who ride only for the success.”

Considering that Croatia is a small country, focused on sports where certain successes and medals already exist, BMX is still not as popular as in other, larger countries. Most riders believe that media coverage of BMX in Croatia is insufficient and not true to their beliefs: “We should be able to control what the media writes. They need to highlight good people and enjoyment, not tricks, craziness and backflips. It’s good they write about Ranteš [i.e., the best BMX rider in Croatia] at all, but it’s kind of a preposterous way to represent BMXing.” Since there are about fifty active riders, members of the scene see the main advantage of including freestyle BMX in the Olympics as helping to garner recognition and increase the popularity of the sport. BMX is still not well known in Croatia: For example, some people see us jumping on a wall. They do not see us training, they see we are destroying the wall. But if someone hits a football into the wall, then they call it exercise.” However, they are aware of the strict Olympic rules that will take away something they consider the main value of their sport, the lifestyle: “I think it’s great that BMX is in the Olympics because it affects the development of the sport. We try hard to make it a ‘real’ sport. But I think as much as the Olympics have a positive impact, they have a negative one as well. They take away our vibe. They’ll call the rider, they’ll do their tricks, and that’s it, it’s like the long jump. The man comes, does his thing, and he’s gone. That’s not what BMX is about. (Fieldwork diary, 10 June 2019)

This research therefore supports and extends some of the conclusions drawn by other scholars who have investigated this specific case (Rinehart, 2008, Wheaton and Thorpe, 2011, Wheaton 2019). The cultural politics within this group is unique, based on a distinctive history, ideology and identity. Lifestyle sports provide an important lens for understanding the empirical and theoretical trajectories and challenges of sport in the twenty-first century.

## Conclusion

In sum, this research provides valuable information about local BMX riders’ attitudes to the commercialization of lifestyle sports, and their inclusion in the Olympic Games. In their efforts to fast-track the inclusion of action sports into the Olympic program, the IOC (International Olympic Committee) incorporated them with little knowledge of the unique cultural values or practical requirements of lifestyle sports participants. Many participants see a potential loss of autonomy within the Olympic structures. However, since BMX is still not well known in Croatia, the riders see the benefits of inclusion only in the popularity and progress of the sport itself. While the marriage between action sports and the Olympic Games will certainly add to the popularity of BMX worldwide, it can be assumed that there will be a further rift within the BMX scene given that the Olympics exclude the core and genuine values of lifestyle sports, at least from the perspectives of riders. This methodological approach can help shed further light on the complex dynamics of commercialization in lifestyle sports.

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# **Social Sciences and Humanities**

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## BODYBUILDING AND FUNCTIONAL FITNESS WOMEN IMAGE AND IDENTITIES: INSIGHTS FROM SELECTED HUNGARIAN WOMEN ATHLETES

Airnel Abarra<sup>1</sup>, Tamas Doczi<sup>2</sup>

<sup>1</sup>*Doctoral School of Sport Sciences University of Physical Education, Hungary*

<sup>2</sup>*Department of Social Sciences University of Physical Education, Hungary*

**Introduction:** Bodybuilding and its related categories have their aims of presenting the ideal physique that showcases muscularity, definition, symmetry, and balance. Women practicing the sport are training to the fullest of their potential to showcase their physique. Meanwhile, women athletes who are engaged in Functional Fitness, known for its common name CrossFit, perform a different set of fitness and strength exercises to showcase their capacities and limits in being the “fittest” (Washington & Economides, 2015). Although having a muscular and defined physique for women training for functional fitness is not a criterion in their events and competitions, it is initially seen that most of the women doing the sport manifest muscular and defined physiques (Coyne & Woodruff, 2020). These similarities/dissimilarities of the two disciplines make it an interesting question for research to undertake in-depth analysis of the athletes engaged in these activities, in order to explore their narratives, motivations, and ideals.

**Methods and Results:** My aim for this study is to observe, and determine the similarities and dissimilarities of these women in terms on their perceptions towards muscular and strong physique. Through the analysis of a number of case studies based on participant observation and semi-structured in-depth interviews, the author aims to document the stories, ways, and means of the athletes (Coyne & Woodruff, 2020).

**Conclusion:** I hope through this study it can contribute to the body of knowledge about women in physique and strength sports and provide further discussion on this theme especially on the sociological aspect of women functional fitness and physique athletes.

**Key words:** *Bodybuilding, Functional Fitness, Women, Physique, Identities, Hungary*

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# GENDER DIFFERENCES IN BODY IMAGE CONCERNS, DISORDERED EATING, AND QUALITY OF LIFE IN THE SAMPLE OF LITHUANIAN STUDENTS: THE RESULTS OF THE PILOT STUDY

Vaiva Balciuniene

*Lithuanian Sports University, Lithuania*

## Abstract

**Purpose:** Body image concerns, disordered eating, health-related lifestyle, and quality of life contain a significant problem in the student-aged youth. The present pilot study aimed to examine gender differences in body image concerns, disordered eating, quality of life, self-esteem, and physical activity in the sample of Lithuanian students. **Methods:** A gender-mixed sample of undergraduate ( $n = 298$ ) and graduate students ( $n = 84$ ) participated in this pilot study. The mean age of the sample was  $24.0 \pm 6.4$  years. Students completed a self-report online questionnaire measuring body image (LT-MBSRQ-AS), the risk of eating disorders Eds (LT-EDE-Q 6.0), quality of life (LT-WHOQOL-BREF), self-esteem (RSES), and the level of physical activity (GSLTPAQ). **Results:** Men demonstrated significantly greater body areas satisfaction and lower overweight preoccupation and appearance orientation compared to women. For women, the general mean score of eating disorders was higher compared to men. There were observed no significant differences between men and women for the mean general score of quality of life scale and self-esteem. However, men reported significantly higher physical activity compared to women. **Conclusions:** Women reported significantly greater prevalence in body image concerns and disordered eating, and lower physical activity levels than men. There were no significant differences in the quality of life and self-esteem between genders. Prevention of body image concerns and promoting a healthy lifestyle is important for student-aged women and men.

**Key words:** *body image concerns; disordered eating; quality of life; physical activity, students*

## Introduction

Research shows that body image concerns and disordered eating are major health-related problems in youth (Neumark-Sztainer et al., 2018). To date, there is a lack of epidemiological studies on the prevalence of eating disorders (Eds) or disordered eating performed in Lithuania. However, in the young people population, body image concerns, disordered eating, health-compromising eating behaviors, and quality of life contain a significant problem and area of research (Baceviciene, Jankauskiene, & Emeljanovas, 2019; Jankauskiene & Baceviciene, 2019; Lesinskiene et al., 2018). The present pilot study aimed to examine gender differences in body image concerns, disordered eating, quality of life, self-esteem, and physical activity in the sample of Lithuanian students.

## Methods

### Participants, procedure, and ethical considerations

A gender-mixed sample of undergraduate ( $n = 298$ ) and graduate students ( $n = 84$ ), all from various state universities and colleges in Lithuania, participated in this study. The data were obtained during April-June in 2019, and the representativeness of the sample of students was achieved by the compliance of the respondents to the numbers of students in all study areas. Thus, according to the distribution of the available numbers, students in this sample were enrolled in natural and agricultural (2.6%), technology (10.6%), medical and health (24.9%), social and humanities (61.9%) study areas. Students completed a self-report online questionnaire measuring body image (LT-MBSRQ-AS), the risk of eating disorders Eds (LT-EDE-Q 6.0), quality of life (LT-WHOQOL-BREF), self-esteem (RSES), and the level of physical activity (GSLTPAQ). The procedure was scheduled in-class time, with no time limit. Three hundred and ninety-three questionnaires were completed, and three hundred and eighty-two questionnaires were employed for this study. The data were excluded from the study if not all items of the polls were consequently filled in by the study participants. The researchers received ethical approval to conduct this study by the Committee for Social Sciences Research Ethics of the Lithuanian Sports University (protocol No. SMTEK-7, 13-03-2019). The laws of anonymity, goodwill, and volunteering were followed during the survey.

## Measures

*Demographic data.* Participants in the study were asked to specify their gender, age, type of higher education institution (university or college), the level of study cycle, study area, and the year of study.

*The Body mass index (BMI)* was based on the self-reported data of students' height and weight, from which BMI was calculated ( $\text{kg/m}^2$ ). For sample characteristics, as recommended by the World Health Organization classification, the students' sample was arranged into four body mass categories: underweight ( $\text{BMI} < 18.5 \text{ kg/m}^2$ ), normal weight ( $\text{BMI} = 18.5\text{--}24.9 \text{ kg/m}^2$ ), overweight ( $\text{BMI} = 25.0\text{--}29.9 \text{ kg/m}^2$ ) and obese ( $\text{BMI} \geq 30.0 \text{ kg/m}^2$ ) (World Health Organization, 1997).

*The Lithuanian version of the Eating Disorder Examination Questionnaire 6.0 (EDE-Q 6.0)* (Fairburn & Beglin, 2008) is a 28-item self-report questionnaire and provides a comprehensive evaluation of the essential behavioral characteristics of Eds and eating disordered behavior. The tool concentrates on one's focus on the last 28 days and establishes two models of data. First, the six open-ended questions result in frequency data on the essential behavioral characteristics of Eds: objective binge eating, self-induced vomiting, laxative use, and excessive exercise. Second, 22 attitudinal questions comprise four subscales (restraint, eating concern, shape concern, and weight concern) and result in subscale scores that reflect the severity or frequency of Ed's characteristics. The answer options are arranged on a 7-point Likert scale from 0 (no day) to 6 (every day). A higher score reflects either greater severity or frequency. The Lithuanian version of the EDE-Q 6.0 (LT-EDE-Q 6.0) has demonstrated good validity and reliability in a student population sample (Baceviciene, Balciuniene, & Jankauskiene, 2020). In the present study, Cronbach's alpha for the LT-EDE-Q 6.0 general scale was 0.94.

*The Lithuanian version of the Multidimensional Body-Self Relations Questionnaire – Appearance Scales MBSRQ-AS* (Brown, Cash, & Mikulka, 1990) was employed to assess the appearance-related elements of the body image construct. The instrument of the 34-item consists of five subscales (appearance evaluation, appearance orientation, overweight preoccupation, body areas satisfaction, and self-classified weight) with responses on a 5-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree). Research has supported the reliability and validity of the Lithuanian version of the MBSRQ-AS (LT-MBSRQ-AS) in a student population sample (Miskinyte & Bagdonas, 2010). The internal consistency of the appearance evaluation, appearance orientation, overweight preoccupation, body area satisfaction, and self-classified weight subscales was 0.78, 0.83, 0.71, 0.86, and 0.82, respectively. Cronbach's alpha for the LT-MBSRQ-AS general scale was 0.75.

*The Lithuanian version of the World Health Organization Quality of Life-BREF Questionnaire (WHOQOL-BREF)* (The WHOQOL Group, 1998) is a self-report questionnaire with 26 items and was used to assess the quality of life. Two questions of the overall perception of the quality of life and the overall understanding of health were evaluated separately. The remaining 24 items of the questionnaire comprise four domains: physical health, psychological health, social relationships, and environment. The responses can range from 1 (very dissatisfied) to 5 (very satisfied). The scores are transformed into a scale between 0 and 100, with 0 being very poor and 100 being very good. The reliability and validity of the Lithuanian version of the WHOQOL-BREF (LT-WHOQOL-BREF) in a student population sample have been demonstrated (Ducinskiene, Kalediene, Petrauskiene, & Sumskas, 2002). The internal consistency of physical health, psychological health, social relations, and the environment domains were 0.75, 0.83, 0.74, and 0.83, respectively. Cronbach's alpha for the LT-WHOQOL-BREF general scale was 0.92.

*The Lithuanian version of M. Rosenberg's Self-Esteem Scale (RSES)* (Rosenberg, 1979) was used to assess self-esteem and general feelings of self-worth. The scale is composed of 10 items scored on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree), yielding scores from 10 to 40. After reversing the positively worded items, the overall self-esteem score is computed. A higher score denotes a greater level of self-esteem. RSES is the most widely used measure of global self-esteem (Schmitt & Allik, 2005). Cronbach's alpha for the RSES in this study was 0.91.

*The Lithuanian version of the Godin-Shephard Leisure-Time Physical Activity Questionnaire GSLTPAQ* (Godin & Shephard, 1985) was used to assess leisure-time physical activity in an average week. The self-report instrument measures mild, moderate, and strenuous leisure-time physical activity over a week. The number of bouts of mild exercise is multiplied by 3, moderate exercise by 5, and strenuous exercise by 9, resulting in a general score of leisure-time physical activity (as the sum of these three components), which provides a total metabolic equivalent by each intensity level. A higher score indicates a higher leisure-time physical activity level.

## Statistical Analysis

First, descriptive statistics and distribution normality testing of the study variables were performed. The results were presented as the means  $\pm$  standard deviations and percentages according to the type of variable. The Kolmogorov-Smirnov test was used to determine the normality distribution of the variables. Second, for normally distributed study variables, comparisons between males and females were made using an independent sample t-test; for non-normally distributed variables, the Mann-Whitney U test was applied. Cronbach's alpha coefficients ( $\alpha$ ) were used for the evaluation of the internal consistency of study scales. The statistical analyses were carried out using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY, USA).



## Results

There were significant differences in BMI between genders. Men reported a significantly higher mean BMI score than women ( $24.98 \pm 3.22$  versus  $22.16 \pm 3.78$ , respectively,  $p < 0.001$ ). The majority of the sample was of normal weight; 87 (22.7%) were overweight or obese, 34 (8.9%) were underweight (Table 1). However, 31 (8.1%) of students underestimated their body weight, 95 (24.8%) reported overestimation, and 256 (67%) showed an adequate estimation of body weight. The results showed that 69.5% of surveyed men and 66.2% of women evaluated their body weight adequately. The body weight underestimation was more prevalent among men than among women (24.2% and 2.8%, respectively,  $p < 0.001$ ), while overestimation – among women (31.0 and 6.3% respectively,  $p < 0.001$ ). The majority of the study participants were sufficiently physically active, 33 (8.6%) were moderately active, and 36 (9.4%) reported being physically inactive.

Table 1. Descriptive characteristics of the gender-mixed Lithuanian student sample ( $n=382$ )

Characteristics		
Gender, % (n)	male	24.9 (95)
	female	75.1 (287)
Age, years, $m \pm SD$		$24.0 \pm 6.4$
Type of the higher education institution, % (n)	university	77.2 (295)
	college	22.8 (70)
Level of study cycle, % (n)	undergraduate	78.0 (298)
	graduate	18.3 (70)
	Ph.D.	3.7 (14)
Study area, % (n)	natural and agricultural	2.6 (10)
	technology	10.6 (40)
	medical and health	24.9 (94)
	social and humanities	61.9 (234)
Bodyweight groups, % (n)	underweight	8.9 (34)
	normal weight	68.3 (261)
	overweight	16.2 (62)
	obese	6.5 (25)
Physical activity level, % (n)	inactive	9.4 (36)
	moderately active	8.6 (33)
	active	81.9 (313)
Body mass perception adequacy, % (n)	Overestimation	24.8 (95)
	Adequate estimation	67.0 (256)
	Underestimation	8.1 (31)

Note:  $n$  = number of study participants, % = percentage,  $m$  = mean,  $SD$  = standard deviation.

The present study demonstrated significant differences in body image (Table 2). Men demonstrated a significantly greater body areas satisfaction compared to women ( $3.43 \pm 0.80$  versus  $3.19 \pm 0.72$ ;  $p = 0.004$ ) and reported lower overweight preoccupation than females ( $1.98 \pm 0.80$  versus  $2.40 \pm 0.92$ ;  $p < 0.001$ ). Additionally, the appearance orientation subscales mean score of  $3.54 \pm 0.56$  was higher for women than for men  $3.21 \pm 0.58$  ( $p < 0.001$ ).

Next, the general disordered eating mean score for women ( $1.60 \pm 1.20$ ) was significantly higher compared to men ( $1.10 \pm 1.10$ ),  $p < 0.001$ . However, there were observed no significant differences in disordered eating and compensatory behaviors between men and women.

Further, there were no significant differences in quality of life (general mean score) and self-esteem between men and women observed. For women, physical activity level was significantly lower compared to men ( $53.38 \pm 37.03$  versus  $77.28 \pm 46.69$ ;  $p < 0.001$ ) (Table 2).

Table 2. Comparison of the study variables in male and female students (n=382)

Variables	Men (n=95)		Women (n=287)		p
	m	SD	m	SD	
LT-EDE-Q 6.0 general	1.10	1.10	1.60	1.20	<0.001
Disordered eating behaviors, LT-EDE-Q 6.0:					
Dietary restraint (Item 2)	0.55	1.31	0.82	1.58	0.112
Binge eating distinguished by loss of control (Item 14)	3.39	11.49	2.07	4.33	0.954
Compensatory behaviors, LT-EDE-Q 6.0:					
Self-induced vomiting (Item 16)	0.24	1.61	2.10	31.05	0.609
Laxative misuse (Item 17)	0.12	0.87	0.99	13.15	0.249
Excessive exercising (Item 18)	6.66	8.49	4.43	6.94	0.082
LT-MBSRQ-AS					
Appearance evaluation	3.25	0.70	3.22	0.79	0.697*
Appearance orientation	3.21	0.58	3.54	0.56	<0.001*
Overweight preoccupation	1.98	0.80	2.40	0.92	<0.001
Body areas satisfaction	3.43	0.80	3.19	0.72	0.004
Self-classified weight	3.20	0.74	3.19	0.74	0.990
LT-WHOQOL-BREF					
Physical	70.83	16.03	67.01	15.18	0.024
Psychological	61.67	18.85	57.83	17.06	0.059
Social relationships	58.77	24.56	61.06	22.51	0.522
Environment	65.89	20.46	65.51	15.55	0.618
RSES	30.20	6.71	29.40	5.95	0.081
GSLTPAQ	77.28	46.69	53.38	37.03	<0.001
BMI	24.98	3.22	22.16	3.78	<0.001

Note: \* – scores were compared by an independent sample t-test; n = number of study participants; p = statistical significance level.; m = mean; SD = standard deviation; LT-EDE-Q 6.0 = the Lithuanian version of Eating Disorder Examination Questionnaire 6.0; LT-MBSRQ-AS = the Lithuanian version of Multidimensional Body-Self Relations Questionnaire – Appearance Scales; LT-WHOQOL-BREF = the Lithuanian version of World Health Organization Quality of Life-BREF Questionnaire; RSES = the M. Rosenberg Self-Esteem Scale; GSLTPAQ = the Godin-Shephard Leisure Time Physical Activity Questionnaire; BMI = the Body Mass Index.

Finally, the patterns of disordered eating and compensatory behaviors were assessed, and results are presented in figure 1. 10.7% of students reported that they had kept regular dietary restrictions during the last month. 18.6% of study participants were engaged in regular (once a week) binge eating distinguished by loss of control. The percentage of students involved in regular self-induced vomiting, laxatives use, and excessive exercising during the last month was 2.6%, 1.6%, and 7.6%, respectively. The most prevalent disordered eating pattern was binge eating, distinguished by loss of control.

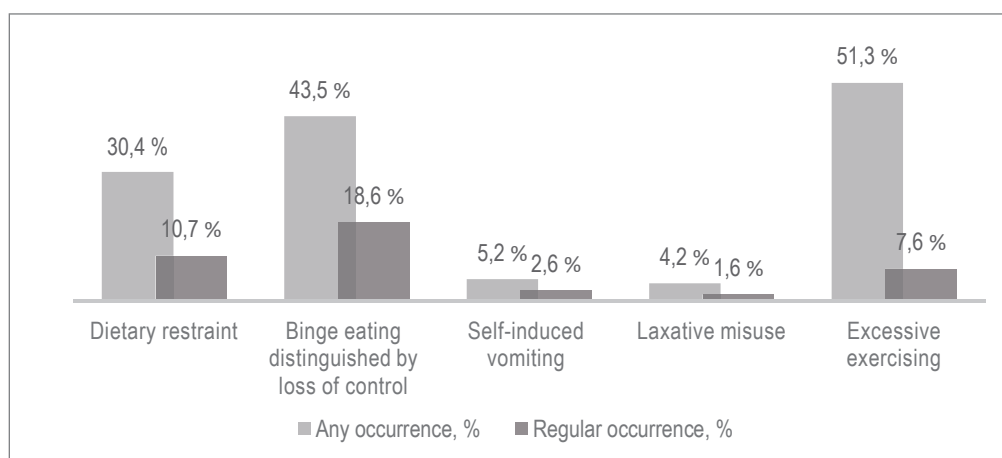


Figure 1. The proportion of students who engaged in any or regular occurrence of disordered eating behaviors and compensatory behaviors during the preceding 28 days. Note: A regular occurrence was determined as  $\geq 4$  times during the preceding 28 days. Exclusion to this criterion was applied to dietary restraint (regular occurrence was defined as  $\geq 13$  days over the preceding 28 days) and excessive exercise (regular occurrence was defined as  $\geq 20$  times over the preceding 28 days).

## Discussion

The present pilot study aimed to examine gender differences in body image concerns, disordered eating, quality of life, self-esteem, and physical activity in the sample of Lithuanian students. This study showed that a significant part of students overestimates their body weight. Research shows that bodyweight overestimation is related to body image concerns and disordered eating (Shagar, Harris, Boddy, & Donovan, 2017).

As expected, the present study demonstrated significant body image differences between men and women. We found that men were more satisfied with their body areas and were less preoccupied with their overweight and appearances than women. Other studies also demonstrated that women express greater body image concerns than men (Argyrides & Kkeli, 2013; Roncero, Perpina, Marco, & Sánchez-Reales, 2015; Untas, Koleck, Rascle, & Borteyrou, 2009). The results of the present study demonstrated that women scored higher on disordered eating compared to men, and these findings go in line with other studies (Carey et al., 2019; Isomaa et al., 2016; Mitsui, Yoshida, & Komaki, 2017; Reas, Øverås, & Rø, 2012; Yucel et al., 2011).

The TIM model can help to explain the underlying mechanisms of Eds (Thompson, Heinberg, Altabe, & Tantleff-Dunn, 1999). According to it, young people experience sociocultural, environmental pressure (from family, peers, and the media, respectively) related to their appearance, body shape, and body weight. This pressure further encourages them to constantly compare their appearance with accepted beauty ideals and internalize those standards. Non-compliance with beauty standards leads to a negative psychological state and frustration with one's body, which causes dissatisfaction with one's body and continues to be associated with disordered eating (Neumark-Sztainer et al., 2018). It is important to emphasize that women tend to internalize the thin body ideal (Shagar et al., 2019), while men's pursuit of appearance expectations is more complex: they internalize muscular/athletic and low body fat ideal (Klimek, Murray, Brown, Gonzales IV, & Blashill, 2018; Tylka, 2011). So a higher level of perceived pressure is associated with greater body image concerns that force to engage in health-unfavorable body change strategies; however, women are exposed much more than men (Esnaola, Rodríguez, & Goñi, 2010). The body image of a young woman formed in the media is unrealistic and unachievable, while the presentation of man body forms in the media is unrealistic and idealized, yet it is closer to the actual image of a man (Frederick & Reynolds, 2021; Tiggemann, Marika, 2012). Besides, compared with men, women are more frequently directed to attain idealized beauty standards in their daily routines (Buote, Wilson, Strahan, Gazzola, & Papps, 2011). Moreover, conducted studies confirm that the upward social comparison with ideal standards affects perception and satisfaction with body image and leads to body dissatisfaction (Myers & Crowther, 2009). This upward social comparison effect is stronger for women than for men (Myers & Crowther, 2009).

The significant gender differences in disordered eating behaviors and compensatory behaviors among the Lithuanian student sample were not observed. However, we found that approximately 11% of the students faced the regular occurrence of dietary restraint, which appears to be much higher than in the Norway study (Rø, Reas, & Lask, 2010) but lower than in Portugal study (Machado et al., 2014). The frequency of binge eating distinguished by loss of control in our sample was approximately 19%, and it is similar to a Spanish sample of undergraduate women (Villarroel, Penelo, Portell, & Raich, 2011). Approximately 3% of the study participants endorsed regular self-induced vomiting, and these findings go in line with Portuguese college women's study (Machado et al., 2014). Similar results were found between our study participants and Norwegian university women on the episodes of excessive exercising (Rø et al., 2010). The research results showed that laxative misuse is a common occurrence in our student sample.

Our study showed that for women, physical activity was significantly lower compared to men. Other studies in youth have demonstrated that males are more physically active than females (de Looze, Elgar, Currie, Kolip, & Stevens, 2019; DeWolfe, Watt, Romero-Sanchiz, & Stewart, 2018). This study adds to the knowledge that the prevention programs for student-age women and men are of enormous importance. Promotion of a healthy lifestyle together with the cognitive dissonance-based programs aiming to decrease body image concerns have been shown to be effective in Western student samples (Linardon, Gleeson, Yap, Murphy, & Brennan, 2019). Our study adds to the knowledge that it is necessary to implement those programs in Lithuania either. However, as it is a pilot cross-sectional study, the generalization of the results is limited. Further studies should analyze associations between the body image concerns, disordered eating, lifestyle, and quality of life in large representative student samples of both genders.

## Conclusions

Women reported significantly greater prevalence in body image concerns and disordered eating, and lower physical activity levels than men. There were no significant differences in the quality of life and self-esteem between genders. Prevention of body image concerns and promoting a healthy lifestyle are important for student-age women and men.

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## DID THE SUPERB ACHIEVEMENTS OF THE CROATIAN SAILORS IN RIO DE JANEIRO INFLUENCE THE ATTITUDE CHANGES TOWARDS SAILING BETWEEN TWO GENERATIONS OF STUDENTS?

**Filip Bolčević<sup>1</sup>, Frane Tomljenović<sup>2</sup>, Nikola Prlenda<sup>3</sup>**

<sup>1</sup>*Zagreb Canoe Association, Croatia*

<sup>2</sup>*Elementary School Markuševac, Croatia*

<sup>3</sup>*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

The purpose of this study was to examine potential differences between two generations of students in attitude changes towards sailing under the influence of the superb achievements of the Croatian sailors in Rio de Janeiro. We included 189 young adult participants (75 women and 114 men), inexperienced in sailing and mostly from the mainland, who anonymously and voluntarily filled out a previously validated Lickert scale-type questionnaire related to their attitudes towards sailing between the Olympic Games. Superb achievements of the Croatian sailors in Rio de Janeiro did not relate to the attitude change between the groups ( $p=.83$ ) as well as when the scores were analyzed separately for the male ( $p=.47$ ) and female sailing beginners ( $p=.18$ ). Although Group 2 had a more positive attitude towards sailing, as well as the women in the same group, statistical significance was not found. Bigger media coverage due to Olympic Games and superb sport results have not related to the attitude change towards sailing, unlike the sailing school which has had a positive influence on the formation of attitude. The specificity of sailing and the huge differences between recreational and professional sailing obviously do not define the observer's attitude towards the sport, unlike active participation in an organised sailing school when such an attitude is clearly being built. The goal of future studies should be to research the influence of targeted interventions for the promotion of the sailing sport results and sailing lessons, to evaluate the influence of such activities with such a highly reliable measuring instrument.

*Key words: sailing beginners, sailing school, olympic games, physical activity*

### Introduction

Sailing is both the most relaxing pastime imaginable and the most complex sport in the world. It is a serious competitive sport for some, and a recreation for others. But the origins of both forms of sailing lie in the distant past and the days of exploration, migration, and commerce across the oceans and the seas (Sleight, 2012). Today there are hundreds of sailing classes, and sailing is as a recreation, a fun pastime and as a competitive sport widespread around the world and is enjoyed by 16 million people (Neville & Folland, 2009; Neville et al. 2009). Most of today's sailors are recreational, but there is also a high number of those who are sailing competitively and who are members of sailing clubs (Allen & De Jong, 2006). As a global sailing destination, Croatia has for the last few years been experiencing a continual growth which is confirmed by every international sailing website, and navigation is part of one of the most important export branches in the Republic of Croatia (<http://www.hjs.hr>, <http://www.sailing.org>, [www.sailmagazine.com](http://www.sailmagazine.com)). For that reason the lack of media interest in exceptional sport results which our sailors achieve at the Olympic Games, and both World and European Championships, as well as poor knowledge of sailing as a sport within the population of young adults, is surprising. Alongside what is listed above, the decreasing activity in young adults also relates to the lack of interest towards sport in general, and therefore towards sailing as well (Trudeau & Shephard, 2005). Attitude can be defined as an acquired, relatively permanent and stable, organisation of positive or negative emotions, evaluations and reactions towards an object, an individual or an idea (Petz, 1992). Even though all attitude in itself contains emotional, cognitive and behavioral components, it is possible to determine an affiliation towards a particular group as they are not innate but are formed in a process of socialization, are gained by experience, and also often under the influence of an emotional experience. What kind of attitude an individual will have depends greatly on the group they belong to, on the information that they are exposed to, the new situations they find themselves in, on the influence of different media and life situations which can then influence the strengthening or the changing of attitude towards someone or something (Aranson et al., 2005; Zvonarević, 1981). A positive attitude towards an activity relates to the willpower and the intention to join that activity (Godin et al., 1987) and it has a great influence on the success rate within that activity which has been confirmed by a number of research (Juhás et al., 2011; Moskovljević & Orlić, 2012; Nieminen & Varstala, 1999; Vlašić, 2010). Past

research have shown how under the influence of great sport events, as well as directed and well organised teachings can relate to an attitude change towards a certain sport just like the authors have shown in the teachings of dance, skiing and soccer (Vlašić et al., 2012; Cigrovski et al., 2014; Cigrovski et al., 2010; Busch et al., 2002). The purpose of this research is to determine, with the help of a highly reliable scale for attitude assessment (Prleđa et al., 2010), how have the top results that have been achieved by our sailors at the Olympic Games in Rio de Janeiro influenced an attitude change towards sailing in students at the Faculty of Kinesiology, University of Zagreb, and does the attitude change differs between male and female participants. The hypothesis is that top results of our sailors at the Olympic Games in Rio de Janeiro will relate an attitude changes towards sailing in students at the Faculty of Kinesiology University of Zagreb and that the attitude change differs between male and female participants.

## Methods

### Subjects

Study included 82 young adult participants (30 women and 52 men; aged 21,76 + 1,03 years) in Group 1 before and 107 participants in Group 2 (45 women and 62 men; aged 21,85 + 1,13 years) after the Olympic Games, naive in sailing and mostly from mainland.

### Procedures

Participants voluntarily filled out previously validated 30-item Lickert-type-scale questionnaire related to attitude towards sailing (test reliability: Cronbach  $\alpha = .95$ , and homogeneity:  $r = .38$ ) (Prleđa et al., 2010; Prleđa et al., 2017). The subjects from Group 1 were tested during the course of sailing in the summer before the Olympic Games and the ones from Group 2 in the same period but one year after the Olympics. The participants were asked to choose one statement from 1 (I disagree at all) to 5 (I totally agree) on each tested item which most accurately describes their feelings. The overall result was calculated as a simple sum of results in claims (after the negative particles, where a higher score suggested a more positive attitude, had been inversely scaled). Data collection was anonymous.

### Statistical analysis

The collected results of the investigation have been put into and processed in the *Statistica 13.0* program (Statsoft, Tulsa, SAD), licensed at the Faculty of Kinesiology, University of Zagreb. For the purposes of this study the descriptive parameters were calculated first. The normality of the distribution the groups was assessed by the Kolmogorov-Smirnov (K-S) test at the level of inference error  $p \leq 0,05$ . The differences between the first and the second group were verified using the t-test for large independent samples. The level of statistical significance is set at the value of  $p \leq 0,05$ .

## Results

Basic descriptive parameters and the results of t-test for independent samples between the groups on attitude towards sailing of the tested sample and its subgroups are presented in Table 1. and Table 2.

Table 1. Results of descriptive statistics and differences between groups on attitudes towards sailing

Group 1 vs. Group 2	T-test for Independent Samples										
	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances
	108,11	109,62	-0,76	188	0,45	82	108	13,77	13,47	1,04	0,83

Table 2. Results of descriptive statistics and differences between subgroups on attitudes towards sailing

	T-test for Independent Samples										
	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances
Group 1 M vs. Group 2 M	108,83	108,26	0,22	112	0,83	52	62	12,94	14,30	1,22	0,47
Group 1 W vs. Group 2 W	106,87	111,69	-1,51	73	0,13	30	45	15,23	12,20	1,56	0,18

Superb results of the Croatian sailors at the Olympic Games have not influenced a significant attitude shift between two generations of students even though the result is somewhat better with the generation after the Olympic Games ( $p=.83$ ), as can be seen in Table 2. The results of the descriptive statistics (given in Table 3) indicate a more positive attitude towards sailing in female participants in the group after the Olympic Games, but the statistically significant difference disappeared ( $p=.18$ ; Table 3). For male participants the result was almost the same, 108,83 compared to 108,26 as can be seen in Table 2 and the statistically significant difference disappeared as well ( $p=.47$ ).

## Discussion and conclusion

Physical activity is tightly connected to the improvement of health, therefore it is of vital importance to find ways of teaching an activity that will, on the one hand, secure the betterment of quality of life and disease prevention, and that will, on the other hand, secure a safe learning of the new activity without pain, discomfort and possible injuries (Trudeau & Shephard, 2005). Several studies have investigated the attitudes towards physical activity, and suggested the potential determinants of such attitudes (Luke & Sinclair, 1991; Christodoulos et al., 2006; Rikard & Banville, 2006). Moreover, gender-related differences in attitudes towards physical activity were acknowledged (Luke & Sinclair, 1991; Milligan et al., 1997; Krouscas, 1999; Kumar & Kumar, 2013). Studies that research the differences in attitudes between men and women towards a specific sport or physical activity in general are not all in agreement. The differences between genders have been found in the attitudes towards combat sports (Bosnar et al., 1999; Busch et al., 2002; Radić, 2003). Also, differences have been found in attitudes towards sailing (Oreb et al., 2011) and rhythmic gymnastics (Moskovljević & Orlić, 2012), but in favor of the female population. Other authors, however, have not found differences in attitudes between two populations in their studies (Babić et al., 2002; Baker & Wideman, 2006; Nieminen & Varstala, 1999; Sanderson, 2001). In both cases it is about sports that could be placed in one of the categories by their stereotypical description of “men’s sports” and “sports for women” (Bosnar et al., 1999). Certainly the sample upon which the researches had been conducted plays a big role. Therefore it is of no surprise that the research conducted on professional dancers does not show differences in attitudes between the two populations (Nieminen & Varstala, 1999), and the same is shown in children that probably still have not had time to form stereotypes towards dance as a female activity (Sanderson, 2001). In their research about dance, sailing and skiing teachings, Vlašić et al. (2012), Cigrovski et al. (2014), Prlenda et al. (2017) prove how exactly through effective and organised teaching a more positive attitude towards a specific sport can be influenced. Also, even though participants can have a positive attitude towards sport in general, what can happen is that they have a negative attitude towards combat sports which they perceive as dangerous exclusively from their lack of knowledge or poor teachings about said sports (Bosnar et al., 1996). Except for the influence of navigation in promoting Croatia across the globe, Croatian sailors are also important – it was because of their results and winning a gold and silver medal at the Olympic Games in Rio de Janeiro in 2016 that Croatia became an international superpower in this sport. Therefore the research goal was to see if an event like this can influence a more positive attitude towards sailing in the young and active student population of the Faculty of Kinesiology that follow sport, and especially the Olympic Games. The results of the research show that there is no significant change in attitude influenced by the Olympic Games and the superbly achieved results between two quite homogenic generations of students. The mildly positive result in the whole generation is noticeable, as well as in women in the generation after the Olympic Games, but statistical significance is lacking. Usually we can find the reason for this in the lack of media interest and coverage of “small” and individual sports and their results but here that is not the case. Bigger media coverage due to Olympic Games and superb sport results have not related to the attitude change towards sailing, unlike the sailing school (Prlenda et al, 2017) which has had a positive influence on the formation of attitude. The specificity of sailing and the huge differences between recreational and professional sailing obviously do not define the observer’s attitude towards the sport, unlike active participation in an organised sailing school when such an attitude is clearly being built. The goal of future studies should be to research the influence of targeted interventions for the promotion of the sailing sport results and sailing lessons, to evaluate the influence of such activities with such a highly reliable measuring instrument. The changing of attitude in a positive direction towards sailing in a population of young kinesiologists will relate to the creation of a wider and efficient staff that will find their professional vocation in navigation, and along with that it will help to raise the quality of nautical tourism in Croatia and the world.

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## OPPORTUNITIES FOR UNDERGRADUATE KINESIOLOGY PROGRAMS IN CANADA: PERSPECTIVES FROM RECENT GRADUATES

Yeu-Yao Cheng<sup>1</sup>, Alexander Klas<sup>2</sup>, Rebecca Ataman<sup>3,4</sup>, Shannon Chou<sup>5</sup>, Sepehr Pouresa<sup>6</sup>

<sup>1</sup>*Faculty of Medicine and Health, The University of Sydney, Australia*

<sup>2</sup>*Faculty of Kinesiology and Physical Education, University of Toronto, Canada*

<sup>3</sup>*School of Physical and Occupational Therapy, McGill University, Canada*

<sup>4</sup>*Centre de recherche interdisciplinaire en réadaptation du Montréal métropolitain (CRIR), Canada*

<sup>5</sup>*Department of Physiotherapy, Vancouver General Hospital, Canada*

<sup>6</sup>*Faculty of Dentistry, McGill University, Canada*

Kinesiologists are a growing group of health professionals who enter practice after completing undergraduate kinesiology programs. Unlike other health professional programs such as medicine and physiotherapy that have well-established curricula and standards, kinesiology programs vary. The resultant disparity in graduates' entry-level skillset, competency, and confidence level contributes to their uncertainty regarding their role in healthcare and the public's underutilization of kinesiology services.

As former kinesiology students, and as current kinesiologists and allied health professionals, we offer our perspective on how undergraduate kinesiology programs could change to respond to the needs of their graduates. Specifically, we suggest an increased emphasis on practical skill development, providing students with kinesiologist mentors or teaching staff, helping students with career planning as kinesiologists, and offering explicit streams of specialization. We hope this perspective will make a contribution that could ultimately better prepare students for a career as a kinesiologist.

**Key words:** *kinesiology, undergraduate, health care, fitness professional, allied health, curriculum*

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## KARATEKA'S IDENTIFICATION WITH THE TRADITIONAL KARATEDO THEORY

Jitka Čihounková

Masaryk university, Faculty of Sport Studies, Czech Republic

### Abstract

The aim of the present study is to find the level of Karateka's identification with the traditional karatedo theory. Data was obtained by controlled depth interviews with selected group of traditional karate Fudokan karateka. The records of the interviews were qualitatively evaluated on the basis of specific coding using software Atlas.ti. The most commonly accruing codes were placed into the net graph, in which the relationships between the codes are described as well. Upper half of graph represents the traditional karatedo and corresponds a lot with karatedo theory. In the lower part of the graph there are codes that represents today's values and motivation for doing physical activity. The results introduced by the net graph reflect today's traditional karatedo in which the traditional values and modern life requirements are interconnected.

*Key words:* Martial art, interview, specific coding, Fudokan

### Introduction

"Although there are many ways, karate is only one." Wellknown Gichin Funakoshi's statement answers all questions about differences among karate styles. There is not only one true way, there is just one true goal – karate. Even with the same goal, different people chose different ways.

The difference of traditional karatedo from other karate was acknowledged by International Olympic Committee in 1993 at its 101<sup>st</sup> General Assembly (Jorga, 2012). After competing karate became the olympic sport we can assume, that the gap between traditional and competitive karate will get wider.

The description of social groups comprising different karate ways helps us to understand them better. These social groups are forming and getting the specific characteristics and values through different influences (sport rules, personality of teacher, moral values and others). The knowledge of the group is essential in the process of deciding which group to join and what kind of person to become with the influence of the group (Čihounková & Reguli, 2016). Some research in this field did prof Cynarski in kadet and youth Polish traditional karateka (Cynarski & Niewczas, 2017, 2019).

To check how traditional today traditional karateka in The Czech Republic are we have realized presented research.

### Methods

The aim of the present study is to find the level of Karateka's identification with the traditional karatedo theory.

The data was obtained by controlled depth interviews with selected group of traditional karate Fudokan karateka. The records of the interviews were qualitatively evaluated on the basis of specific coding using software Atlas.ti.

Karateka for interviews were selected according to following criterias: long time karatedo experience (minimum of 15 years), competing experience (present or in the past), karatedo teacher. Karateka who go through more social roles (beginner – competitor – master – teacher – eventually functionaire of the karatedo club with another administration, social and political demand) were chosen.

The topics of interview were motivation for starting karatedo practice, changes of motivation from the beginning of the karatedo practice till today, pros and cons of long term karatedo practice, karateka's aspiration, rituals in karatedo, competing, and identification (as a karateka and as a member of karatedo group).

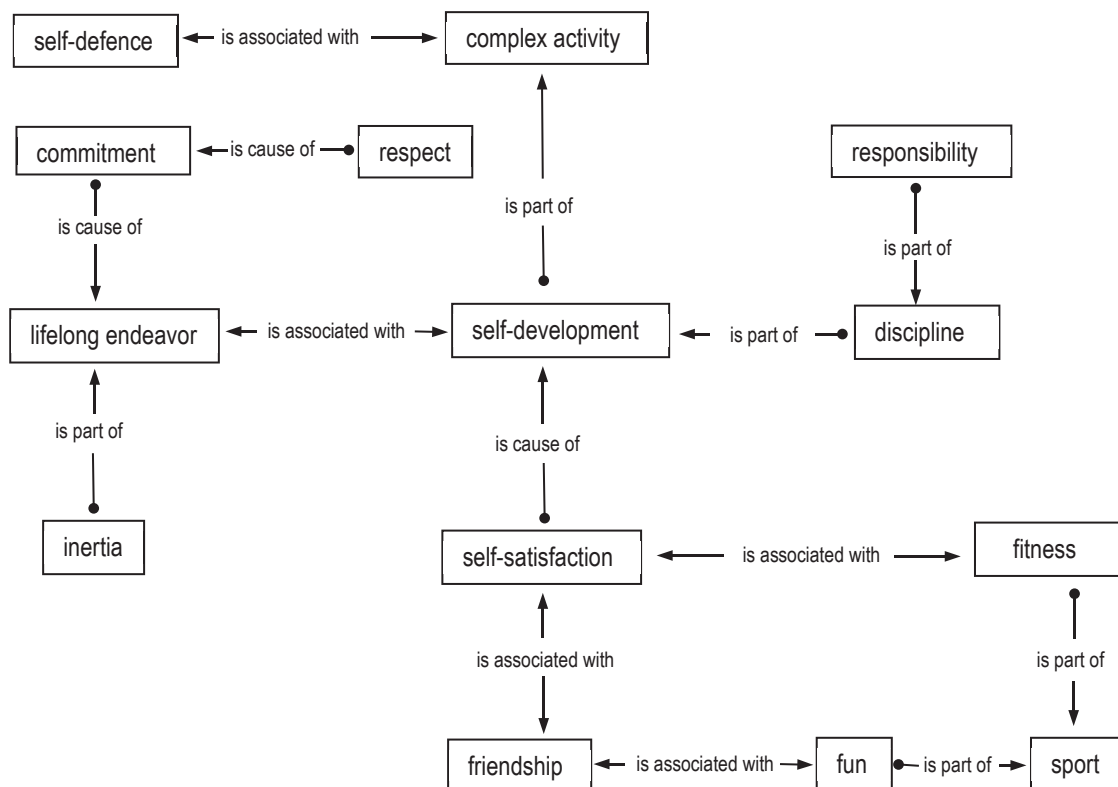
The interviewed group consisted of five traditional karate Fudokan karateka. All of them: have been practicing karate since childhood (minimum 23 years), are karate teachers, are master level of karatedo (achieve black belt), have competing experience, are karate referees. Three of them are functionaire of the karatedo club. Four men and one woman, aged between 33 and 50 years took part in the research. Their characteristics are summed in the table 1.

Table 1. Characteristics of interviewed karateka

	Gender	Age	Technical degree	Karatado practice	Competing	Qualification
interviewee 1	male	33	3. dan	24 years	yes / present	Karate teacher (2 <sup>nd</sup> class) Referee (1 <sup>st</sup> class)
interviewee 2	male	34	3. dan	26 years	yes / present	Karate teacher (2 <sup>nd</sup> class) Referee (3 <sup>rd</sup> class) Funcionaire of karatedo club
interviewee 3	female	34	3. dan	23 years	yes / past	Karate teacher (2 <sup>nd</sup> class) Referee (3 <sup>rd</sup> class) Funcionaire of karatedo club
interviewee 4	male	42	3. dan	29 years	yes / present	Karate teacher (2 <sup>nd</sup> class) Referee (3 <sup>rd</sup> class) Funcionaire of karatedo club
interviewee 5	male	50	6. dan	36 years	yes / present	Karate teacher (2 <sup>nd</sup> class) Referee (2 <sup>nd</sup> class)

## Results

A specific coding using software Atlas.ti, which allows qualitative data processing, was used for evaluation of the interviews. In each interview there were created and to statement assigned codes. The most commonly accuring codes were placed into the net graph, in which the relationships between the codes was described as well. The net graph of codes is shown in picture 1 and described below.



Picture 1. Net graph of codes

Karatado is a **complex activity** focused on the body development as well as mind development and some kind of one's education. This complexity was frequently mentioned and its importance was highlighted in the interviews. Moreover it is the basic definition of **self-defence** (Reguli, 2009). A **self-development** is a part of the complex activity and it is achievable with **discipline** only. Development is coming very slowly or come never with lack of discipline to follow schedules, training demands and others. **Responsibility** is a part of the discipline.

A self-development is connected with a **lifelong endeavor**. A certain degree of **inertia** is part of the lifelong endeavor. A level of inner and external motivation changes over time. People sometimes follow their path without any special motive. They just flow until a new motivation push them forward. The lifelong endeavor brings also a serious **commitment** to hold

on. This commitment is a source of respect – for authorities, set goals and oneself.

A **self-satisfaction** originates in self-development as well. Most activities requiring diligence and effort brings self-satisfaction through experience that provides. Increasing the fitness level (associated with self-satisfaction) is one of the motives for doing physical activities. Fitness and fun are parts of sport. Fun is associated with friendship and friendship is associated with self-satisfaction.

## Discussion

The results introduced by the net graph reflect today's traditional karatedo. The upper half of the graph represents the traditional karatedo and corresponds a lot with karatedo theory (Cruz, 2004; Egami, 2000; Funakoshi et al., 2003). In the lower part of the graph there are codes that represent today's values and motivation for doing physical activity such as fitness (Kuan et al., 2019; Serrano et al., 2019) friendship and fun (Chvátalová et al., 2012). Some codes (self-development and friendship) represent values, that are common with other karate styles (Čihounková & Reguli, 2016). Friendship, fun and fitness are codes that karatedo has in common with other martial arts (Nejedlá et al., 2011).

A pilot attempt to create a net graph according to interviews with karateka we did in 2014 (Čihounková, 2014). This time the group of interviewees is more coherent and more advanced. The results are very similar. There is no code **relax** and the code **responsibility** appeared. It reflects the fact that all interviewees are karate teachers and referees. The responsibility in the relationship to karate was highlighted in Polish kadet and youth representation as well (Cynarski & Niewczas, 2017, 2019).

## Conclusion

The results introduced by the net graph reflect today's traditional karatedo in which the traditional values and modern life requirements are interconnected.

Another step in this research is to apply used methodology to other groups of karateka and compare results.

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## FIFTY YEARS OF JOURNAL KINESIOLOGY - BIBLIOMETRIC ANALYSIS

Ivan Čolakovac, Iva Barković

*University of Zagreb Faculty of Kinesiology, Croatia*

**Purpose:** The aim of this paper is to analyze the articles published in Kinesiology – International Journal of Fundamental and Applied Kinesiology using bibliometric indicators.

**Methods:** The sample consisted of 1082 articles published in the period of 50 years, from the 1st volume in 1971, until the 52nd volume in 2020. Bibliographic units (articles) were observed and analyzed according to next parameters: number of articles per year, categorization of articles, the language of publication and the abstract, number of authors, references and citation according to bibliographic databases. Collected data was processed in Microsoft Excel program.

**Results:** The analysis of the articles revealed that the most common articles were original scientific papers (79.20 %), while the least represented articles were categorized as conference papers (1.01%). From 1971 to 1996 most articles were written in the Croatian language (95.75 %), but since 1997 the articles have been written only in the English language, while the abstracts were in English, Croatian, German or Russian. The analyzed articles contain 27443 references in total, an average of 25.36 references per paper. The journal has been analyzed regarding the data in Web of Science and Scopus bibliographic databases. From 2008 to 2020, there were 399 articles in Web of Science Core Collection, cited in the range from 116 to 0, and 395 articles indexed in Scopus in the range from 110 to 0.

**Conclusions:** A strong international orientation of the journal is conveyed by publishing in English and enabling access to full texts of publications through the Portal of Scientific Journals of Croatia – Hrčak.

**Key words:** *journal, paper analysis, bibliometric indicators, citations, bibliographic database*

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# CORRELATION BETWEEN NUMBER OF MEDALS WON IN ATHLETICS AT THE OLYMPIC GAMES AND WORLD CHAMPIONSHIPS OF WORLD COUNTRIES AND THEIR GEOGRAPHIC, DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

Ivan Dominković, Jerko Čaleta, Luka Dominković

University of Zagreb Faculty of Kinesiology, Croatia

## Abstract

**Objectives:** The aim of this research is to determine the correlation between the economic, geographical and demographical characteristics of the world countries with number of medals won in athletics at the Olympic games and World Athletics Championships from 1999. to 2020.

**Methods:** Sample size which was investigated consisted of 87 world countries. Correlation analysis was done on the aforementioned sample. The aim of the correlation analysis was to determine the connection between individual number of each medal won at World Athletics Championships and Olympic games with geographic, demographic and economic characteristics of the observed countries.

**Results:** There is a correlation between the geographical and demographical factors of the world countries with gold, silver and bronze medals won at the world biggest championships and there is no correlation between the economic factors of world countries with any of individual medals won at the world biggest athletics championships.

**Conclusion:** Therefore, we can conclude that the results of a given country depends on the number of potential athletes being selected from population and surface area of a country. However, financial aspect of a country do not represent an important factor in athletics successfulness of that country.

**Key words:** *athletics, Olympic games, world championship, GDP per capita, total area, population*

## Introduction

Sport is presented as an activity of public interest and it undoubtedly plays a crucial role in almost every country in the world. As such, sport is widely spread area of interest that is globally represented and takes significant place in various social events. Therefore, it is certainly one of the most interesting and widespread human activities. It is important for the population's health and quality of life, national pride, international reputation and affirmation, which has a positive impact on the country as a whole (Milanović, 2013). The emphasis is on achieving internationally recognized results that represent the country in the world. Exceptional sports results contribute in building the reputation of the state, as the so-called "sports forces" (Selhanović, 2007). One of the elementary and most common sports is athletics, which is divided into four basic disciplines: walking, running, throwing and jumping. Due to its complexity and basic motor structures, athletics is the basis of various sports and justifiably bears the epithet of the queen of sports (Antekolović, 2014).

The development of a top athlete requires a high level of knowledge and practice of experts from various scientific fields such as kinesiology, physiotherapy, nutrition and medicine. The top preparation that will result in winning medals requires adequate financial resources. Therefore, it can be stated that countries with higher gross domestic product (GDP) provide their athletes with the best training conditions and success in international competitions. Large population and the country's surface area are important success factors in many sports, including athletics. Population growth and the growth of the size of the country results in better selection when forming national teams. In accordance with the above findings; the main objectives of this paper are to determine the relationship between geographical, demographic and economic characteristics of the country with success in international competitions from 1999 to 2020 (World Championships and Olympic Games) in the number of individual medals won (gold, silver, bronze). The following hypotheses are set according to the defined objective of the paper:

H1: There is a statistically significant correlation between the total number of gold, silver and bronze medals won by world countries from 1999 to 2020 with the total population (in millions).

H2: There is a statistically significant correlation between the total number of gold, silver and bronze medals won by world countries from 1999 to 2020 with the total area (in ).

H3: There is a statistically significant correlation between the total number of gold, silver and bronze medals won by world countries from 1999 to 2020 with GDP (in dollars).



## Research methods

### Sample countries

In this study, the sample represents 87 world countries that have won medals in athletic disciplines in men's and women's competition at world championships and the Olympic Games in the period between 1999 and 2020.

### Variables

Two sets of variables were used in this study. The first set of variables represents the number of gold, silver and bronze medals won, and the second set the economic, geographical and demographic characteristics.

The first set of variables are medals. The medal is a circular object made of metal, awarded for sporting achievements which marks the appropriate success in the competition. The variables represent the number of individually won gold, silver and bronze medals.

- 1) The gold medal represents the highest degree of success in major competitions and is awarded for first place.
- 2) A silver medal signifies less success than a gold medal, and is awarded to the runner-up.
- 3) The bronze medal is awarded to the third place, and is the last medal with which the athlete comes to the podium.

The second set of variables is represented by socio-economic indicators: GDP, country's surface area and population.

- 1) Gross domestic product (GDP) indicates how rich the state is. It shows the value of all completed goods and services produced in a country over a period of time, and includes products and services ready for immediate consumption (Mankiw, 2006). GDP per capita (GDP per capita, PPP) was used and expressed in monetary unit – dollar. A sample and the arithmetic mean of GDP were collected and calculated for each year from 1999 to 2020.
- 2) Country's surface area denotes the total territory of a country. It is expressed in square ( ) and includes the land and water territory of the state.
- 3) The population of the country is the total number of people in the country. It is defined by arrangement, density, movement, composition and other characteristics in space and time. Data on the total population and arithmetic mean were collected and calculated for each year in the period from 1999 to 2020.

### Data processing methods

The analysis was performed using IBM SPSS Statistics and MS Excel. The Excel package was used for statistical data analysis. Correlation analysis (Pearson's correlation coefficient) was used on a sample of 87 countries to determine the relationship between GDP, country's surface area and population with the number of gold, silver and bronze medals won. The method of descriptive statistics was used to analyze the characteristics of the samples. The characteristics are shown in Table 1.

Table 1. Descriptive statistics

Descriptive statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Gold	87	0	116	7,68	16,49
Silver	87	0	108	8,36	17,96
Bronze	87	0	74	7,94	13,08
GDP (\$)	87	523	112.493.111	1.312.477	12.058.427
Area (km <sup>2</sup> )	87	261	17.098.246	1.086.397	2.732.530
Population	87	43.935	2.194.641.150	53.785.519	236.850.777

## Results and discussion

In this paper, the first set of variables (total number of gold, silver and bronze medals won) and the second set of variables (GDP, area and population) were compared with the help of MS Excel package for statistical data analysis. The obtained correlation coefficients are shown in Table 2.

Table 2. Table of correlations between variables

	Gold	Silver	Bronze	GDP (\$)	Area (km <sup>2</sup> )	Population
Gold	1					
Silver	0,95**	1				
Bronze	0,93**	0,93**	1			
GDP (\$)	-0,02	-0,03	-0,03	1		
Area (km <sup>2</sup> )	0,48**	0,63**	0,51**	-0,04	1	
Population	0,20	0,25*	0,28**	-0,02	0,44**	1

P&lt;0,05\*

P&lt;0,01\*\*

This research showed that there is statistically significant correlation between the total gold medals won with the total silver medals won ( $r = 0.95$ ) and the bronze medals ( $r = 0.93$ ). There is also a statistically significant correlation between the total silver medals won and the total bronze medals won ( $r = 0.93$ ).

There was no statistically significant correlation found between gross domestic product (GDP) and the total area of a particular country ( $r = -0.04$ ), nor with the total population of that particular country ( $r = -0.02$ ). Regardless, there is a statistically significant correlation between the total population and the total area of a particular country ( $r = 0.44$ ).

Considering the initially set objective and hypotheses, it was found that there is a statistically significant correlation between the total number of individual medals won with the total area of a country: gold medals ( $r = 0.48$ ), silver medals ( $r = 0.63$ ) and bronze medals ( $r = 0.51$ ). There is also a statistically significant correlation between the total number of individual medals won and the total population of a country: gold medals ( $r = 0.20$ ), silver medals ( $r = 0.25$ ) and bronze medals ( $r = 0.28$ ). However, there is no statistical correlation between any total individual medals won with gross domestic product (GDP); gold medals ( $r = -0.02$ ), silver medals ( $r = -0.03$ ) and bronze medals ( $r = -0.03$ ) and therefore we can claim that the initial hypothesis of this research is partially accepted.

Data analysis identified three levels of correlation. A high level of correlation was found between the number of medals won individually and the total area of the country. A small but still statistically significant correlation was confirmed between the population and the number of individually won medals. Tadić et al. (2019) examined the relationship between the number of individually won boxing medals at European championships, with the geographical, demographic and economic characteristics of European countries. The authors found a statistically significant correlation between the number of individually won boxing medals with the total area of the state and the population. The total area of the country is positively correlated with the population, which means that countries with a large area also have a larger population, which provides them with more professional athletes. A large number of professional athletes make up the list of candidates from which the best with the greatest chance of winning can be selected. Countries like the USA, Russia, Kenya are examples of crowded countries that have a large number of athletes, which allows them to choose the most representative ones. Such a selection of athletes provides them with a large number of medals, and are regularly among the world's leading countries in the number of medals won. What makes the third level is no statistically significant correlation of world countries between GDP and the number of individually won medals, i.e. between individually won medals and economic characteristics from 1999 to 2020. We can conclude that the countries won individual medals at the Olympic Games, and World championships in the period between 1999 and 2000 regardless economic characteristics, i.e. GDP. Consequently, it can be argued that the country's success also depends on some other important factors. Countries with high GDP, highly developed in trade, technology, industry, tourism and all possible branches of the economy are not at an advantage over poor countries and have an equal chance of winning medals. In poor countries, in addition to sports preparation, there is a high internal motivation of athletes to work hard to ensure the livelihood for themselves and their families, to socially promote and prove themselves to the world, which often results in great sporting results and winning the highest medals at major sports competitions. For example, Jamaica, as a small country with a low GDP, creates a number of top sprinters, including the current world record holder in the 100 and 200 meters, Usain Bolt. A similar situation exists in Kenya, which has been forming top runners and record holders in the middle and long distances, and is at the top of the list in terms of medals won at international competitions for many years. To get a better interpretation of countries' performance in international competitions future research should take into account the influence of the history, tradition and systematic organization of athletics in certain countries as possible success factors. An important factor of success are the financial allocations that are allocated exclusively to provide adequate conditions required by top sports training to improve the results of their athletes. Economic, geographical and demographic characteristics, along with culture, systematic sports organization and financial investments in mutual interaction, form the basis for success in major sports competitions.

## Conclusion

Athletics is a fundamental area of almost every sport. Walking, running, throwing and jumping are the basic characteristics of athletics and the basic components of many sports. A wide range of athletic disciplines allows the state to specialize in a particular discipline, which makes winning medals in a specialized discipline easy. Correlation analysis determined a statistically significant correlation between all individually won medals (gold, silver and bronze). Gross domestic product (GDP) analysis found that there is no statistically significant correlation with any of the individually won medals, which tells us that a country's wealth is not a guarantee or a measure of success in major competitions; athletics provides an equal chance to rich and poor countries to win medals at international sports competitions. There is a statistically significant correlation with the total population and country area. Correlation coefficients between the area of the state and individually won medals show a statistically significant correlation, of which the highest degree of correlation has the number of silver medals won and the country area. The population shows a smaller but still statistically significant correlation with the number of individually won medals. All this indicates that big countries and countries with large population have the possibility of better selection of athletes and thus a greater chance of winning medals. In addition to GDP, population and total area, the influence of cultural-traditional and historical factors, personal characteristics and internal motivation of athletes, the development and financing of sports systems by competent state bodies can be included in interpreting the data, which in joint interaction determines the success of the country in major sports competitions.

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## PHYSICAL ACTIVITIES OF UNIVERSITY STUDENTS DURING THE COVID 19 PANDEMIC

Irena Durdová<sup>1</sup>, Aleš Sekot<sup>2</sup>

<sup>1</sup>Technical University Ostrava, Czech Republic

<sup>2</sup>Masaryk University Brno, Czech Republic

### Abstract

**Purpose:** The aim of the paper is to present the results of a recent research survey (February 2021) in a broader context of the issue to determine whether university students devote themselves as much as possible to specific sports and physical activities even at the time of the ongoing pandemic associated with the spread of COVID-19, i.e. at a time when the possibilities of sports and physical activities are limited, and the contact Physical Education lessons (hereinafter referred to as PE) are cancelled at schools.

**Methods:** To meet the objectives of the research survey, the method of questioning – an online questionnaire – was chosen. The total number of the university students who were addressed was 1164 - first-year students from all seven faculties of VSB – Technical University of Ostrava (hereinafter referred to as VSB-TUO) answered. The questionnaires were subjected to the statistical classification of the first-level data. Another method was the comparative method of working with documents, comparing with the results of comparable questionnaire surveys from 2015 and 2018, and relevant scientific discussion in this contest

**Results:** The results of the research confirmed that first-year students of all VSB-TUO faculties, who as graduates of the relevant secondary school could no longer complete the subject Physical Education due to pandemic measures, preferred unorganized physical activities in accordance with the situation, such as walks, including walking the dog. 34.8% of respondents answered that they “did not miss sport” or that they “were not interested in sport at all”. A high percentage of respondents (44.3%) admitted that they “did not miss” organized Physical Education lessons “at all”, while some (31.3%) stated that thanks to the subject Physical Education, they were able to play sports “at least once a week”.

**Conclusion:** Due to the high number of interviewed first-year students of VSB-TUO, it can be assumed that we would reach similar results in a vast population of peers, and the findings can be generalized. The study summarizes the latest reflections on impersonal forms of teaching of Physical Education on the motivation and intensity of sports and physical activities within the general level of foreign surveys as well. Relevant research in our cultural setting coincidentally conclude indispensable importance of growing role of regular physical activity in the field of school, family and leisure including its attractive innovation during lock down pandemic situation.

**Key words:** *Physical Activities, Sport, University Students, Pandemic Situation, COVID-19*

### Opinions of university students on the changing conditions of Physical Education

Physical Education at schools is thus limited or completely suspended during the fight against the pandemic. Due to the nature of this subject, remote approach is almost impossible; in addition, preference in teaching was given to theoretical subjects. The term school Physical Education refers to children, youth and adults from primary and secondary schools to universities. Gradually, Physical Education teachers began to engage in contact with pupils and students using mobile applications or online teaching. Without previous experience, they started shooting training videos, encouraging regular sports activities, and emphasizing the importance of indoor activities.

During the COVID-19 pandemic, the WHO (World Health Organization) currently recommends moderate-intensity physical activity in the public virtual Internet space for 140 minutes a week (WHO: Lack of exercise kills. How long should we exercise daily? - CNN Prima NEWS? - CNN Prima NEWS (iprima.cz)) Adequate physical activity is a prevention of many diseases, supports the proper function of the immune system, and contributes to better coping with stressful situations. Exercise is an integral part of mental hygiene, and stress management appears to be essential in demanding quarantine conditions and implementing all pandemic measures all pandemic measures. At the same time, it is recalled that, on the other hand, a single high-intensity exercise in untrained individuals can lead to impaired immunity and an increased risk of infection (Simpson et al., 2020).

Teachers at the Institute of Physical Education and Sports (hereinafter referred to as IPES, formerly the Department of Physical Education and Sports – DPES) were also fully aware of the risks involved in banning full-time Physical Education. The impossibility of contacts with students led to the severance of relations between the IPES (teaching winter and summer sports courses) and students of all grades. The consequences of the cancelled university PE at VSB-TUO for first-year students of all faculties are particularly noticeable, not only in terms of the offer of physical exercises but also in the equally significant level of limiting social contacts. Students of the first years of universities in the academic year 2020/2021 are also those who completed their secondary school studies at the pandemic and were affected by epidemiological measures in the final year of secondary school. After about 14 days of full-time teaching at the university, they were again dependent on the distance form of education. They did not have enough time to get acquainted with the course of study at the university, they did not gain contacts with students in higher years, and probably they do not even know the other members of the created study groups.

IPES at VSB-TUO has long been interested in the opinions of VSB-TUO students on teaching PE, and their leisure-time physical activities. Whenever it has been possible, IPES has always adapted the offer of physical exercises to the requirements of the respondents - VSB-TUO students. Research surveys with the aim of finding out students' opinions on teaching PE and its quality, on the possibilities of sports at VSB-TUO, on the level of the sports environment, has been conducted repeatedly since 1998, the number of respondents ranged up to 500 respondents. The survey took the form of filling in questionnaires in paper form, since 2015, using modern electronic technologies. The last research before the COVID-19 pandemic took place in 2018 (Durdová, 2018); 530 respondents, students of all years and all faculties of VSB-TUO took part in the online survey out of 2469 students who had been addressed. We were interested in the choice of sport, in satisfaction with sports activities at VSB-TUO, in preferring a specific day and time to exercise during the day. We were also interested in how many times a week students use the DPES' offer for their leisure activities. This research survey showed a positive evaluation of the work of the DPES (23% of respondents were very satisfied with the programme offered, and 47.5% stated that they were rather satisfied, while only 5.8% were rather dissatisfied and 1.5% were very dissatisfied). Similarly, students evaluated the possibilities of PE and sport at VSB-TUO – 28.3% were very satisfied, and a total of 49.4% of respondents were satisfied.

The last targeted survey of VSB-TUO students under the auspices of IPES took place in February 2021, at the time of the PE ban and the consequences of measures related to limiting the spread of COVID-19. In this survey, we were mainly interested in the first-year students. As previously mentioned, these students did not have continuous teaching of PE in the second half of the last year at the secondary school (2019/2020) or in the winter semester of the academic year 2020/2021.

The online questionnaire survey in February 2021 was attended by 1164 respondents, the 1st year students of all seven faculties of VSB-TUO. There were 758 men and 406 women, 32.2% of whom were students of the Faculty of Economics and 22.8% of the Faculty of Electrical Engineering and Computer Science. The other five faculties did not differ much in the number of respondents, and it was 10-16% of the total number of respondents.

When asked whether students currently, at the time of epidemiological measures, miss sports activities, 65.2% answered “yes, I do”, 25.3% “No, I do not”, and 9.5% answered that they were “not interested in sport”.

Another question concerned physical activities that respondents could perform themselves during epidemiological measures. The answers can be summarized as follows:

- I did exercise at home (42.5%),
- I took the opportunity to play sports in nature (31.4%),
- I did not regularly engage in physical activities (22.3%),
- I did not perform any physical activities (3.8%).

By asking about specific regularly performed sports activities, the following order of activities was created:

1. walks, including walking the dog,
2. regular exercise at home,
3. running,
4. cycling,
5. Nordic walking
6. other physical activity.

In other questions, we were interested in the involvement of respondents in activities offered by the IPES VSB-TUO at the time of the release of epidemiological measures (outdoor sports ground, gym, aerobic hall - always in compliance with the permitted number of people and all epidemiological measures). 74.1% “did not use this option at all”. This fact is certainly influenced by the fact that students accommodated at VSB-TUO university dormitories moved out and went to their places of permanent residence. 15.4% of respondents used the opportunity to play sports at VSB-TUO sports grounds (albeit with restrictions) “very often” and 10.6% of respondents “occasionally”.



When, due to the worsening pandemic situation in the Czech Republic, all sports activities were banned, the IPES offered short video training (aerobic exercises, stretching, Pilates, circle training) on its YouTube channel, which could be used for doing exercise at home.

When asked whether these videos were a stimulus or inspiration for doing exercise at home, the vast majority of respondents (73%) answered that they did not know about these videos at all. At the same time, notifications about the possibility of training online under the guidance of the IPES teachers were announced on the IPES website or the IPES Facebook.

The answer of the respondents to a specific question also leads to reflection: “Do you miss organized Physical Education at VSB-TUO?” Their answers:

- I miss it very much (24.4%),
- Thanks to teaching PE, I had the opportunity to play sports at least once a week (31.3%),
- I do not miss it at all (44.3%).

It should be reminded again that the respondents – the first-year students, due to government measures and the introduction of distance learning, practically did not have time to look around the university, did not get acquainted with the university environment and university specifics. They did not find opportunities for sports at VSB-TUO and did not get acquainted with the offer of sports activities of IPES. Since mid-September 2020, when the distance form of teaching was introduced, it has been impossible to play sports and use the well-equipped VSB-TUO sports grounds. We firmly believe that we will once again continue the regular teaching of PE, the traditional offer of the IPES sports activities in the academic year 2021/2022. Unfortunately, we have lost the students of the first years of the academic year 2020/21 and let us hope that the IPES will have to strive for them with a well-established offer of sports activities in the nearest possible future.

## Final summary

If the demonstrable fact that regular sports and physical exercise not only affect physical and mental health but that they strongly affect the immune system of those who do physical activities is accepted, then a one-year break from PE in the case of children and adolescents can have serious, as well as far-reaching consequences. If the relationship to sports is not supported in the family (Sekot, 2019), the absence of PE, closed playgrounds, and sports grounds can negatively affect the health of children, youth, and the general population. In this context, the socio-psychological and highly socializing significance of Physical Education, physical exercises and games cannot be underestimated. Joy, relaxation, healthy competition in the company of friends during physical activities leads to positive feelings and moods to stress reduction.

In growing urgency, the educational institutions have to take into account that also for parents, it is recommendable to be a positive role model (Sekot, 2019). No matter how young or old the children are, they will likely look for guidance to help them respond to these circumstances. And in the specific situation of distance learning and perhaps training, guidance from their teachers, coaches and parents in a unique and unrepeatable situation can help the children find productive, favourable, meaningful ways to spend that time, rather than spending hours and hours in front of a screen. Supporting children to stay busy helps them to avoid focusing all of their attention on the negative ramifications of the pandemic, such as event cancellations, school closures, and social isolation. Not being able to compete could be a potential identity crisis for some athletes. Therefore, it is a priority to let children and young people enjoy feelings of intensive physical sportive experiencing. School and parental investment can help ease the pain and confusion they might be feeling, helping children find ways to be productive, physically and mentally active, and take care of themselves physically and mentally in a pandemic situation.

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## HANDBALL COACH MATCH STRESS RESPONSES: A PRELIMINARY STUDY

Nikola Foretić, Zoran Nikolovski, Vladimir Pavlinović

*Faculty of Kinesiology, University of Split, Croatia*

### Abstract

Sports coaching have always been considered stressful occupation. Coach must deal with wide range of roles and challenges which increase demands and complexity of the job. These demands are possible stressors that might cause stress, especially in competitive conditions. Competitive stress mostly results with a negative emotional response or competitive anxiety. Data about competitive anxiety are very important for developing effective strategies for coping with stress. Hence, the main goal of this study was identification of handball coach's competitive stress. According to the cognitive activation theory of stress, authors hypothesised that different match situations will increase stress level at handball coach. In this research competitive stress was monitored before, during and after 5 professional handball matches. Physiological markers of stress were represented by salivary levels of cortisol (C), alpha-amylase (AA) and heart rate (HR) while emotional state was measured with State-Trait Anxiety Inventory (STAI). Study revealed several important findings; 1) handball match triggered stress mechanisms even before it has started, 2) influenced by the match, all stress markers had significant higher values comparing to values on the rest day, 3) cortisol and alpha-amylase showed different dynamics and effect duration, 4) just 90 minutes after the match stress indicators came to normal values, 5) match result was not indicator of the coach's emotional state. Results of this study can help handball coaches in better understanding of competitive stress and also can be useful in finding psychological strategies for coping with it.

*Key words: cortisol, alpha-amylase, biomarkers, heart rate, anxiety*

### Introduction

Studying stress in sport is of great interest to academics researching and professionals who support and train sports performers (Jones & Hardy, 1990). Both coaches and athletes are exposed to competitive stress and knowledge of dealing with it have great applicability in practice. Competitive stress is defined as an ongoing transaction between an individual and the environmental demands associated primarily and directly with competitive performance. It is influenced by the competitive stressors (environmental demands) and competitive strains (an individual's negative psychological, physical and behavioural responses to competitive stressors), most of the time resulting with competitive anxiety – a negative emotional response to competitive stressors (Mellalieu, Hanton, & Fletcher, 2009).

There is no doubt about the stressful nature of sports coaching (Fletcher & Scott, 2010). Coaches' performances (and future employability), are often judged by the success of their athletes (Gould, Greenleaf, Guinan, & Chung, 2002). Coaches must play multiple roles and endure the technical, physical, organizational, and psychological challenges in their jobs. It is, therefore, not surprising that coaches experience stress as a result of the growing demands they encounter (Olusoga, Butt, Hays, & Maynard, 2009). It is obvious that coaching is considered as a stressful occupation with numerous identified stressors that can also develop a risk of coaching burnout (Kelley, 1994). In order to cope with stressful situations it is important to monitor level of stress that coach experience during the competition. Majority of studies that dealt with this issue used interview or questionnaire as a main tool (Olusoga et al., 2009; Olusoga, Butt, Maynard, & Hays, 2010). This approach is adequate for measuring general but not sufficient for measuring actual stress that is occurring just before, during and immediately after the competition.

It has been reported that various types of psychological stress activate hypothalamus-pituitary-adrenocortical system (HPA) and consequently induce substantial increases in salivary cortisol level (Takai et al., 2004). Alpha-amylase is a major salivary enzyme and is secreted from salivary glands in response to sympathetic stimuli (White & Averner, 2001). Levels of salivary cortisol and salivary alpha-amylase have been used as stress biomarkers (Rai & Kaur, 2011). Because these biomarkers can be sampled noninvasively and fast they are acceptable tool for measuring acute competitive stress of sports coaches. Yet, there is a lack of researches that studied stress responses of the coach during the competition. Just 2 studies used C and AA as stress markers for coaches. Loupos et al. (2004) studied salivary cortisol concentration in eight coaches during a national swimming championship (Loupos, Tsalis, Barkoukis, Semoglou, & Mougios, 2004) while Hudson et al. (2013) explored ten male team sport coaches before, during and after the match by assessing salivary AA activity (Hudson, Davison, & Robinson, 2013). To the best of our knowledge no study used both biomarkers together.

Regarding all mentioned the main goal of this study was determination of handball coach psychophysiological responses to competition by obtain both; stress biomarkers (salivary C and AA) and anxiety inventory (STAI). Specifically, to compare physiological and psychological data before, during and after competitive stress appear.

## Methods

In study participated just one professional handball coach, age 37. Participation in this study was voluntary. Stress markers were measured during 1 rest day and 5 official matches in the First Qatar Handball League. To establish normal circadian rhythm values of stress biomarkers (C and AA) coach spent 1 day fasting without any physical activity in his apartment. During this day from 9:00 am till 21:30 pm 10 samples of his saliva was taken. In second part of the study stress markers were monitored before, during and after handball matches. All 5 matches held in the same hall (QHA sports hall) in period of 35 days. Match schedule varied between 16:30 pm and 20:30 pm. Match stress was measured with salivary cortisol (C) and alpha-amylase (AA) concentrations, heart rate (HR) and with State Trait Anxiety Inventory.

Saliva samples were collected in 5 time points 20 minutes before the match, at the halftime, directly after the match, 45 and 90 minutes after the match. Coach avoid eating a major meal 60 minutes before sample collection, rinsed his mouth thoroughly with water 10 minutes before each sample was collected. For this purpose, SalivaBio Oral Swabs - SOS (Salimetrics LLC, State College, PA, USA) were used, placing them underneath the tongue on the floor of the mouth for 2 minutes. After collection, swabs were placed into a storage tube and were refrigerated immediately. Within 2 hours following sampling, samples were frozen at below -20°C until centrifugation. On the day of analysis, samples were thawed completely and centrifuged at 1500 x g (3000 rpm) for 15 minutes. After centrifugation, assays were performed. Saliva cortisol and alpha-amylase were analysed with a commercially available enzyme-linked immunosorbent assay (ELISA) purchased from Salimetrics LLC (State College, PA, USA) on a microplate reader (Infinite 200PRO, Tecan, Mannendorf, Switzerland). All samples were analysed in the same batch to avoid interassay variability.

Heart rate was measured by heart rate monitor that coach wore 4 hours: 30 minutes before and 90 minutes after the match (Polar M430, Finland).

Coach emotional state was measured with State-Trait Anxiety Inventory (STAI) which he filled directly after match finished. STAI is an instrument that quantifies state anxiety and includes a 20 question that indicated how participant felt at the moment he was filling the inventory. These questions are answered on the basis of a 1-4 scale, with the focused areas including: worry, tension, apprehension, and nervousness. Result is presented as a score (Spielberger, 2010).

Statistical analysis included calculation of descriptive statistic parameters while normality was tested using the Kolmogorov–Smirnov test procedure. The Friedman ANOVA was calculated to evidence differences between levels of salivary biomarkers and heart rate. Spearman rank order correlation was used to establish relations between stress markers at the end of the match and State-Trait Anxiety Inventory and with final outcome of the match. The software Statistica ver. 13.0 (Dell Inc, USA) was used for all analyses.

## Results

Results of descriptive statistics are presented in table 1. Although the sample was consisted of only 5 cases all variables showed normal result distribution.

Table 1. Descriptive statistics

Variable	N	Mean	Std.Dev.	Minimum	Maximum
HR 1	5	94.48	7.60	85.54	105.60
HR 2	5	110.04	20.36	89.61	141.60
HR 3	5	121.56	13.22	101.17	134.71
HR 4	5	111.04	11.76	99.73	130.32
HR 5	5	85.48	22.95	66.29	124.16
C 1	5	0.38	0.08	0.27	0.47
C 2	5	0.38	0.16	0.23	0.56
C 3	5	0.27	0.06	0.22	0.35
C 4	5	0.25	0.05	0.19	0.31
C 5	5	0.16	0.02	0.14	0.19
AA 1	5	57.66	24.07	38.64	97.42
AA 2	5	112.37	22.26	75.41	130.61
AA 3	5	116.27	28.93	75.16	155.62
AA 4	5	46.94	23.66	22.50	84.07
AA 5	5	35.85	7.15	28.75	46.31
STAI	5	42.20	13.55	27.00	61.00

Figure 1 is presenting stress markers dynamic that coach undergo during the handball match. Heart rate (HR) rose from the beginning till the end of the match. It never exceeded 125 beats per minute and 90 minutes after the match it came to normal. Cortisol (C) values were elevated before the match when comparing with baseline values (0.38 vs. 0.15). The values decreased after the halftime. 90 minutes after the match it came on baseline values. Alpha-amylase (AA) values were elevated before the match when comparing with baseline values (57.66 vs. 24.70). Values were slightly increasing during whole match. Even 90 minutes after the match AA was elevated when comparing to the baseline values (35.85 vs. 24.70).

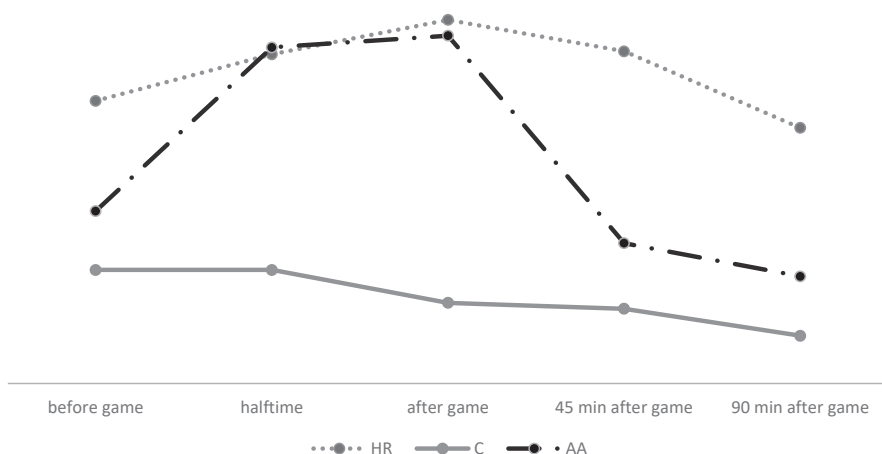


Figure 1. Coach stress marker dynamics before, during and after the handball match

Figure 2 presents differences between stress markers in 5 testing points. Cortisol showed biggest changes. Significant decrement was noticed through the whole process of monitoring; before the match till the end of the match ( $p=0.02$ ), and before the match till 90 after the match finished ( $p=0.00$ ). Alpha-amylase show significant changes in results before the match till 90 after the match finished ( $p=0.00$ ). Heart rate dynamics showed significant increase till the end of the match (0.04).

Results of the Spearman rank order correlation showed significant negative correlation between STAI and cortisol (-0.90) while correlation with alpha-amylase (0.40) and with heart rate (-0.70) after match were not significant. No significant correlations were noticed between final match outcomes and with C (-0.28), with AA (-0.86), with HR (0.00) nor with the STAI scores (0.00).

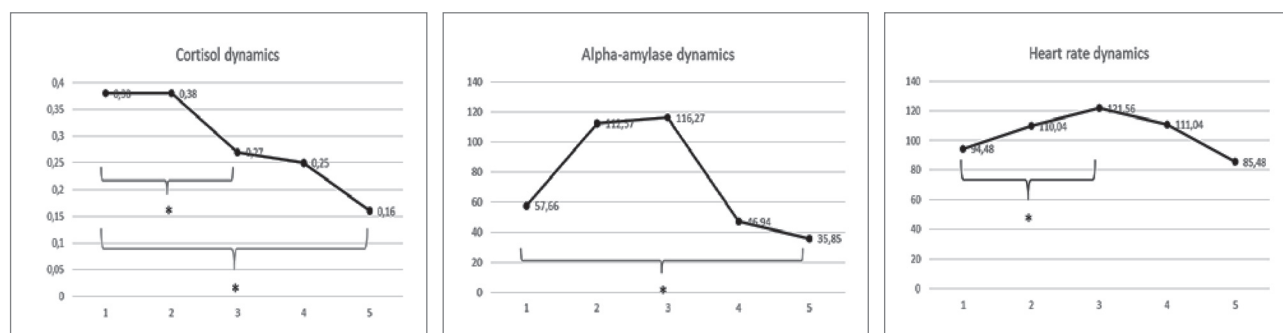


Figure 2. Differences between 5 testing points calculated with Friedman ANOVA for C, AA and HR

## Discussion

This study have 4 major findings: 1) match influenced coach in a way that all stress markers had significant higher values comparing to values when stress was not applied, 2) 90 minutes was sufficient time for stress markers to come to normal values, 3) although both biomarkers are used in acute stress monitoring; cortisol and alpha-amylase showed different dynamics, 4) match result is not indicator of the coach's emotional state.

From data in this study it can be seen that handball match causes series of emotional challenges before, during and after the match. Those challenges induce hormonal (C) and nervous system (HR and AA) responses. 90 minutes after the match stress indicators came close to normal. This information suggests the magnitude of stress that coach deals with. Similar results were found by Hudson et al. (2013) where authors reported that unpleasant emotions, arousal and salivary AA were elevated on competition day. Between adjacent time points, higher levels of external stress discrepancy were associated with elevated salivary alpha-amylase activity and, higher levels of pleasant emotions with lower levels of alpha-amylase activity (Hudson et al., 2013). Generally speaking, elevated AA indicate state of stress and in our study AA was

elevated from the beginning till the end of the match implying high level of stress that coach endure. In study conducted on swimming coaches cortisol level was elevated and even was rising during 3 day of the national championship implying that constant stress perception influenced C levels (Loupos et al., 2004). Our study was shorter and had more time points when C was measured so it is not comparable with 3 days trial. However like in the before mentioned study in our study also C was significantly elevated in comparison with baseline values on the rest day. Normalization of C values 90 after the handball match is somehow expectable. In the study on soccer coaches similar trend was reported. C concentration increased as a result of the competition and normalised after one hour (Kugler, Reintjes, Tewes, & Schedlowski, 1996).

Alpha-amylase dynamics, very similar to the heart rate dynamics, constantly grew up during the match and gradually decreased after the match. In contrast to AA cortisol level was constantly decreasing till 90 minutes after the match. This differences in dynamics should be considered in the context of biomarker's circadian rhythm. As matches occurred in the afternoon hours, underlying dynamics of two biomarkers is different. Cortisol has downward tendency so dynamics during match is overlapped with C increase due to the arousal and competitive stress. This results in higher values and sharpened decrease after the match which follows normal diurnal rhythm of decrease. Contrarily, in the case of the AA circadian rhythm is opposite (increase in afternoon hours). So AA also shows increase during the match due to competitive stress and in late afternoon hours starts normal diurnal descend (Nater, Rohleder, Schlotz, Ehlert, & Kirschbaum, 2007). From these data it is clear that even though two biomarkers have opposing circadian rhythm in afternoon hours, arousal and competitive stress affect in a similar manner.

Lack of correlations between measured stress markers and match result is most probably connected with coach perception of player's performance rather than with final outcome of the match. In other words team can loose from better opponent but coach can be satisfied with the team performance and vice versa.

## Conclusion

This study was first that examined competitive stress in handball coaches. It show dynamics of physiological (C, AA and HR) and psychological markers of stress before, during and after the match. It is clear from the obtained data that handball coach is in the state of emotional stress and arousal even before the match starts. Also 90 seems to be enough time to normalise stress markers. Dynamics of measured biomarkers have similar trend despite dissimilar circadian rhythm. Nevertheless, AA and C might be useful indicators for competitive stress monitoring in handball coaches. Results of this measurements indicate need of implementation of stress coping strategies and methods for handball coaches.

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## THE BEST CROATIAN MALE TENNIS PLAYERS AT A TURNING POINT – STUDIES OR PROFESSIONAL SPORT

**Marin Galić**

*University of Zagreb Faculty of Political Science, Croatia*

### Abstract

Tennis is currently the most popular individual sport in the world, often considered to be 'elitist'. This statement is somewhat contradictory as it is through tennis that many tennis players and their families see the possibility of social mobility, that is, through this sport they want to permanently change their social status. This phenomenon has especially been pronounced in the countries of Eastern and Southeastern Europe since the fall of the Berlin Wall. A descriptive qualitative analysis of the development of the top ten male junior tennis players on the Croatian Tennis Association (CTA) annual lists from 2010 to 2019 was used as a research method. In the 10-year sample analyzed, the only male Croatian player who became an ATP player in individual competition was Borna Ćorić, which shows that a good junior tennis career in Croatia does not guarantee a professional one in the future. There are professional tennis competitions at a lower level as well (Challenger, ITF Tour). However, they do not ensure financial profit, thus being a transitional rather than permanent solution for tennis players. Therefore, tennis players are at a turning point, having a dilemma whether they should continue trying to break into professional tennis, or commit to their studies. The analysis showed that as many as 33 Croatian male tennis players (out of a total of 72 listed) opted for pursuing their studies in order to obtain an academic title after their junior careers. Tennis offers great opportunities to get a scholarship to study abroad, primarily at colleges in the USA.

*Key words: tennis, junior ranking, ATP tour, challenger, college tennis, ITF tour, social mobility*

### Introduction

In developed industrial societies, educational attainment forms the basis for gaining social status, and the expansion of education that occurred in the second half of the 20<sup>th</sup> century gave rise to people's trust in a meritocratic overcoming of social inequalities and social mobility through access to education (Erikson, et al., 2005). However, in Eastern and South-Eastern European countries, many families do not see the possibility of social mobility through education but through sport. They frequently opt for tennis, which is contradictorily considered to be an 'elitist' sport. Consequently, people of lower social status are supposed to climb the social ladder by means of professional tennis.

As early as in 1938, Huizinga (1970: 281) wrote that modern sport had left the area of play, primarily because of its increasing discipline, systematization and professionalization. When it comes to today's tennis, the professionalization of sports is indisputable. The transition from junior, amateur competition to professional ATP Tour and possible sports success is a complex and difficult process. The results indicate that 91% of top-20-ranked boys achieve a professional men's ranking (Reid et al., 2007). Another study analyses data which included 82 top 10 professional players between 2007 and 2017. The results reveal that good performance at the highest junior level of competition is shown to be a critical precursor to eventual top-level professional success (Li et al., 2018).

### Methods

In the preliminary research, the method of descriptive qualitative analysis is used to investigate the development of tennis players from junior to senior age. The aim of the research is to determine how they completed or are drawing to a close their junior sports careers, and what professional path they have taken / are taking. The subject of the research are 72 male tennis players who are on the official annual ranking lists for the under-18 category, released by the Croatian Tennis Association for the period from 2010 to 2019. The second phase of the research is aimed at establishing the character of their further professional commitment. Only male tennis players are taken into consideration, as men's tennis has been in focus in Croatia since the male team won the Davis Cup in 2018 for the second time. The descriptive method is the process of simply describing or outlining facts, processes, and objects in nature and society and their empirical validation of relations and connections. This method is applied in the initial phase of scientific research, and is of greater value

if simple description is related to explanations of the identified important features of the described facts, objects and processes, their laws and causal connections and relationships (Zelenika, 2000: 338-339).

With a view to conducting the preliminary research, four research questions were asked:

Is success achieved in male junior tennis a guarantee for professional tennis success?

Is reaching a position in the 'international ranking' in junior categories a prerequisite for success in ATP tennis?

Is intensive tennis training during one's junior days an obstacle to progress in school education?

Does playing high-quality tennis in junior categories make it easier to study at colleges in the U.S.A.?

## Results

Table 1. Current Status of junior tennis players in the period 2010-2019. Source: CTA

	Name	Born	Status		Name	Born	Status
1.	DŽUMHUR, D.	1992	ATP Tour – B&H	37.	MANDIĆ, F.	1996	Manager
2.	PAVIĆ, M.	1993	ATP Tour Doubles	38.	ILIĆ, M.	1998	Studies USA
3.	OSTOJIĆ, T.	1994	Graduated USA	39.	ŠOLAJA, N.	1996	Studies CRO
4.	LOVRIĆ, I.	1993	Graduated CRO	40.	VARGA, M.	1998	Studies USA
5.	GREGUROVIĆ, T.	1992	Graduated USA	41.	MARIĆ, F.	1998	ITF Tour
6.	BRKIĆ, G.	1992	Coach	42.	NINČEVIĆ, F.	1999	ITF Tour
7.	DRAGANJA, T.	1994	ATP Challenger	43.	TONEJC, F.	1997	Graduated USA
8.	PEHAR, A.	1992	Coach	44.	SAVIN, R.	1999	Studies USA
9.	RUŽIĆ, M.	1992	Privat company	45.	VESELIĆ, L.	1998	Studies CRO
10.	DUPOR, J.	1993	Graduated CRO	46.	ŠULER, J.	1999	Studies USA
11.	LEVAR, I.	1994	Coach	47.	SELAJ, M.	1998	Studies CRO
12.	ŽUNIĆ, A.	1992	Graduated USA	48.	GOJO, B.	1998	ATP Challenger
13.	GOLEŠ BABIĆ, M.	1994	Graduated USA	49.	DIVKOVIĆ, K.	1999	Studies USA
14.	ŠIŠKO, S.	1994	ITF Tour	50.	MARKUŠIĆ, B.	1999	Studies USA
15.	ĆORIĆ, B.	1996	ATP Tour	51.	MARTINIS, J.	1998	Coach
16.	POPOVIĆ, O.	1996	Coach	52.	KRNETA, N.	1998	Studies USA
17.	DELIĆ, M.	1993	No occupation	53.	KOSTIĆ FERČEK	2001	ITF Tour
18.	VEGER, F.	1994	Coach	54.	BAŠIĆ, N.	2001	ITF Tour
19.	ĐULA, R.	1995	Graduated USA	55.	GALIĆ, M.	2000	Studies USA
20.	ZGOMBIĆ, F. Z.	1996	Studies CRO	56.	BAN, I. K.	2002	ITF Juniors
21.	KRALJEVIĆ, F.	1996	Graduated USA	57.	ŠALER, F.	2000	High School
22.	BABIĆ, Z.	1995	Graduated USA	58.	STEPANIĆ, P.	2000	ITF Tour
23.	LOZIĆ, K.	1997	Graduated USA	59.	JURKOVIĆ, M.	2000	High School
24.	CVEK, F.	1996	Graduated CRO	60.	DEVALD, B.	2002	ITF Juniors
25.	MIKOVIĆ, R.	1994	Studies CRO	61.	KALENDER, A.	2001	ITF Tour
26.	SERDARUŠIĆ, N.	1996	ATP Challenger	62.	MATIĆ, M.	2001	ITF Tour
27.	PODVINSKI, T.	1997	Studies USA	63.	ŠKREB, D.	2002	ITF Juniors
28.	BILJEŠKO, D.	1997	ITF Tour	64.	ŠARUNIĆ, A.	2002	ITF Juniors
29.	GLASNOVIĆ, R.	1997	Graduated USA	65.	AJDUKOVIĆ, D.	2001	ITF Tour
30.	SAMARDŽIJA, D.	1997	Studies USA	66.	KROLO, K.	2002	ITF Juniors
31.	SVJETLIČIĆ, M.	1995	Studies USA	67.	SUEVICH, L.	2002	High School
32.	PETERLIN, D.	1996	Studies CRO	68.	JAKIĆ, M.	2002	ITF Juniors
33.	KRSTANOVIĆ, J.	1997	Graduated USA	69.	BILL, A.	2003	ITF Juniors
34.	PEHNEC, J.	1996	Graduated USA	70.	STIPETIĆ, R.	2003	ITF Juniors
35.	ROGIĆ HADŽALIĆ	1997	ITF Tour	71.	BABIĆ BRAJKO	2004	ITF Juniors
36.	ANTOLJAK, T.	1996	Studies USA	72.	VUKADIN, N.	2004	ITF Juniors

An analysis of the ten most successful tennis players on the male annual lists in the category under 18 years showed that in the ten-year period (from 2010 to 2019), there was a total of 72 names. These are the annual ranking lists of the most successful male tennis players under the age of 18, which means that they can also include younger tennis players who participate in tournaments of this category, so that the same names can appear for three years in a row (e.g., Maks Kostić Fereček and Marko Ilić). The list most often refers to tennis players of entry age (16-17 years) and tennis players of exit age (17-18 years). In addition to the top ten young players in each year, tennis players who were on a separate list, in the so-called 'international ranking', were additionally considered. These players had been given this status due to their excellent performances and results at international tournaments. In fact, they are the male junior tennis elite of Croatia. A total of four players received this status in the ten-year observation period: Damir Džumhur, Mate Pavić, Borna Ćorić and Admir Kalender.

## Discussion

A tennis player who ranks among the top ten in the male junior under-18 list has the possibility of achieving social mobility for himself and his family over the course of his professional tennis career. The ten-year study shows that currently only three out of the 72 players analyzed have been able to make an ATP career. It is important to note that all three of them were at one time classified in the junior lists of the 'international ranking', which is indicative of the fact that this placement is a prerequisite for professional tennis success. The only tennis player who currently does not have an ATP career and has been classified in the 'international ranking' is nineteen-year-old Admir Kalender who is young enough to prove himself in professional tennis. However, if the three ATP players are analyzed more closely, then it should be emphasized that Damir Džumhur represents Bosnia-Herzegovina in senior competition; ten years ago he was only registered with a Croatian club. Therefore, he cannot compete as a Croatian tennis player, being a B&H citizen. Mate Pavić is successful on the ATP Tour, but he specializes in doubles, where he ranks among top players in the world, while he has not achieved notable results in individual competition. From this class, only Borna Ćorić has been able to prove himself as a world-level single player in the last ten years. According to statistics, only 1.4 percent of the best male junior tennis players in Croatia have achieved a professional level in tennis, which means that only one of them has become an ATP player in singles.

Three more players covered by this research are currently trying to make their way in tennis through Challenger tournaments, which represent a lower category of professional tennis: Nino Serdarušić and Borna Gojo are trying to succeed in individual competition, while Tomislav Draganja as a doubles player. In Challenger tournaments, player costs are still higher than potential revenue. The financial investments can be considerable, given the fact that the cost of competing on tour has been estimated at a minimum \$121,000 per year and only the top 130 professionally ranked athletes earned enough money to cover this cost (Bane et al., 2014).

Eleven players encompassed by the research are currently playing actively as part of the ITF Tour, a series of tournaments formerly known as 'Futures', the lowest category of professional tennis. The prize pool of these tournaments is a maximum of \$ 25,000, which cannot be a permanent solution for players. The ITF Tour, and even the Challengers are intermediate stages in the player-to-tennis relationship. After three to four years of competing in Challengers or ITF tournaments, unless there is a result, players usually leave professional tennis and start the process of retraining, mostly to become coaches.

It can be observed that the path of teaching others was the choice taken by six gifted Croatian tennis players in the past: four work as coaches in Croatia, one in neighbouring B&H, while Filip Veger works in Qatar. Out of the eleven players currently competing on the ITF Tour, Duje Ajduković is the highest-ranked player, who, together with the aforementioned Kalender, has the highest probability of making a breakthrough in tennis.

Intensive tennis training in junior days does not necessarily mean that young tennis players will neglect school or, subsequently, their university studies. This is evidenced by the fact that out of the 72 male juniors included in this survey, 33 have university experience, which accounts for 46 percent of the total junior population analyzed. Good junior tennis ranking provides a great potential for studying abroad. As many as 24 Croatian junior tennis players from this circle have been awarded scholarships to U.S. colleges. Currently, twelve of them have already attained their degree, while other twelve are in the process of studying and they are likely to complete their studies successfully due to the fact that the drop-out rate at colleges was only 12 percent in 2018 (Hosick, 2018).

Two levels of study in the U.S.A., where Croatian young athletes go, need to be distinguished. On the one hand, there is the sporting quality of the college and, on the other, the scientific and educational dimension. As many as three Croatian tennis players have been awarded scholarships by one of the so-called Ivy League universities, the most prestigious tertiary education institutions in the United States. Croatian junior tennis players are awarded scholarships in various parts of the United States, from Mississippi, Minnesota to Michigan, without any predefined rules. Nine former tennis juniors have decided to study in Croatia: three have already completed their studies, namely Law, Electrical Engineering and Computing, and Kinesotherapy, while four are still studying (Science, the Catholic University, etc.).

Some of the younger tennis players who were ranked in the 2017-2019 lists are actually still in high school and are playing mostly in junior ITF tournaments. It can be expected that one part will choose to go to the U.S.A. to pursue their studies, as this will allow the continuation of their tennis careers as well as the completion of their studies. With the exception of Kalender, no junior currently has achieved an 'international ranking', and none competed in any of the Junior Grand Slam tournaments (Australian Open, Roland Garros, Wimbledon, US Open) last year. Therefore, they are less likely to reach the highest level of professional tennis. It is evident from this observation that there are currently ten tennis players competing in junior ITF tournaments where there are no cash prizes. For this reason, some of the costs are covered by the Croatian Tennis Association and most of them will eventually end up at colleges in the United States.

The observation shows that six players can not be classified in any of the categories considered. Mate Delić was a promising tennis player, yet he failed, and today he is without professional engagement. Three of the top 10 juniors have abandoned tennis and are currently about to graduate from high school, while Franco Mandić runs a restaurant in Split.

## Conclusion

The preliminary research analysis conducted among the most talented Croatian juniors in tennis from 2010 to 2019 shows that a good junior 'ranking' is no guarantee for success in professional tennis. In the observed period, only Borna Ćorić (out of 72 tennis players) succeeded as a Croatian professional tennis player in singles competition on the ATP Tour in terms of rating, results and his position in the world ranking list, while Mate Pavić also succeeded, but only as a doubles player. Both of them had achieved an "international ranking" in their junior days. The answer to the second research question about the importance of 'international ranking' is best given by the fact that no other Croatian tennis player out of this category has managed to reach the ATP level in the last ten years. As many as 33 players covered by this analysis decided to go to university, which gives an answer to the fourth research question: intensive tennis training in junior years is no obstacle to education. In addition, tennis allowed 24 students to study at U.S. universities where they utilised sports scholarships. The opportunity to win a U.S. scholarship shows that tennis facilitates one's studying abroad, especially in the U.S.A. The analysis showed that only a small number of Croatian male tennis players in junior categories succeed in professional tennis, while gaining a scholarship to study in the U.S.A. is a more realistic option.

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## TESTING THE EFFECTIVENESS OF A RUNNING PROGRAMME ON THE MENTAL HEALTH OF CROATIAN POLICE OFFICERS

Ivana Glavina Jelaš, Ruža Karlović, Jurica Pačelat

*Police College Zagreb, Croatia*

### Abstract

Police work is one of the most stressful in the world and can leave consequences upon officers' health. One of adaptive coping mechanisms that officers often use is workout, but with emphasis on the physical not psychological benefit, and more often they use anaerobic programs. Research shows that running workout improves mental health so the aim of this study was the experimental validation of the effectiveness of running workout program regarding the mental health of officers. The study was conducted on 31 subjects - 14 officers were in the experimental and 17 in the active control group. Before and after the completion of the 8 week running program, the respondents completed questionnaires: BAI (Beck Anxiety Inventory), BDI (Beck Depression Inventory), ASI (Anxiety Sensitivity Index) and CORE-OM (Clinical Outcomes in Routine Evaluation – Outcome Measure). There were statistically significant differences between the results prior and after the program for the whole sample. Results of Wilcoxon signed-rank test showed that there was statistically significant improvement of BDI results and the results on 3 CORE-OM subscales for the whole sample regardless of the group qualification. Regarding the comparison between groups, results showed that there was statistically significant improvement on BDI - in the experimental but not in the control group. This research confirmed well known fact regarding running workout – that it significantly improves mental health, in this case the health of police officers. This experimental study shows that running workout should be systematically offered to officers as effective mental health improvement tool.

*Key words: police, mental health, depression, anxiety, running, exercise*

### Introduction

Police work is unquestionably one of the most stressful occupations in the world (Frank et al., 2017). Police stressors are grouped into operational and organisational. Operational stressors include all stressors arising from the nature of police work, such as exposure to danger, work with the perpetrators and victims of criminal offences, etc. Organisational stressors are those related to the organisation of the system and police work, such as relations with colleagues, bureaucratic limitations, inadequate equipment, etc. Research in Croatia and elsewhere has repeatedly confirmed that police officers find organisational stressors more difficult to handle than operational stressors (Collins and Gibbs, 2003; Glavina Jelaš et al., 2015; Glavina et al., 2013; Tot, 2010).

In view of the above, it is not surprising that police work leaves consequences on the mental and physical health of police officers, despite valid selection procedures at the time of admission to service and the selection of the best suited individuals for the performance of this demanding work. Arnetz, Lumley and Nevadal (2009) pointed out that police officers are at an increased risk of developing different mental health issues. Depressive and anxiety disorders are a frequent consequence of police work amongst the police population (Want et al., 2010; Husain 2014).

Research has shown that police officers are prone to the use of maladaptive coping mechanisms (Williams et al., 2010), while exercise as adaptive coping mechanism is eminent in police. Bezzera et al.(2013) listed exercise as the most effective strategy to mitigate the consequences of stress in their research on police officers. Anshel et al. (2012) showed the efficiency of a ten-week exercise programme on stress, work satisfaction, and energy levels amongst police officers. Maran, Zedda and Varetto (2018) also showed the efficiency of an exercise programme for stress reduction amongst police officers. Gerber et al. (2010) found that exercise certainly helped those facing chronic stressors, and that exercise was negatively correlated with the use of sick-leave of officers and emergency workers. Lyoka (2011) showed that a well-organised exercise programme contributed to the management of stress, anxiety and anger amongst police officers, and that it could increase self-confidence, emotional stability and cognitive functions of the subjects.

Both correlational and experimental research have confirmed that exercise leads to better mental health, in both clinical and non-clinical samples, irrespective of age and sex (Guszkowska, 2004). Skead and Rogers (2016) pointed out that research over the past one hundred years and more has consistently confirmed the efficacy of exercise in relation to stress, anxiety and depression. Conducted meta-analysis consistently confirm the efficacy of exercise in relation to stress, anxiety and depression (Josefsson et al., 2014; Statopholou et al., 2006; Rebar et al., 2015; Wipfli, Ramirez et al., 2013).



Further, physical exercise was shown to be very significant for cognitive functions, such as attention (Rassovsky and Alfassi, 2019), learning (Cotman et al., 2007) and memory (Roig et al., 2016). The positive effects of exercise on mental health are present in both aerobic and anaerobic exercise programmes (Kianian et al., 2018), although some authors give priority to aerobic programmes (Schmitt et al., 2019; Guszowska, 2004).

The role and efficacy of exercise is still mostly promoted for the expected and logical purpose of caring for physical health and it seems it is not deservedly recognised as a valid resource for maintaining and improving mental health. Sharma et al. (2006) and Callaghan (2004) pointed out that the importance of exercise is not adequately understood or appreciated by patients and mental health professionals alike and it is neglected treatment in the mental health care system.

Various theoretical hypotheses that try to explain how psychological mechanisms influence the effects of exercise on mental health have been proposed, the main being distraction hypotheses and self-efficacy hypotheses (Mikkelsen, 2017; Craft, 2013). The distraction hypothesis suggests that exercise provides diversion from unfavorable stimuli which leads to an improved mood (Peluso and De Andrade, 2005) while a distraction from stressors and a “time out” from daily activities leads to reducing anxiety (Anderson, 2013). The self-efficacy hypotheses suggests that dedicated involvement in challenging activities like regular exercise might lead to improved mood, self-confidence (Peluso and De Andrade, 2005) and self-esteem, which is a strong predictor of overall, subjective well-being (Cooney et al., 2013). Anderson (2013) states that, according to social cognitive theory, individuals with a sense of high self-efficacy (who trust their ability to manage potential threats) worry less and experience lower levels of anxiety arousal, while exercise can increase self-efficacy by providing experiences of successfully coping with the stress of exercising. Other explanations of psychological benefits of exercise include social interaction, contact and mutual support (Peluso and De Andrade, 2005); reducing anxiety sensitivity; changes in accessibility or intensity of ruminations, worries, and anxiety (Gaudlitz et al., 2013); the affect regulation hypothesis; behavioral activation hypothesis (Craft, 2013); and the sense of autonomy over our own exercise process (Skead and Rogers, 2016).

Regarding physiological mechanisms, alterations in the activity of the autonomic nervous system (Harvey et al., 2017) and the functioning of the HPA axis are often cited. Schmitt et al. (2019) stated that there are significant alterations in growth factors, immune-related mechanisms, neurotransmitters and that the endocannabinoid system may mediate the effects of aerobic exercise on neuroplasticity. The monoamine and endorphin hypothesis of the impacts of exercise on mental health is commonly mentioned (Peluso and De Andrade, 2005), while recent studies are focused on brain-derived neurotrophic factor (BDNF). A meta-analysis by Szuhaniya et al. (2015) showed that exercise enhances BDNF levels. BDNF is often examined in the studies of biological foundations for various mental disorders, especially depression and anxiety (Yu and Chen, 2011), so it is not surprising that there is a large number of studies examining the connections between BDNF, exercise and mental health. Their results support the efficacy of exercise (Takahashi et al., 2019).

Furthermore, running as a form of exercise has been consistently proven to be exceptionally useful for mental health. Keating et al. (2018) showed the positive effects of a 12-week running programme on stress, anxiety and depression. Nabkasorn et al. (2006) also confirmed the positive effects of an 8-week running programme on the symptomology and hormonal responses to stress. Babyak et al. (2000) confirmed the efficacy of a 10-month fast walking and running programme on the symptoms of major depressive disorder. Blumenthal et al. (2007) showed that their 16-week walking/running programme had an almost identical effect on the remission of depressive symptoms compared with pharmacotherapy. In their comparison of the effects of running and clomipramine, Bandelow et al. (2000) showed that both treatments were useful for anxiety symptoms in subjects suffering from panic disorder and agoraphobia.

In view of all the above, the first objective of this study was to develop an 8-week running programme and to examine its effects on the mental health of police officers regarding overall mental health, depressive symptoms, anxiety symptoms. In line with this aim of the study and earlier findings, our first hypothesis was that the participants will show reduction in mental health problems, depressive and anxiety symptoms after participating in the 8-week running programme relative to baseline. Another research question was to examine whether participants who trained under the active guidance and supervision of a coach (experimental group) would benefit more from the exercise than participants who trained on their own (active control group). The second hypothesis was that the experimental group will show significantly more reduction in mental health problems, depressive and anxiety symptoms after participating in the 8-week running programme relative to active control group.

## Methods

### Participants

Table 1 shows the characteristics of the research participants. The participants (19 M, 11 F) of the survey were police officers with an average length of service in the police force of 6.1 years (min 0 g, max 12 g) and at the same time students of the Police College mostly first year students with an average age of 27 years (min 19, max 35). After initial testing, participants were divided into experimental group (E) and active control group (Ac); first, the whole group participated in an assessment of the 1000-meter run, and participants were assigned to experimental or active control group based on

their score. Participants were divided into groups in such a way that it was possible and practical to implement training program, while two groups were similar in most measured characteristics. Former sport experience was also taken into account (measured at baseline by questionnaire created for the purpose of this research).

*Table 1. Sociodemographic characteristics of participants*

		f	%
Gender	M	19	63,3
	F	11	36,7
Group	E	14	46,7
	Ac	16	53,3
Age	19-21	6	19,9
	24-26	4	13,3
	27-29	11	36,7
	30-33	6	19,9
	34-35	3	10
Study year	I.	14	48,3
	II.	8	27,6
	III.	7	24,1
Years of police service	0-4	8	29,6
	5-8	13	48,2
	9-12	6	22,2

## Instruments

### **Beck Anxiety Inventory (BAI), Beck, Epstein, Brown and Steer, 1988; Beck and Steer, 1990**

The instrument consists of 21 items that are regarded as common symptoms of anxiety. The subjects are asked to use a 4-point scale to indicate the number of times during the past week they felt the symptoms. The total score is calculated by adding the score for all items. The calculated internal consistency was satisfactory and was Cronbach  $\alpha=0,903$ .

### **Clinical Outcomes in Routine Evaluation – Outcome Measure, CORE–OM; Barkham et al., 1998, 2001, 2005; Evans et al., 2002**

The instrument consists of 34 statements that are used to evaluate general psychopathological conditions and the risk for the onset of psychological problems, and accompanies the effect of counselling and psychotherapy. The statements are grouped into four subscales: subjective well-being, problems/symptoms, functioning, and risk to self or others. The subjects use a 5-point scale in relation to the preceding week to express their degree of agreement with the statements. The score is calculated as a ratio of the sum of all answers and the number of statements answered. It is used to determine the critical value on the basis of which it is possible to recognise people with pronounced psychological conditions. The calculated internal consistency of each subscale was satisfactory and was Cronbach  $\alpha=0,782$  for the scale of subjective well-being, Cronbach  $\alpha=0,943$  for the scale of problems/symptoms, Cronbach  $\alpha=0,763$  for the scale of functioning, and Cronbach  $\alpha=0,639$  for the scale of risk to self or others.

### **Beck Depression Inventory, - BDI-II, Beck, Steer and Brown, 1996**

The instrument consists of 21 statements that measure different levels of depression. A set of four possible responses are offered for each statement, ranging in intensity. The subject answers the questions by circling one of the four responses. The total score is the sum of all statements. The calculated internal consistency was satisfactory and was Cronbach  $\alpha=0,919$ .

### **Anxiety Sensitivity Index (ASI); Reiss, Peterson, Gursky and McNally, 1986; Peterson and Reiss, 1992)**

The instrument is a 16-item scale that measures the amount of concern about various symptoms of anxiety. The subjects report their level of aversion towards various symptoms of anxiety on a scale from 1 to 5. The total result is the sum of numbers next to each item. The calculated internal consistency was satisfactory and was Cronbach  $\alpha=0,883$ .

## Procedure

Ethical considerations regarding voluntary participation, informed consent, potential risk for the participants and confidentiality were taken into account when gathering participants and conducting the study, that received approval of the Police Academy Ethics Committee prior to implementation. Lecture concerning the research project and effects of exercise on mental health were held for full-time criminology students at the Police Academy where they had the opportunity to apply for participation in the study with a written informed consent and application form. Applied subjects were tested in a 1-km run, and they represented the final sample. On the basis of their results, they were divided into an experimental and active control group. As it was important to ensure homogeneity in the experimental group, slower and faster runners were placed into the active control group based on their results in the 1-km run.

Before the first training, all participants filled out all the questionnaires (Croatian versions) administrated by psychologists from Mental Health Centre of the Police College in Zagreb (who also corrected, analysed and interpreted the psychological measures). Screening process at the baseline psychological measures showed no evidence of elevated risk or severe levels of symptoms that would require exclusion from participation in the study or some other type of intervention. Besides questionnaires, prior to the first training session, participants were weighed, and provided with smart bracelets to measure blood pressure and heart rate before and after each training session as well as distance crossed in every training.

The E group was under the guidance of a professional running coach who prepared each workout and the entire programme. The Ac group did the trainings on their own, without active guidance. They received instructions before each workout about the length of the warm-up/stretching and running programme for the E group, and they were told to set their own tempo based on their physical abilities and spend the same amount of time doing physical activity, without any instructions about how it should be conducted. Trainings was held at the same time for both groups—three times a week over eight weeks, and with the same training sessions duration. After the programme ended, the subjects completed the same questionnaires as before the first training sessions, including an evaluation form, and they were once again weighed.

## Results

The Wilconxon rank test results on the overall sample (Table 2.) showed a statistically significant decrease in the total scores on the Clinical Outcomes in Routine Evaluation measure (CORE - OM), expressed in medians (Md1 = 18, Md2 = 12),  $z = -2.583$ ,  $p = 0.01$ , with a medium effect size ( $r = 0.333$ ), after participating in the running program. Also, a statistically significant decrease in post-test outcomes was obtained in three out of four subscales of the questionnaires with a slightly lower effect size; functioning (Md1 = 8.5, Md2 = 6,  $z = -2.196$ ,  $p = 0.028$ ,  $r = 0.283$ ), problems/symptoms (Md1 = 10, Md2 = 5.5,  $z = -2.371$ ,  $p = 0.018$ ,  $r = 0.306$ ) and subjective well-being (Md1 = 3, Md2 = 2,  $z = -2.449$ ,  $p = 0.014$ ,  $r = 0.316$ ). A significant decrease was also found in the symptoms of depression on Beck's Depression Inventory measure from Md1 = 2.5 in pretesting to Md2 = 1.0 after participating in the running program, with a medium effect size of  $r = 0.344$ . A statistically significant difference between pre-test and post-test was not obtained on the Anxiety Sensitivity Index and Beck's Anxiety Inventory.

Table 2. Wilconxon signed-rank test results - differences in pre-test and post-test for the total sample

	Pre-test (Md)	Post-test (Md)	Z	p	r
CORE	18.000	12.000	-2,583	,010	0.333
CORE F	8.500	6.000	-2,196	,028	0,283
CORE P	10.000	5.500	-2,371	,018	0,306
CORE W	3.000	2.000	-2,449	,014	0,316
CORE R	0.000	0.000	-1,663	,096	0,215
BAI	5.000	5.000	-0,850	,395	0,157
BDI	2.500	1.000	-2,577	,010	0,344
IAO	27.500	29.500	-.661	,509	0,085

The results of testing the differences between pre-test and post-test within the groups (E - experimental and Ac - active control groups), shown in Table 3., showed a greater decrease in symptoms in the experimental group on almost all measures except for the Anxiety Sensitivity Index. Almost statistically significant differences with the medium effect size were found in the experimental group on the CORE scales ( $z = -1.884$ ,  $p = 0.60$ ,  $r = 0.356$ ) and on the subscales CORE P ( $z = -1.959$ ,  $p = 0.050$ ,  $r = 0.370$ ) and CORE W ( $z = -1.855$ ,  $p = 0.064$ ,  $r = 0.350$ ). However, a statistically significant difference was only found in the experimental group on Beck's Depression Inventory with Md = 4 in pre-testing to Md = 1.5 in post-testing ( $z = -2.242$ ,  $p = 0.025$ , with a medium to high effect size  $r = 0.423$ ).

Table 3. Wilcoxon signed-rank test results - differences in pre and post-testing by measures and by groups

	Group	Pre-test (Md)	Post-test (Md)	Z	p	r
CORE	E	14,4310	10.0000	-1,884	,060*	0,356
	Ac	23,5000	15.5000	-1,657	,097	0,293
CORE F	E	7,5000	5.5000	-1,571	,116	0,297
	Ac	8,5000	6.5000	-1,366	,172	0,241
CORE P	E	7.5000	4.5000	-1,959	,050*	0,370
	Ac	11.0517	7.5000	-1,346	,178	0,238
CORE W	E	2.5000	1.0000	-1,855	,064*	0,350
	Ac	3.0000	2.0000	-1,712	,087	0,303
CORE R	E	0.0000	0.0000	-,406	,684	0,076
	Ac	0.0000	0.0000	-1,802	,072	0,318
BAI	E	7.0000	4.5000	-1,141	,254	0,215
	Ac	4.0000	5.0000	-,105	,916	0,018
BDI	E	4.0000	1.5000	-2,242	,025	0,423
	Ac	2.0000	0.5000	-1,337	,181	0,236
IAO	E	27.0000	30.0000	-,157	,875	0,029
	Ac	29.5000	28.5000	-1,195	,232	0,211

Table 4. Mann – Whitney test results - differences between groups by measures in pre and post test

	Group	Pre-test (Md)	Mann-Whitney	Z	p	Post-test (Md)	Mann-Whitney	Z	P
CORE	E	14,4310	88.000	-0.998	0.318	10.0000	88.500	-0.978	0.328
	Ac	23,5000				15.5000			
CORE F	E	7,5000	104.000	-.334	0.739	5.5000	95.000	-0.709	0.478
	Ac	8,5000				6.5000			
CORE P	E	7.5000	91.000	-.874	0.382	4.5000	100.000	-0.504	0.614
	Ac	11.0517				7.5000			
CORE W	E	2.5000	99.000	-.546	0.585	1.0000	92.000	-0.847	0.397
	Ac	3.0000				2.0000			
CORE R	E	0.0000	111.000	-.047	0.963	0.0000	93.000	-1.015	0.310
	Ac	0.0000				0.0000			
BAI	E	7.0000	86.000	-1.086	0.277	4.5000	97.000	-0.351	0.726
	Ac	4.0000				5.0000			
BDI	E	4.0000	87.500	-1.027	0.305	1.5000	90.000	-0.388	0.698
	Ac	2.0000				0.5000			
IAO	E	27.0000	112.000	.000	1.000	30.0000	88.500	-0.978	0.328
	Ac	29.5000				28.5000			

Despite the non-random allocation of participants to groups and certain differences between groups, there is no statistically significant difference between groups in the baseline on any measured scales (shown in Table 4). Table 4. also shows the results of testing the difference between groups in the post-test where there are also no statistically significant differences between the groups on any measured scales.

## Discussion

The results on the total sample of participants who participated in the running program (regardless of participation in the program with or without the trainer) indicate the usefulness of this type of exercise regarding mental health shown by significantly better results on the dimensions of functioning, problems/symptoms and subjective well-being. These results are consistent with findings of other researchers examining the effects of exercise programs on police officers regarding management of stress, anger, self-confidence, emotional stability and cognitive functions (Lyoka, 2011). Also, the results on the total sample of participants in this study showed reduction in symptoms of depression, measured by

Beck's Depression Inventory, which is consistent with the results of meta-analysis conducted by Josefsson, Lindwall, and Archer (2014) and meta-analysis of Statopholou et al. (2006) regarding the promising effectiveness of exercise in reducing depressive symptoms.

No statistically significant difference was found in the post-test between the experimental and active control group on any measured scale and the only statistically significant difference within the group was obtained on the measure of depression symptoms within the experimental group. Also, no statistically significant results were found regarding anxiety symptoms which is inconsistent with other researches mentioned in the introduction of this paper.

This study has several limitations. Firstly, it is a quasi-experimental design: the initial groups were not equalised, i.e. they were not grouped by case, so the inference power of the design is diminished. The principal deficiency is the absence of a true control group, i.e. one that was not exposed to the exercise programme as opposed to the active control group in this study, which—although it was not exposed to the independent variable, i.e. guided programme—was included in exercise. Another limitation of this study is the small sample size and it would be useful to repeat the research with more participants and improved design in the next phases of the project.

This is the first study of its kind conducted on police officers in Croatia. Police officers will have access to a programme whose efficacy on mental health has been demonstrated precisely on the population of police officers. Scepticism as a classic element of police subculture (Crank, 2004) is very useful in terms of quality performance of police work. However, this element of the so called working personality of police officers (Glasner, 2005) leaves its trace in other areas of their life and makes police officers suspicious in general. The essence of police work is search for evidence, and scientific evidence concerning the efficacy of a programme conducted on police officers can be truly useful in terms of their motivation to participate and use the programme.

In addition to introducing a control group, equalising the groups of participants, and increasing their number, future research should enhance control of specific external variables, such as the number of calories consumed, and overall diet. It would also be useful to control the duration and quality of sleep and all other factors that improve or undermine physical fitness.

In terms of the practical usability of the results, it is necessary to emphasize that exercise is one of the adaptive mechanisms that the police population uses to cope with stress (Bezzerà et al., 2013). The efficacy of exercise has been scientifically proven, not only in terms of physical, but also mental health (Guszkowska, 2004). Police work as one of the most challenging and stressful jobs in the world (Frank et al. 2017) requires constant and systematic care for the mental health of police officers. However, in view of the specific elements of the police subculture, access to this population is a challenge for mental health experts. Without belittling the value of classical psychological counselling and treatment to preserve the mental health of police officers, we wish to emphasise the importance of exercise as a proven and very logical way of caring for officers' mental health. We are not referring here to police officers who have already developed serious mental health issues, in which case professional help in the form of psychological therapeutic treatment is imperative. Since mental health, like physical health, must be maintained, running is a useful tool in this respect. In the care for mental health of police officers, the emphasis should be on prevention. Despite the successfulness of selection of the psychologically and physically fittest candidates, police work leaves consequences on the health of police officers. That is why it is paramount to build mental resilience in healthy police officers, as they will inevitably be exposed to exceptionally difficult stressors whilst in service. It is vital to keep healthy police officers healthy and to work on their mental resilience, which will keep them functional despite exposure to stressors. One of the ways to build resilience is mental training, such as the MBCT (*Mindfulness Based Cognitive Therapy*) or MBSR (*Mindfulness Based Stress Reduction*), but also through physical exercise, as analysed in this study. Exercise is widely accepted by police officers, albeit primarily as a way of taking care of their physical health. Mental trainings are indispensable in caring for the health of police officers and they are being introduced in police systems throughout the world more and more frequently. However, in terms of mental health, it is very useful to examine tools that are more accessible to police officers and which they find easier to accept, such as aerobic physical exercise.

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## THEORY OF IRONIC PROCESSES OF MENTAL CONTROL IN SPORT-RELATED MOTOR PERFORMANCE: A SYSTEMATIC REVIEW

Eslem Gokcek<sup>1</sup>, Recep Gorgulu<sup>2</sup>

<sup>1</sup>Hacettepe University, Turkey

<sup>2</sup>Bursa Uludag University, Turkey

**Introduction:** Wegner (1994) predicts that performance when anxious will break down precisely where it is least desired. This manner has been explained by the Ironic Processes of Mental Control Theory by social psychologist Daniel Wegner however it applies to cognitive tasks in range of areas such as psychology, medicine, and sport. The aim of this systematic review was to provide a comprehensive understanding of ironic processes theory via sport related motor performance studies.

**Methods:** In this review, studies published between 1998 and 2020 were reviewed via Web of Knowledge, PsycINFO, MEDLINE/PubMed, and Science Direct databases. The search terms were “ironic process”, “ironic error”, “motor performance”, “ironic processes of mental control” and “ironic process of mental control in sport” respectively. Overall, 20 articles were selected based on the series of exclusion and inclusion criteria then classified into the six sub-groups based on their methodology and design.

**Results:** Accordingly, results showed that selected articles were classified into 6 groups as follows; a) verification of ironic effects in motor performance, b) ironic effects in motor performance under pressure, c) investigation the mechanism of ironic effects in motor performance with eye movement, d) comparing the ironic processes theory with different theories in motor performance, e) differentiating the ironic error from the general performance error, f) investigation the mechanism of ironic effects in motor performance through technological measures. Results revealed that the most recent sport related motor performance studies conducted in ironic processes were focused on testing the theory under pressure that enables a deeper understanding performance and pressure relationship.

**Conclusions:** Understanding the mechanism of the ironic processes of mental control theory may be a promising theoretical framework which could provide practical interventions for better understanding of anxiety-performance relationship in sport.

**Key words:** *Ironic effect, ironic error, ironic processes, motor performance, sport, systematic review*

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## THE RECIPROCAL RELATIONSHIP BETWEEN SOCIAL LOAFING AND INTERMITTENT ENDURANCE PERFORMANCE: THE MODERATING ROLE OF THE NARCISSISM IN BASKETBALL PLAYERS

Recep Gorgulu

*Psychology of Elite Performance Laboratory, Faculty of Sport Sciences, Bursa Uludag University, Turkey*

### Abstract

In sport, individuals high in narcissism excel when opportunities for personal glory are evident. However, when there is no such opportunity, the detrimental effect of narcissism is less known. Therefore, the present study aims to investigate the effect of narcissism as a personality factor on the endurance performance task. Participants' narcissism was measured with the Narcissistic Personality Inventory -16. Participants' psychophysiological measures such as heart rate and heart rate variability were also obtained throughout the experiment. The final sample comprised 42 male basketball players ( $M_{\text{age}}=22.60$ ;  $SD=1.70$ ;  $M_{\text{experience (in years)}}=8.45$ ;  $SD=2.45$ ). All participants twice performed a multistage 20-meter shuttle run test in two occasions first when identifiability was low and second when identifiability was high. The significant Narcissism x Performance interaction illustrates those narcissists experienced significantly greater decreases in performance from high- to low-identifiability performance conditions, whereas others displayed no such performance differences. These results support the hypotheses that narcissists performed better when there was a chance for glory and socially loafed when no such opportunity was available. In conclusion, the present study provides a sound basis foundation for future sport-related studies on which to explore narcissism as individual differences in the competitive environment for team sports such as basketball.

**Key words:** *Performance, narcissist, individual, group, team, effort, running, basketball*

### Introduction

Personality traits predict several performance markers in competitive contexts such as work and academia (see, e.g., Poropat, 2009). Organised sport represents another competitive context in which some personality traits have been found to coincide with greater levels of success. For example, individuals high in narcissism excel when opportunities for personal glory are evident; however, when there is no such opportunity, the detrimental effect of narcissism is less known. Unsurprisingly, the study of narcissism has been a stalwart feature of the sport psychology literature, and there is an ever-growing body of research endorsing positive associations between a large number of psychological factors and performance outcomes. In clinical settings narcissism is defined as "a pervasive pattern of grandiosity, need for admiration, and a lack of empathy" (American Psychiatric Association 2013, p. 669). In the current article, as opposed to people with a narcissistic personality disorder, the terms narcissists are used to interchangeably to describe individuals who report relatively highly on valid self-report personality measure of narcissism such as the Narcissistic Personality Inventory (NPI; Raskin, & Hall, 1979; Ames, Rose, & Anderson, 2006). Narcissists consider themselves to be special people who are superior to others (Gabriel, Critelli, & Ee, 1994), report high levels of confidence (Campbell, Goodie, & Foster, 2004) and are self-focused and vain (Morf, & Rhodewalt, 2001). Furthermore, narcissistic individuals enjoy competitions (Morf, Weir, & Davidov, 2000), and thrive in challenging, tough and pressurised situations where others often choke (e.g., Guekes et al., 2012; Wallace, & Baumeister, 2002; Woodman et al., 2011). Moreover, narcissistic individuals seem to enjoy competition because the competitive environment provides them with an opportunity to demonstrate their (self-perceived) abilities and skills to the world. Therefore narcissists are keenly aware that different situations and environment offer more or less opportunity for their glory (Roberts et al., 2014).

To better understand the processes connecting the level of narcissism in sub-clinical settings to athletic success, researchers attempt to explore associations between the degree of narcissism and discrete athletic behaviour. It has been found that narcissists often do not perform any better than low narcissistic individuals (Gabriel et al., 1994). For example, Wallace and Baumeister (2002) conducted research with psychology students and results revealed that the narcissists' performance would be moderated by the degree of self-enhancement opportunity afforded by the task. Similar associations might be observed in team sports, and this could have applied implications for practitioners and trainers in terms of selecting or deselecting players to fit the needs of a particular team or competition.

Given the previous findings, the potential personality trait of narcissism appears to hold much promise in a sporting environment because it seamlessly dovetails the psychological process of endurance performance (less technical) in sport. More importantly, the role of narcissism in sports teams and exercise groups have received less empirical attention. Therefore, the present study aims to test the effect of narcissism as a personality factor on the endurance performance task.

## Methods

### Participants

48 participants agreed to take part in the current study and attended in the first experiment. 6 participants did not turn up for the second experiment therefore the final sample of the present study comprised 42 male basketball players ( $M_{age}=22.60$ ;  $SD=1.70$ ;  $M_{experience\ (in\ years)} = 8.45$ ;  $SD=2.45$ ). All participants voluntarily invited to the current study via the university website and they were physically active and training minimum 3 times per week and free from the alcohol, drug any medications for the past six months. This study received an institutional ethics approval and all participants provided written informed consent before participating.

### The Narcissistic Personality Inventory (NPI-16)

Participants' narcissism was measured with the Narcissistic Personality Inventory -16 (Ames, Rose, & Anderson, 2006; adopted into Turkish by Atay, 2009). The NPI 16 is a 16 item measure of narcissism that is based on the 40 item NPI (Raskin, & Terry, 1998). Each item from the inventory contains a narcissistic statement and a non-narcissistic statement in a forced-choice format. For example for the narcissistic statement; *I expect a great deal from other people*, and for the non-narcissistic statement; *I like to do things for other people*. According to the NPI-16 participants receive a narcissism score that ranges from 0 to 16. Cronbach's alpha in the present study was .82.

### Ratings of Perceived Exertion (RPE)

Participants rated their perceived exertion on a scale ranging from 6 (no exertion at all) to 20 (maximal exertion) on a vertical scale. Participants responded by pointing to their ratings of perceived exertion on the scale displayed (vertical cardboard with a 60 cm x 40 cm diameter) in front of them.

### Heart rate (HR) and Heart rate variability (HRV)

Participants' psychophysiological measures were also obtained throughout the experiment such as heart rate (BPM), heart rate variability. HR and HRV were recorded using a Polar V800 heart rate monitor with a Polar H7 chest strap at a sampling frequency of 1000 Hz. Recordings were subsequently imported into the PolarFlow and the Kubios HRV 2.2 software (Tarvainen et al., 2014). The data were computed heart rate (beats per minute), as well as the standard deviation of NN intervals (SDNN) and root mean square of successive R-R intervals (r-MSSD), as two time-domain measures of HRV. These measures were chosen because increased heart rate and decreased SDNN and r-MSSD have previously been associated with elevated physical exertion (Hardy, & Hutchinson, 2007; Marcora, & Staiano, 2010; Gorgulu, Cooke, & Woodman, 2019).

### Bioelectrical Impedance Analysis (BIA)

The Tanita BC 418 MA Segmental Body Composition Analyzer (Tanita, Japan) is a single-frequency (50 kHz) BIA device incorporating eight electrodes. BIA measurements were carried out according to the manufacturer's manual in this study. Information on participant age, height, and body type were manually entered into the Tanita BC 418 MA. BIA was performed in participants wearing light clothes, standing erect, and with bare feet on the analyser's footpads.

### Task and Procedure

On arrival, participants performed the multistage 20 meter (m) shuttle run test (Leger, Mercier, Gadoury, & Lambert, 1988). For the 20 m shuttle run test, participants were required to run back and forth on a 20 m course and must touch the 20 m line at the same time that a beep signal is emitted from a pre-recorded tape. Over the course of 20m shuttle run test in every 20 beep sounds (1, 20, 40, 60, 80, 100 and 120) participants were asked to rate the RPE scale that displayed in front of them and their HR and HRV were recorded via Polar V800 monitor throughout the test. During the second visit, participants were asked to run a 20 m shuttle test as a group of 3 as a part of a competition. This time, participants were told that their scores were not recorded individually but rather as a team and the competition was not ending until the last teammate stop running. In this second experiment, the procedure was identical to that reported in the first experiment. In the end, participants were debriefed, thanked for their participation.



## Results

Regression analyses (Judd, Kenny, & McClelland, 2001) were used to examine the potential moderating effects of narcissism (N) on the performance of 20-meter shuttle run test, first under high-identifiability and the second under low-identifiability. Regressing performance outcomes in two occasions on narcissism yielded  $\hat{Y}_{1i} = 98.20 - 1.65 N_i$  and  $\hat{Y}_{2i} = 108.05 + 2.34 N_i$ , respectively. Narcissism was a significant predictor of performance under low-identifiability ( $t_{41} = -1.87$ ,  $p = .001$ ). Under high-identifiability conditions the slope for narcissism was significantly different from zero,  $t_{64} = 2.75$ ,  $p = .004$ . Regressing the performance difference,  $Y_d$  (i.e.,  $Y_1 - Y_2$ ), on narcissism yielded  $\hat{Y}_{di} = -6.30 + .86 N_i$ . The slope for narcissism was significantly different from zero,  $t_{41} = 1.84$ ,  $p = .005$ . The significant Narcissism x Performance interaction illustrates those narcissistic experienced significantly greater decreases in performance from high- to low-identifiability performance conditions, whereas others displayed no such performance differences.

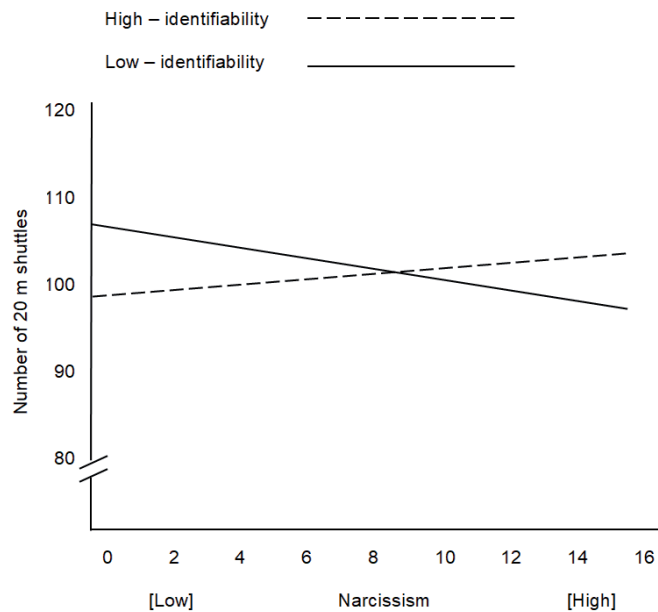


Figure 1. Regression slopes for performance under high- and low-identifiability conditions regressed on narcissism; a significant narcissism x identifiability interaction for performance.

## Discussion

The current study aimed to examine narcissism as a personality moderator under high-identifiability performance conditions with a 20-meter shuttle run test. Results support the hypotheses that narcissists performed better when there was a chance for glory and socially loafed when no such opportunity was available. These results are in line with the vast majority of within-person narcissism research in performance settings (Woodman et al., 2011; Wallace & Baumeister, 2002). These findings perhaps are not surprising, as narcissists do not perform well when facing the situation that does not provide a specific opportunity for personal glory and the self-enhancement opportunity was lower.

The current study is not without its limitations. The opportunity for self-enhancement might not have been enough to motivate participants to invest extra effort under low- and high-identifiability conditions, especially in the sporting context. To tackle this issue, we need further investigation of narcissism with independent participants in relation to group dynamics and team environment with specific team sports. In addition to this, future research should consider incorporating additional methods of measuring sub-dimensions of narcissistic grandiosity and vulnerability that would be more meaningful for further understanding of the construct of narcissism and its relationship with performance.

## Conclusion

In conclusion, the present study provides a sound basis foundation for future sport-related studies (i.e., endurance sports) on which to explore narcissism as individual differences in the competitive environment for team sports such as basketball.

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## THE MEASURE OF EMOTIONAL INTELLIGENCE OF COACHES AS PERCEIVED BY ATHLETES

Miroslav Hrženjak<sup>1</sup>, Vladimir Takšić<sup>2</sup>, Ksenija Bosnar<sup>3</sup>

<sup>1</sup>Zagreb Sport Association, Croatia

<sup>2</sup>Faculty of Humanities and Social Sciences, University of Rijeka, Croatia

<sup>3</sup>University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The aim of this paper is to present the modification of The Emotional Skills and Competences Questionnaire (ESCQ-45) prepared with the purpose to assess emotional intelligence of coaches as perceived by athletes. The instrument consists of 45 questions divided into three subscales, measuring three dimensions: perceiving and understanding emotions, expressing and labeling emotions and managing and regulating emotions. The evaluation of modified ESCQ-45 was performed on the sample of 602 athletes from 39 different sports. The sample consists of 365 male (60.63%) and 237 female (39.36%) athletes, with average age of 23.31 years. The athletes assessed the latest coach they were working with at last one full year. The analyses of metric properties show good metric characteristics of total result in three subscales as well as overall total result. Cronbach's alpha coefficients are high,  $\alpha=0,92$  for perceiving and understanding emotions subscale,  $\alpha=0,87$  for expressing and labeling emotions subscale,  $\alpha=0,88$  for managing and regulating emotions subscale and  $\alpha=0,96$  for overall total result. The results show that ESCQ-45 is appropriate questionnaire not only as a self-report measure but also as instrument to assess others.

**Key words:** *The Emotional Skills and Competences Questionnaire, coaches, metric properties*

### Introduction

The concept of emotional intelligence was introduced thirty years ago by Salovey and Mayer (1990). From then on, a considerable amount of research was done to clear the definition, to develop measures and to find the correlates of the concept. The research show that emotional intelligence defined as a trait and measured by self-report instruments is valid predictor and explanatory variable for many important human states and behaviors (Brackett, Mayer, & Werner, 2004; Takšić, Mohorić, & Munjas, 2006). In the field of sport, the interest for emotional intelligence research was not so intense as in some other fields; possible reasons could be incongruent empirical results and the deficit of measuring instruments appropriate in the sport situations (Bosnar, 2002; Takšić, Rukavina & Linardić, 2005; Stough et al., 2009). To research the relationship of athletes' motivation with the assessment of coaches' emotional intelligence, Hrženjak (2017) had to adjust some existing instrument, in this case, Takšić's Emotional Skills and Competences Questionnaire (Takšić, 2002).

The Emotional Skills and Competences Questionnaire (ESCQ-45) was developed under the Mayer and Salovey (1997) model of emotional intelligence by V. Takšić (1998; 2002). Initially, it consisted of 136 items to measure 16 hypothetical dimensions; further research, using factor analysis procedures, resulted in three-factor solutions (Takšić, Jurin, & Cvenić, 2001); factors were recognized as *perceiving and understanding emotions*, *expressing and labeling emotions* and *managing and regulating emotions*. Consequently, the instrument was shortened to 45 items measuring those three dimensions (Takšić, 2002). Questionnaire was promptly translated to English and presented in 2001. at the 7th European Congress of Psychology in London; soon, it was translated to Portuguese, Finnish, Swedish, Slovene, Spanish, Japanese etc. (Takšić, Mohorić, & Duran 2009; Takšić et al., 2009) Today, it is translated to more than twenty languages and used in a number of countries. Cross-cultural studies show respectable metric properties of ESCQ-45 subscale results, as well as total 45-item result. Three-factor structure was proven in all culturally different samples; two of three dimensions, *perceiving and understanding emotions* and *expressing and labeling emotions*, show stable definition across cultures; some variations were found in *managing and regulating emotions* dimension (Faria et al, 2009; Takšić et al., 2009; Takšić, Mohorić, & Holmstrom, 2018). The Emotional Skills and Competences Questionnaire is widely recognized as reliable and valid instrument and therefore could be useful in research in sport.

The aim of this paper is to present the modification of ESCQ-45 prepared with the purpose to assess emotional intelligence of coaches as perceived by athletes.

## Methods

The research was done on the sample of 365 male (60.63%) and 237 female (39.36%) athletes, the total of 602 athletes with mean age of 23.31 years. The sample was collected in a three-month period in city of Zagreb (Croatia) and included 39 sports. The athletes were approached after their training sessions and were informed about the aims of research. The measurements were done anonymously and voluntarily. The athletes' task was to assess only one of their coaches, the last one they were working with not less than a full year. To ensure that, the athletes had to give answers about sex and approximate age of targeted coach first. The total of 602 coaches was assessed, 509 male (84,47%) and 93 female (15,53%) coaches.

The modified questionnaire retained the same form as the original one; it consists of 45 items with answers on five-point scale (1-never, 2-seldom, 3-occasionally, 4-usually, 5-always). It can be used as a measure of general competence or treated as three-dimensional instrument: *perceiving and understanding emotions* (15 items), *expressing and labeling emotions* (14 items) and *managing and regulating emotions* (16 items).

Ethics approval of the research was obtained by the University of Zagreb Faculty of Kinesiology's ethics committee. Data analysis was done using software package Statistica 13.

## Results and discussion

The items of *Perceiving and understanding emotions* subscale show good metric properties (Table 1). All items have substantial values on the first principle component (the lowest value is 0,41) and medium to high item-total correlations (the lowest value is 0,47). The total result of subscale show also very good metric properties. The first eigenvalue of item correlation matrix (Table 4) explains high percentage, 49,76% of total variance and Cronbach's alpha coefficient of reliability is high 0,92. The distribution of total subscale result does not show statistically significant difference from normal; Kolmogorov-Smirnov test  $d=0,04085$ , statistical significance  $p>0,2$ .

The items of *Expressing and labeling emotions* subscale (Table 2) show also very good metric properties, with exception of three items having lower values: *When something doesn't suit my coach, he/she show this immediately*, *Behavior of my coach is a reflection of his inner feelings* and *People can tell what mood my coach is in*. The content of these items is *expressing emotions* but, there is possibility that they are perceived as contaminated with control of emotional behavior. On the other hand, it is not an easy task to recognize other's inner feeling. Perhaps, that can make some difficulties in answering this type of questions. Nevertheless, the total result is highly reliable; Cronbach's alpha coefficient is 0,87 and the first eigenvalue of item correlation matrix explains 42,18% of total variance (Table 4). The distribution of total subscale result does not show statistically significant difference from normal; Kolmogorov-Smirnov test  $d=0,04337$ , statistical significance  $p>0,2$ .

The items of third subscale *Managing and regulating emotions* also show high enough item-total correlations and values on the first principle component, with exception of item *When my coach doesn't like a person, he/she find ways to let him/her know* (Table 3). Cronbach's alpha coefficient is high 0,88 and the first eigenvalue of item correlation matrix explains 37,12% of total variance (Table 4). The distribution of total subscale result does not show statistically significant difference from normal; Kolmogorov-Smirnov test  $d=0,04911$ , statistical significance  $p>0,1$ .

The correlations of subscales are high (Table 5); the subscales mutually share more than half of variance, indicating the existence of higher order factor. Therefore, it is justifiable to use the ESCQ-45 as unidimensional instrument. The total result defined as unpondered linear combination of 45 item results obtained respectable Cronbach's alpha coefficient 0,96 (Table 4). The distribution of total 45 item result does not show statistically significant difference from normal; Kolmogorov-Smirnov test  $d=0,02684$ , statistical significance  $p>0,2$ .

High values of Cronbach's coefficients of internal consistency suggest that the subscales of ESCQ-45 could be shortened and nonetheless preserve adequate reliability. Undoubtedly, ESCQ-45 could be shortened considerably when only general measure of emotional intelligence assessment is needed.

Table 1. Descriptive statistics, values on the first principle component and item-total correlations of items of modified ESCQ-45 Perceiving and understanding emotions subscale

	Question	Mean	SD	K1	Rit	a-min
1.	When he/she meets an athlete, my coach immediately notices his/her mood.	3,82	0,93	0,57	0,63	0,92
2.	When my coach sees how an athlete feels, he/she usually know what has happened to him.	3,36	0,97	0,64	0,69	0,92
3.	My coach is able to tell the difference if his/her athlete is sad or disappointed.	3,80	1,02	0,66	0,72	0,91
4.	My coach is able to detect his/her athlete's mood changes.	3,96	0,97	0,66	0,71	0,91
5.	My coach can easily think of a way to make an athlete happy on his/her birthday.	3,56	1,21	0,52	0,58	0,92
6.	If my coach observe a person in the presence of others, he/she can determine precisely his/her emotions.	3,69	0,94	0,64	0,70	0,92
7.	My coach does not have difficulty to notice when somebody feels helpless.	3,73	0,96	0,68	0,73	0,91
8.	My coach is able to tell somebody's feelings by the expression on his/her face.	3,63	0,94	0,71	0,76	0,91
9.	My coach can detect his friends' concealed jealousy.	3,25	0,96	0,41	0,47	0,92
10.	My coach notices when somebody tries to hide his/her bad mood.	3,52	0,93	0,69	0,75	0,91
11.	My coach notices when somebody feels guilty.	3,59	0,92	0,71	0,76	0,91
12.	My coach notices when somebody tries to hide his/her real feelings.	3,50	0,96	0,74	0,79	0,91
13.	My coach notices when somebody feels down.	3,67	0,96	0,71	0,77	0,91
14.	My coach notices when somebody's behavior varies considerably from his/her mood.	3,59	0,95	0,65	0,71	0,92
15.	My coach knows how to pleasantly surprise each of his/her athletes.	2,86	1,04	0,65	0,69	0,92

Legend: Mean = proportion of correct answers, SD = Standard deviation, K1 = value on the first standardized principle component,  $R_{it}$  = item-total correlation,  $\alpha$ -min = Cronbach' alpha if the item is omitted.

Table 2. Descriptive statistics, values on the first principle component and item-total correlations of items of modified ESCQ-45 Expressing and labeling emotions subscale

	Question	Mean	SD	K1	Rit	a-min
1.	Putting her/his feelings and emotions into words comes easily to my coach.	3,42	0,98	0,62	0,72	0,86
2.	When something doesn't suit my coach, he/she show this immediately.	3,86	1,03	0,18	0,19	0,88
3.	My coach can easily think of a way to approach a person he/she likes.	3,63	0,99	0,48	0,55	0,87
4.	My coach is capable to list the emotions that he/she is currently experiencing.	3,52	0,99	0,65	0,74	0,86
5.	My coach is able to express his/her emotions well.	3,63	1,01	0,70	0,78	0,86
6.	My coach can recognize most of his/her feelings.	3,68	0,94	0,73	0,82	0,86
7.	My coach is capable to describe his/her present emotional state.	3,79	0,90	0,70	0,76	0,86
8.	I can say that my coach knows a lot about his/her emotional state.	3,84	0,92	0,66	0,75	0,86
9.	Behavior of my coach is a reflection of his inner feelings.	3,51	0,96	0,33	0,34	0,88
10.	People can tell what mood my coach is in.	3,81	0,96	0,29	0,28	0,88
11.	My coach usually understands why he/she feels bad.	3,81	0,91	0,56	0,65	0,86
12.	My coach finds it easy to display fondness for a person he/she likes.	3,56	1,01	0,41	0,46	0,87
13.	My coach can easily name the most of his/her feelings.	3,57	0,93	0,67	0,76	0,86
14.	My coach is able to express how he/she feels.	3,75	0,89	0,67	0,75	0,86

Legend: Mean = proportion of correct answers, SD = Standard deviation, K1=value on the first standardized principle component,  $R_{it}$  = item-total correlation,  $\alpha$ -min = Cronbach' alpha if the item is omitted.



Table 3. Descriptive statistics, values on the first principle component and item-total correlations of items of modified ESCQ-45 Managing and regulating emotions subscale

	Question	Mean	SD	K1	Rit	a-min
1.	My coach is able to maintain a good mood even if something bad happens.	3,49	0,96	0,53	0,61	0,87
2.	My coach can maintain a good mood, even when the people around him/her are in a bad mood.	3,70	0,90	0,66	0,72	0,86
3.	Unpleasant experiences teach my coach how not to act in the future.	3,80	1,02	0,54	0,62	0,87
4.	When somebody praises my coach, he works with more enthusiasm.	3,95	0,89	0,48	0,54	0,87
5.	When my coach doesn't like a person, he/she find ways to let him/her know.	3,30	1,01	0,27	0,32	0,88
6.	When my coach is in a good mood, it is difficult to bring his/her mood down.	3,76	1,00	0,47	0,55	0,87
7.	When my coach is in a good mood, every problem seems soluble to him/her.	4,05	0,85	0,59	0,66	0,87
8.	When he/she is with a person who thinks highly of her/him, my coach is careful about how he/she behaves.	3,95	0,92	0,46	0,53	0,87
9.	My coach studies and learns best, when he is in a good mood and happy.	3,90	0,90	0,58	0,65	0,87
10.	If he/she really wants to, my coach will solve a problem that may seem insoluble.	3,81	0,98	0,51	0,58	0,87
11.	My coach doesn't have difficulty to persuade an athlete that there is no reason to worry.	3,96	0,99	0,60	0,67	0,87
12.	My coach tries to control unpleasant emotions and strengthen positive ones.	3,90	0,94	0,59	0,67	0,87
13.	There is nothing wrong with how my coach usually feels.	3,97	1,03	0,55	0,62	0,87
14.	My coach does his duties and assignments as soon as possible, rather than think about them.	3,91	0,90	0,47	0,54	0,87
15.	My coach tries to keep up a good mood.	4,10	0,94	0,66	0,73	0,86
16.	As far as I am concerned, it is normal to feel the way my coach is feeling now.	4,05	1,03	0,46	0,55	0,87

Legend: Mean = proportion of correct answers, SD = Standard deviation, K1=value on the first standardized principle component, R<sub>it</sub>=item-total correlation, a-min=Cronbach' alpha if the item is omitted.

Table 4. Metric properties of the total result in modified ESCQ-45 and three subscales

	Subscales of modified ESCQ-45			Total result (45 items)
	Perceiving and understanding emotions	Expressing and labeling emotions	Managing and regulating emotions	
Number of items	15	14	16	45
Number of valid cases	577	581	571	547
Mean	54,52	51,39	61,39	167,03
Standard deviation	10,23	8,34	9,20	25,40
Minimum value	15	15	28	58
Maximum value	75	70	80	225
First eigenvalue of correlation matrix and percentage of total variance	7,46 49,76%	5,90 42,18%	5,93 37,12%	16,35 36,34%
Average inter-item correlation	0,46	0,36	0,32	0,34
Cronbach's alpha coefficient of reliability	0,92	0,88	0,88	0,96
Standardized Cronbach's alpha coefficient	0,93	0,88	0,88	0,96

Table 5. Correlation matrix of subscales of The Emotional Skills and Competences Questionnaire

	Perceiving and understanding emotions	Expressing and labeling emotions	Managing and regulating emotions
Perceiving and understanding emotions	1,000	0,735	0,773
Expressing and labeling emotions	0,735	1,000	0,718
Managing and regulating emotions	0,773	0,718	1,000

## Conclusion

The analyses of metric properties show good metric characteristics of total result in three subscales as well as overall total result. The results show that ESCQ-45 is appropriate questionnaire not only as a self-report measure but also as instrument to assess others.

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## SUDDEN INTERRUPTION OF THE SPORTS CAREER OF TOP CROATIAN ATHLETES

Dajana Jašić

*University of Zadar, Croatia*

### Abstract

The purpose of this paper is to determine the causes of sudden interruption of sports careers of top athletes, the ways, methods or tools used to achieve in the most effective way the transition from active competition period to the period of forced sports retirement, as well as possible common characteristics. The sample of male and female examinees consists of ten top Croatian athletes, representatives of various sports, and the method of semi-structured interviews is applied. The emotional experience of the examinees at the time of finding out that their career would terminate is - similar or the same, and the methods and tools they used to facilitate the transition from one lifestyle to another - different. The reasons for sudden sports retirement are a combination of various factors, from injuries to various diseases, and nine out of ten interviewed athletes during active sports period did not think about the possibility of a sudden career interruption. Those athletes who invested in their education in parallel with their sports careers overcame the transition more easily. Surrounding factors such as the support of family, friends and coaches has also proven to be one of the more significant common elements of help, but much of the successful transition is attributed to their own psychophysical abilities and individual efforts. Playing sports is a valuable benefit for all the examinees in solving the problem of transition.

*Key words: sports career, transition*

### Introduction

The aim of this paper is to determine the causes of sudden interruption of sports careers of top athletes, the ways, methods or tools used to achieve in the most effective way the transition from active competition period to the period of forced sports retirement, as well as possible common characteristics. A top sports career is conditioned by a number of other factors that affect the lifetime expectancy of an athlete, first of all sports injuries, various psychophysical illnesses, etc., which the athletes do not generally think about during an active career. Therefore, for such athletes the end of a top sports career can be a strong emotional experience, and sports identity is a factor that can significantly affect the course of transition, so more difficulties arise the stronger it is. This prolongs the adjustment period (Alfermann et al., 2004, Stambulova et al., 2009). Ending a sports career can be a difficult and destructive process. Early and long-term identification with the role of the athlete, when leaving the sport, can lead to the feeling of being lost and be a significant stressor (Baillie & Danish, 1992). During this process, the athletes must deal with new demands and must find a new balance between demands and resources (Wylleman et al., 1999, 2004). The exit from top sports requires from the athletes to face adjustment on a social, physical and personal level. However, only a small percentage (13% - 19%) face serious difficulties after career termination and require significant emotional adjustment. The overall quality of adaptation depends on the cause of retirement, developmental factors related to the adjustment process, as well as on the strategy of coping with the ending of a sports career (Wylleman et al., 2004). The transition in top sport often coincides with the transition to college. In order to overcome many challenges brought by these transitions, it is essential to approach them as a process, not an occurrence, and to prepare for it for at least a year (MacNamara & Collins, 2010). How the retirement of an athlete will proceed depends on the voluntary nature of cessation, subjective assessment of sports achievements, intensity of sports identity, educational status, the occurrence of negative non-sports transitions (Cecić Erpič et al., 2004), and experiences of the athletes in top sports are crucial, (Tshube, Feltz, 2015). Social support and interpersonal relationships are extremely important (Cecić Erpič & Wylleman, 2005). If at the time of the end of the sports career the athletes have support, then there is no significant connection between the reasons for retirement and the problems that may arise (Hemmatinezhad et al., 2013). Forced retirement (injury or non-selection), a strong, purely sports identity, the lack of planning and using the pre-retirement support services have the greatest impact on a difficult transition (Smith & McManus, 2008). An injury seems to be the most unfortunate forced reason for an early sports retirement (Wylleman et al., 1999., 2004). In this regard, the results of this research can contribute to a better understanding of the consequences and situations in which athletes find themselves when forced to end their careers, especially in the most productive period of playing sports. Having in mind the importance of this issue for ten top Croatian athletes, the reasons for sudden career breakdowns, self-help methods

used in that transition were determined and an attempt was made to determine the possible value and positive role of sport in the context of the transition, from the position of an active competitor to the sports retiree.

## Methods

The sample of the examinees consists of ten top Croatian athletes, representatives of various sports: football (1), athletics (1), alpine skiing (2), basketball (1), table tennis (1), tennis (1), gymnastics (1), water polo (1) and boxing (1). The method of semi-structured interviews according to a predetermined protocol is used. Data are processed by qualitative method, using compression and structuring procedures. The qualitative analysis is part of a qualitative research approach based on experiential material, oral descriptions, conversation records, CVs, etc. The qualitative analysis is a procedure in which the outcome depends primarily on the researcher's ability to shape concepts and theories (Mesec, 1998). The chosen interview technique is a personal face-to-face interview conducted once with each examinee. An interpretive approach to qualitative analysis is applied in this paper. The instrument for the semi-structured interview consists of sixteen questions, of which the first nine refer to the first thematic unit - common characteristics of the examinees, and the remaining seven to the second thematic unit - the distinctive characteristics of the examinees. The duration of the interview was not limited in time, so the examinees had as much time to answer as they needed. A pre-prepared protocol was followed during the interview, but the questions were freely formulated and adjusted to the answers of the examinees. The interviews were recorded on a mobile phone, and notes on signs of nonverbal communication were recorded during the interview. The survey was conducted in 2018 and 2019 in the Republic of Croatia. The criteria for including people in the research were the status of a top athlete and the premature and unplanned termination of a sports career due to an injury or other health problems. Participants were asked to participate in the research for the purpose of writing a scientific paper, and they volunteered for the interview.

The questions related to the first thematic unit (common characteristics) were as follows:

1. Did the sudden end of your career find you unprepared?
2. Are you above average competitive?
3. Was top performance your only priority?
4. Did you have lack of free time due to sports commitments?
5. Has the lack of free time impeded your commitment to additional activities such as socializing and going out?
6. Who helped you the most in the transition process?
7. Do you still play the sport in which you competed?
8. How much did playing sports help you in the transition process?
9. How did you feel in the moment you found out you could no longer play competitive sports?

The questions related to the second thematic unit (distinctive characteristics) were as follows:

1. Were you able to balance sports commitments and additional education?
2. What do you think about dual careers?
3. Was the occurrence of an illness the reason for the termination of your career?
4. Was an injury the reason for the termination of your career?
5. Have you experienced a sudden career termination dramatically?
6. During your competitive career, have you ever considered ending it abruptly?
7. Besides family, who or what was your biggest support?

## Results

Table 1. Common characteristics of the athletes

n=10	1. All the examinees were unprepared for facing the new circumstances when the sudden termination of their career occurred.
n=10	2. All the examinees are extremely competitive.
n=10	3. Top performance was the only priority to all of the examinees.
n=10	4. Due to sports commitments all of the examinees had lack of free time.
n=10	5. The lack of free time impeded all of the athletes in their commitment to additional activities such as socializing and going out.
n=10	6. In the transition process their biggest support were family and close friends.
n=10	7. All the examinees still play recreational sport, but not the one in which they competed.
n=10	8. To all of them playing sports was an important benefit in the transition process.
n=10	9. All of them experienced very strong emotions in the moment they found out they could no longer play competitive sports.

Table 2. Distinctive characteristics of the athletes

n=10	1. Eight out of ten examinees were not able to balance sports commitments and education.
n=10	2. Eight examinees did not know what a dual career was.
n=10	3. The occurrence of an illness was the reason for the termination of the career for five athletes.
n=10	4. A sports injury was the reason for the termination of the sports career for five athletes.
n=10	5. Eight athletes have experienced a sudden career termination dramatically.
n=10	6. During the active sports career, only one examinee considered the possibility of ending it abruptly.
n=10	7. Besides family and close friends, two examinees found support in faith during the transition process.

Qualitative analysis of the conducted interviews provided data that show the subjective opinion of the examinees in the period during and after the termination of their career in the competitive sports. During their athletic careers none of the athletes interviewed thought about the possibility of a sudden career termination, either permanent or temporary, while one athlete thought about that possibility about two years before the end of her career. Hard training took up most of the time for most of them, which affected their free time and possible commitment to additional activities, such as socializing and going out. Eight examinees experienced a sudden and unplanned career termination dramatically and painfully. This was the point at which they differed in common characteristics, as they showed a difference in approach to addressing the transition process, i.e. the passage from active sports life to an abrupt and early sports retirement. Individual approaches in finding the optimal path is a feature of this research, so we can see that two examinees cope with the career termination, not only with the help of close persons and family, but also with a strong commitment to faith. All the participants in the research, with the help of close persons and family successfully overcame the transition, eight of them are linked to jobs closely related to sports, while two of them are engaged in occupations not related to sports. It is interesting that even after the end of their careers, all examinees continue to play sports on a recreational level, but most often in sports in which they did not compete. The common characteristic of a highly developed anthropological status proved to be crucial, especially in the sensitive period of the career interruption and transition to a new lifestyle. Namely, it has been established that exactly playing sports has become a valuable benefit in restoring their life balance. The emotional experience of the examinees at the time of learning about the termination of their career was - similar or the same, and the methods and tools they used to facilitate the transition from one lifestyle to another were - different. The reasons for sudden sports retirement were a combination of various factors, from injuries to the occurrence of various diseases, and nine out of ten interviewed athletes did not think about the possibility of a sudden career termination during their active sports careers. Those athletes who invested in their education in parallel with their sports careers overcame the transition more easily (two examinees). All the examinees in this study showed exceptional mental and physical strength, in the period when they needed it the most, so it can be concluded that precisely this fact is the most important common feature of this study.

## Discussion and conclusion

The research showed that playing sports had become a valuable benefit for all the examinees in restoring their life balance. All the examinees in this study showed exceptional mental and physical strength, in the period when they needed it the most, so it can be concluded that precisely this fact is the most important common feature of this study. Being the best and staying in that position for as long as possible is the common motto for all the interviewed athletes. The top result was the exclusive goal for all of them and in their sports they achieved, by world standards, above-average results. Matching obligations, such as training and education, proved to be a major challenge for most examinees. It is clear how



much the sport in its original sense really justifies all the values that characterize it, especially in situations of inevitable transition, when it is necessary to activate all the internal capacities that an athlete has.

After a sudden career termination, the athletes should focus on finding new focuses of interest, surround themselves with friends, family, because social support has a significant impact on the athletes' adjustment, and new programs should provide athletes with clinical guidance or counselling, preventive educational modules (which optimize the athletes' skills and resources to cope with the transition), and skills and means to cope with the transition specific to sports careers, as well as those transitions that occur for athletes in non-sporting spheres of life, but which affect sports career development, (Wylleman et al., 2004). The fact is that modern professional sport represents a model of industrial, highly productive commercialization, oriented towards the creation of sports results and spectacles, in the service of profit maximization, (Šurbatović, 2014). To come and survive at the top level of competitive sport in such circumstances requires, not only from the athletes but also from everyone around them, an investment at different levels (physical, social, financial...). Thus, the termination of such a top sports career can be a powerful emotional experience, not only for athletes but also for their immediate surroundings, parents, partners, children, friends (Wylleman et al., 2004). This topic is obviously the focus of interest of many scholars, so some have portrayed the transition of athletes through aspects of historical and conceptual issues, theoretical perspectives of the career termination, the causes of termination, the evidence of the trauma at the career termination, factors contributing to crisis at the career termination, prevention and treatment of grief due to the career termination and the possibility of further theoretical and empirical research on sports career termination, (Ogilvie, Taylor, 2011). Precisely the end of the sports career is in its etymology a moment that is similar and inherent for all the athletes on all the continents, so in that sense the Croatians do not differ from other elite names in the world. The aid system in Croatia, and even in Europe, is obviously different from, let's say, the American system. In other words, we lag far behind in caring for athletes who are forced to end their careers, especially those in the ascending, the most potent phase of creating the top results. The support of family, friends and coaches has also proven to be one of the more significant common factors in helping these athletes, but much of the successful transition is due to their own psychophysical ability and individual effort.

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## PERSONALITY TRAITS OF VOLLEYBALL AND BASKETBALL PLAYERS IN REGARDS TO POSITION AND PROFESSIONALISM

Tea Magdić<sup>1</sup>, Gordana Ivković<sup>1</sup>, Melanija Miodrag<sup>2</sup>

<sup>1</sup>University of Zadar, Croatia

<sup>2</sup>Hotel, tourism and catering school Zadar, Croatia

### Abstract

Basketball and volleyball are complex games that demand a level of cognitive abilities and specific personality traits. The most used model of personality is the Big Five model, which differentiates openness to experience, conscientiousness, extroversion, agreeableness and neuroticism. Many researchers differentiate a sport personality from a non-sport personality, which is characterised by specific levels of the five traits. The aim of the research was to examine the five personality traits and its potential differences on female volleyball and basketball players in regards to position and professionalism. The research was conducted on 112 female athletes, from which 46 were basketball players and 68 were volleyball players, all of them participants of University Sport national tournament. For the measurement, a General information questionnaire and IPIP-50 (Croatian version) were used. The results of t-tests showed statistically significant differences in all of five personality traits in regards to sport. The results of ANOVA showed statistically significant differences in personality traits in regards to position in both volleyball and basketball players. This and similar research could benefit in sportsmen selection and practice with athletes, to both coaches and sport psychologists. However, there are some limitations. A part of the sample were non-professional players, whose personality traits could be different from the professional athletes' personality.

**Key words:** *Big Five model, basketball players, volleyball players, position*

### Introduction

One of key constructs in psychology is personality. Although there is no consensus on what exactly personality is, Petz (2005) defines it as a unit, integration of ones characteristics in a relatively stable and unique organisation that determines his activity in an ever-changing environment and changes under the influence of that activity. In sports psychology, personality and its relationship to success is one of the most exciting areas (Cox, 2005). Personality of athletes is different from that of non-athletes. Some research suggests that athletes are less dependent, more objective and less anxious compared to non-athletes (Schurr, Ashley and Joy, 1997; Cox, 2005), often more intelligent than the average (Hardman, 1973; Cox, 2005) and more confident and socially open than non-athletes (Cooper, 1969; Cox, 2005). Athletes show higher results of extraversion, independence and confidence, which is why they gravitate towards sports activities. However, the relationship is reciprocal (Cox, 2005). Schurr, Ashley and Joy (1977; Cox, 2005) differentiate personality types between players of team and individual sports and between contact and parallel sports players. In team sports, there is a higher level of anxiety, dependence and extraversion, and in contact sports (like basketball or football) athletes are less dependent and have a lower strength of ego than those in parallel sports (like basketball). It appears that athletes in similar sports characteristics share some of the personality characteristics but are still different to some extent. The most often personality model used in sports psychology is the Big Five model, which poses that there are five main personality traits on a continuum. Those are openness to experience, extraversion, agreeableness, conscientiousness and emotional stability. One of the latest research in this area is the one conducted by Steca, Baretta, Greco, D'Addario and Monzani (2018) on 881 male athletes and non-athletes. The results showed significant differences between athletes and non-athletes (the more successful athletes had higher scores on all five dimensions, with the exception of openness, while the less successful athletes had higher scores only in extraversion and agreeableness).

Basketball and volleyball are complex games that demand a high level of cognitive skill. Both games are dynamic and interactive team sports (Lames and McGarry, 2007). Basketball is played in a relatively small space and in a short time; the players must make a decision, react quickly and try to hit a small target (Horga and Sabioncello, 1994). There are three different core positions (Dizdar and Jaklinović-Fressl, 1999). Those are guards, forwards and centres and they are each specific in terms of roles and game tasks. Guards have a role of bringing actions to reality, controlling the intensity and the rhythm of the game (Trninić, 2015). Forwards are the players whose role is to take over the responsibility and take

the shot, while having an understanding with inner players. Centres are the inner players and have the most responsibility in defence, especially when stopping opposite players from scoring and catching rebounds (Trninić, 2015).

Volleyball is a sport with no direct physical contact between opposite teams. Correct passes, strong spikes and precise setting are some of the typical volleyball plays (Kwong, 2012). There are also three wide key positions: libero, setter and hitter (outside hitter, middle blocker and opposite). Libero's job is to receive the ball and be the main defensive player. Setter's job is to set the ball and come up with actions that will bring the point to his team. Outside hitters, middle blockers and opposite are the team's offence and should spike the ball to the opponent's field.

Cox (1987; Cox, 2005) posed an interesting research question: is it possible to differentiate personality characteristics between players in terms of their positions? Research suggests that there are no larger differences, but that in comparison with blockers and hitters, setters have a wider internal focus and are able to think of more things at once. A volleyball setter is analogue to a basketball playmaker – their positions demand that they know what type of game to play in that instance and that they are familiar with strengths and weaknesses not only of their teammates, but also their opponents. Considering the so far conducted research, the goal of this research was to investigate if there is a difference between volleyball and basketball personality values in the Big Five model and to investigate if there is a difference between personality values depending on the three positions. There are three main hypotheses. Firstly, it is assumed that there will be no statistically significant difference on the five personality factors between volleyball and basketball players. Secondly, it is assumed that there will be a statistically significant difference on the five personality factors between professional and non-professional players. Thirdly, it is assumed that there will be a statistically significant difference on the five personality factors considering the three main positions.

## Method

*Participants.* A number of 112 female athletes took part in this research. Of the total number, 46 were basketball and 66 volleyball players. All of the participants are students of Croatian universities and were participants of UNISPORT national competition. From all of the 112 athletes, 68 of them were professional first league players (both volleyball and basketball), 44 of them were non-professional athletes. 65 of the players identified as position 1 (hitter, forwards), 18 identified as position 2 (centre, libero), 29 identified as position 3 (guards, setter).

*Instrument.* IPIP-50 (International Personality Item Pool, 50 items, Croatian version, Mlačić) was used to collect information on five personality factors. The questionnaire consists of 50 items on which the participants had to answer on a scale of 1 to 5, 1 meaning "it completely does not apply to me" and 5 meaning "it completely applies to me".

*Procedure.* IPIP-50 was given to the participants during UNISPORT qualification and final tournament in a span of three months. The researchers first asked the responsible person (ex. coach) and then the papers were distributed among the players. Afterwards, the participants could ask questions if they had any. The questionnaire was filled under the supervision of the researchers.

## Results

To determine the differences in five personality factors between basketball and volleyball players, a t-test was done. All of the differences between the five personality factors between volleyball and basketball players are statistically significant (Table 1), with the volleyball players scoring higher on all factors.

Table 1. Results of t-test for five factors between basketball and volleyball players

Variable	T-tests; Grouping: Sport Group 1: 1 Group 2: 2							
	Mean	Mean	t-value	df	p	Valid N	Valid N	Std.Dev
Extraversion	3,09	3,61	-5,64	108,00	0,00*	46,00	64,00	0,31
Agreeableness	3,35	4,01	-7,52	108,00	0,00*	46,00	64,00	0,41
Conscientiousness	3,27	3,79	-5,67	108,00	0,00*	46,00	64,00	0,37
Emotional stability	2,97	3,22	-3,10	108,00	0,00*	46,00	64,00	0,50
Intellect	3,28	3,62	-4,09	108,00	0,00*	46,00	64,00	0,44

\*Statistically significant differences at the level  $p < 0.05$

To determine the differences between five personality factors between professional and non-professional players a second t-test was done. Results (table 2) show statistically significant differences on extraversion, agreeableness, conscientiousness and intellect and no differences on emotional stability. Athletes competing professionally have lower average results on all five personality factors.

Table 2. Results of t-test between the five personality factors between professional and non-professional players

Variable	T-tests; Grouping: category Group 1: 1 Group 2: 2							
	Mean	Mean	t-value	df	p	Valid N	Valid N	Std.Dev.
Extraversion	3,30	3,54	-2,32	108,00	0,02*	67,00	43,00	0,49
Agreeableness	3,55	4,01	-4,52	108,00	0,00*	67,00	43,00	0,52
Conscientiousness	3,38	3,87	-5,21	108,00	0,00*	67,00	43,00	0,44
Emotional stability	3,07	3,18	-1,23	108,00	0,22	67,00	43,00	0,48
Intellect	3,39	3,62	-2,59	108,00	0,01*	67,00	43,00	0,50

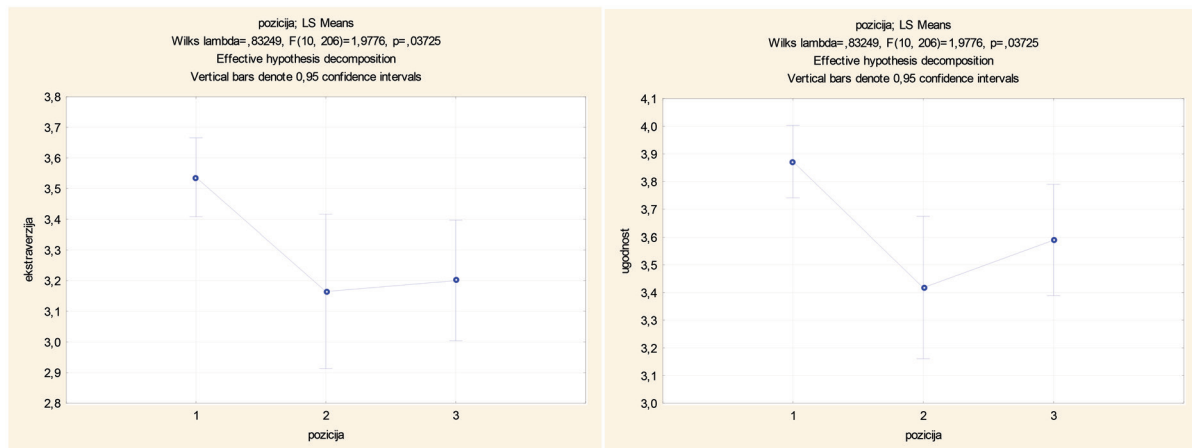
\*p&lt;0.05

To determine differences between five personality factors in relation to the positions ANOVA was used. The results showed significant differences on extraversion and agreeableness considering the position. Further analysis resulted in statistically significant results on extraversion and agreeableness for the position forward/hitter.

Table 3. ANOVA for the five personality factors in relation to the positions in the game

Variable	Analysis of Variance (ipip positions of basketball/volleyball players) Marked effects are significant at $p < .05000$							
	SS	df	MS	SS	df	MS	F	p
Extraversion	3,28	2,00	1,64	29,39	107,00	0,27	5,96	0,00*
Agreeableness	3,53	2,00	1,76	30,48	107,00	0,28	6,19	0,00*
Conscientiousness	0,94	2,00	0,47	29,95	107,00	0,28	1,68	0,19
Emotional stability	0,62	2,00	0,31	20,44	107,00	0,19	1,63	0,20
Intellect	0,36	2,00	0,18	23,32	107,00	0,22	0,82	0,44

\*p&lt;0.05



Legend: position 1 - forward, hitter; position 2 – centre, libero; position 3 – guard, setter

Picture 1. Extraversion and agreeableness considering positions

Picture 1 shows the differences in the mean values for two statistically significant results in ANOVA, considering positions. It is visible that position 1 has higher average results on extraversion and agreeableness than position 2 and 3.

Table 4. Post-hoc analysis

pozicija	All Groups Scheffe Test; Variable: extraversion (ipip positions of basketball/volleyball players) Marked differences are significant at $p < ,05000$		
	Forward/hitter	Centre/libero	Guard/setter
Forward/hitter		0,038*	0,02*
Centre/libero	0,037*		0,98
Guard/setter	0,02*	0,98	

\* $p < 0.05$ 

Post-hoc analysis (Scheffe Test) showed that the position forward/hitter has a statistically significant difference from the other two positions on the scales of extraversion and agreeableness. There is no statistically significant difference between positions centre/libero and guard/setter.

## Discussion

The first hypotheses stated that there would be no differences between volleyball and basketball players on the five factors. However, our results suggest that volleyball and basketball players are significantly different on those five factors. Schurr, Ashley and Joy (1977; Cox, 2005) got similar results, stating clear differences between direct contact and parallel sports. Further, a big part of the volleyball players sample was made of non-professional players or non-players, but students who came to participate nonetheless. For this reason, it is possible that these differences are a methodological artefact and are not caused by actual differences in the population.

The second hypotheses stated that there would be statistically significant differences on the five factors between professional and non-professional players is confirmed. Previous research showed that for a successful athlete lower results on emotional stability, higher results on extraversion and higher results on conscientiousness are important (Hagberg et al., 1979, Ingledeu, Markland & Sheppard, 2004, Gallucci, 2008; Trninić, 2015). Allen, Greenless and Johnes (2013) also showed that athletes show higher extraversion, emotional stability and openness, and comparing professional and recreational athletes, professionals have higher results on emotional stability. It is also important to bear in mind an information regarding the sample. This sample is specific, for its athletes are all students who have to coordinate both careers and schedules in order to be successful.

The third hypotheses was that the values of the five factors would be different between the three positions. The results showed statistically significant differences (higher results) in extraversion and agreeableness for position 1 in comparison to the other two positions. Some research conducted on male athletes shows different results. Sindik (2011) got no statistically significant differences on four of the five factors in male basketball players, but on intellect. Results of Trninić's (2015) research suggests that outer players (guards and forwards) have higher levels of conscientiousness compared to inner players (centre). Hitters and forwards have key roles in making points and are more dependent on the cooperation with teammates than other players in the game. Both players need to be fearless under the pressure and take responsibility in the key moments to finish the point. Some research results indicate that the athletes in the attacking positions may be more extroverted than the athletes on the defensive positions (Schurr et al., 1984), and that they are less emotionally stable (Kirkcaldy, 1982).

Finally, there are some limitations and implications for future research. There is a big number of this sample that is made of non-athletes and non-professional players, which could have had an impact on the results. Furthermore, all of the professional athletes are also full-time or part-time students, which affects their relationship with sports. Future research should focus on getting representative, large samples of both male and female volleyball and basketball players of first, second and third league and then compare these groups to get better results.

## Conclusion

The aim of the research was to examine the five personality traits and its potential differences on female volleyball and basketball players in regards to position and professionalism. The results of t-test showed statistically significant differences in all of five personality traits in regards to sport, with volleyball players scoring higher, and also statistically significant differences between professionals and non-professionals, with the non-professionals scoring higher on extraversion, agreeableness, intellect and conscientiousness and no statistically significant differences on emotional stability. The results of ANOVA showed statistically significant differences in personality traits in regards to position in both volleyball and basketball players, with forwards/hitters scoring higher on extraversion and agreeableness than other two positions. More research with better sampling should be done in the future.



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## ANALYSIS OF THE LANGUAGE OF SPORT-RELATED RESEARCH

**Darija Omrčen, Matea Perkušić**

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

The aim of this research was to analyse the language of sport-related research. The sample was comprised of 319 cases and included the titles of articles published in academic journals, titles of articles published in conference proceedings or titles of presentations (abstracts) delivered at conferences, and titles of books or parts/sections in books. The titles were analysed in terms of the publication year, the topic they covered and the type of source from which they were collected. The time span covered ranged from 1952 to 2020. In most publication years articles published in academic journals were the predominant source in which the language of sport-related research was delivered. Discourse and terminology were the primary foci of research into the language of sport. Further, discourse was the primary focus of research published in two source categories – academic journal articles and books or parts/sections of books, whereas terminology was the most frequent subject matter of research presented at conferences. The results have shown an overall increase in the incidence of research output over the span of the publication years covered.

**Key words:** *discourse, language, research, sport, terminology*

### Introduction

Whereas research into multiple subject matters connected with sport as a worldwide phenomenon is extensive (e.g., sports medicine, sports psychology, physiology of sport and exercise, biomechanics, game analyses, sociology of sport, history of sport, etc.), research into the sport-related language (the term *sport* being used here in a broad meaning implying sporting activities in the widest sense) is not as comprehensive as would be expected when its worldwide character is taken into account. Still, a notable body of research into the language of sport-related topics does exist and allows for a detailed enough insight into its multifaceted scope – from analyses regarding its theoretical background to those addressing its practical implications. The survey of past research has shown investigations into the aspect of the language of sport to be two-fold.

On the one hand there is research in which *language* does not imply the construct comprised of words and rules of their combinations, but a non-verbal communication means conveying information (cf. Blake, 1996). To clarify – being a global phenomenon, sports possess an outstanding capacity for the transfer of messages such as solidarity, tolerance, respect for all, fair play, but also effort and excellence in performance. The diachronic view of sport development has shown the emergence of diverse concepts connected therewith, one of them frequently hypothesising athletes as heroes and role models (cf. Segrave, 1993; Read, 2016). On the other hand, the language of sport – defined by Spurr (2001, p. 82) as the linguistic representation of sporting activity – has also been dealt with, and this has been done from various points of view, e.g., from the perspective of textual analysis (Beard, 1998), in terms of the distinctiveness of the language of sport (Lipoński, 2009), with respect to related sciences (Fazio, 2012), etc. Regarding language analysis, throughout several past decades some sports have drawn more attention than others. As evidenced, this was particularly the case with football (soccer) (Lavric, Pisek, Skinner, & Stadler, 2008) whose global popularity continues to be unparalleled. Ultimately, language and sport were also investigated in combination with other domains, e.g., communication and media (Born & Gloning, 2015), gender (Fuller, 2006), culture (Halone & Meân, 2010), etc. Language of sport has also been the source of terminology compiled in numerous dictionaries.

### Methods

The aim of this research was to analyse the language of sport-related research. The sample was comprised of 319 cases collected from three sources – the titles of articles published in academic journals, titles of books or parts/sections in books, and titles of articles published in the conference proceedings or titles of presentations (abstracts) delivered at conferences. The cases were extracted from Google, Google Scholar and Web of Science as well as from publications accessible in the Centre for Library Information and Publication Activities of the Faculty of Kinesiology (University of Zagreb). The time span covered ranged from 1952 to 2020. The titles were analysed in terms of the publication year, the topics they covered and the type of source from which they were collected. The survey of languages in which the published

research results were conveyed was provided to show the span of coverage thus also pointing to one of the limitations of the study. Due to the wide array of possible topics, for a more practical review they were eventually condensed into five groups: *discourse*, *terminology*, *teaching*, *communication* and *general*. The categories in the variable *source* were the three previously mentioned ones: academic journals, books or parts/sections in books and conference proceedings.

## Results

As for the sample in this research, English was by far the most frequent language of delivery followed by Spanish, German and Croatian (Table 1). The category *other* contained titles of publications in Portuguese, Polish, Russian, etc. As evidenced in Table 2, discourse and terminology were the primary foci of research into the language of sport – 45.4% and 25.7%, respectively. The cases included in the category *general* addressed the language of sport from various points of view, for example, from the point of view of its distinctive features, relatedness to culture, connection of physical activity and language, etc. Most of 319 cases were titles of articles published in academic journals (64.6%), followed – as for their incidence – by titles either of books or parts/sections in books, and the titles of articles published in conference proceedings or titles of presentations delivered at conferences (Table 3).

Table 1. Frequency distributions of languages of delivery

LANGUAGE	COUNT	PERCENT
English	196	61.4
Spanish	42	13.2
German	31	9.7
Croatian	20	6.3
French	11	3.5
Italian	9	2.8
Other	10	3.1

Table 2. Frequency distributions of topics

OPIC	COUNT	PERCENT
Discourse	145	45.4
Terminology	82	25.7
General	45	14.1
Teaching	26	8.2
Communication	21	6.6

Table 3. Frequency distributions of the sources of titles

SOURCES	COUNT	PERCENT
Articles in academic journals	206	64.6
Books or parts in books	60	18.8
Presentations at conferences/Articles published in conference proceedings	53	16.6

Figure 1 shows two compelling results. The first one is that publication incidence in academic journals increased continuously throughout the analysed period and the second that in most publication years the journals were the predominant sources in which the language of sport-related research was published. The interaction plot of variables *topic* and *source* (Figure 2) shows discourse to be the primary focus of research published in two source categories – academic journal articles and books or parts/sections in books, whereas terminology was the most frequent subject matter of research presented at conferences.

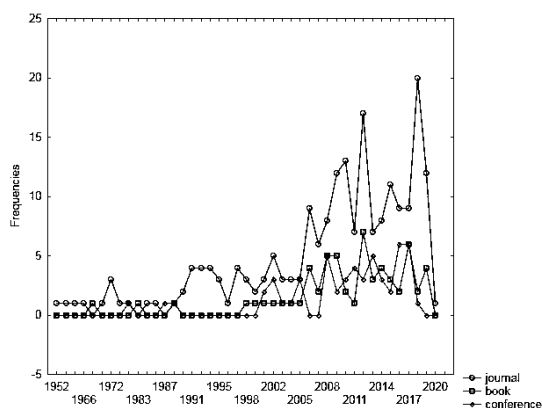


Figure 1. Interaction plot of publication year and source

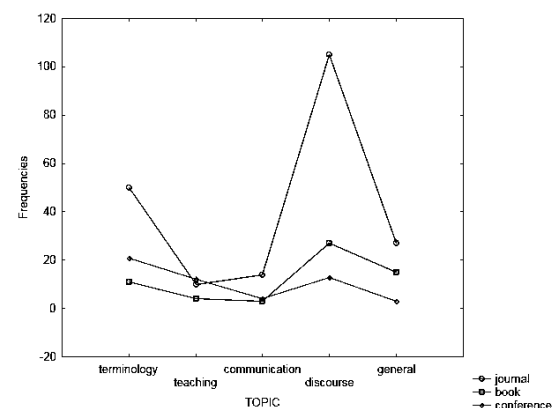


Figure 2. Interaction plot of topic and source

The results displayed in Figure 3 show an overall increase in the incidence of research results delivery over the span of publication years covered. Additionally, the incidence of discourse-related research rose significantly and continuously from the 1980s to date, whereas the occurrence of terminology-related research increased significantly from 2000 onwards. Analyses of the language of sport in more general terms started at the end of the 1970s and seem to have achieved its peak as regards their frequency around 2010 and onwards. The period of the two decades in the 21<sup>st</sup> century seems to be the time span in which most analyses of the communication-specific research realm of the language of sport appeared.

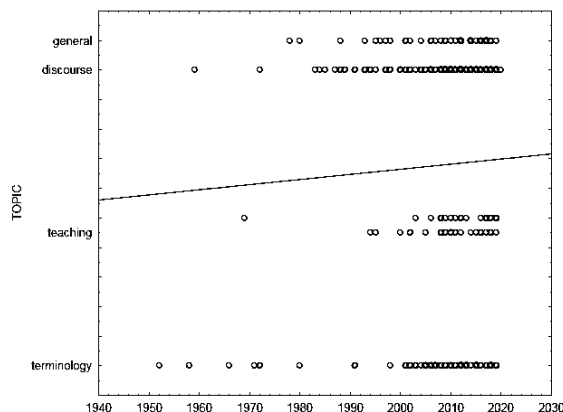


Figure 3. Scatterplot – publication year and topic

## Discussion

The increase in the incidence of the language of sport-related research in the last 40 years is not accidental. There are at least three major reasons which may be said to have contributed to this exceptional growth. The first one is the skyrocketing development of technologies that have allowed communication to extent that was not possible previously. The Internet era – particularly from the 1980s and 1990s onward – has changed our world substantially, ultimately changing the way we share information at a global level. As for sport, these developments have resulted in its worldwide popularity in general, thus significantly contributing to its universal nature. The second reason lies in the development of a domain of applied linguistics which has long been neglected – namely, terminology and, more broadly, language for specific purposes. Although in existence since 1931 – the year in which Eugen Wüster published his pioneering work *International standardisation of technical terminology* (he was not the one to coin the term *terminology*, however, he was the first to use it systematically – Kingscott, 1998, p. 14) – it took years for this newly emerging domain to have a considerable impetus in the 1950s, 1960s and the beginning of 1970s. While Wüster (1973, p. 571) regarded terminology as a system of concepts and their designations in a particular subject field and posited this system to encompass all terms (Germ. *Fachausdrücke*) commonly used in this specialised domain, language for specific purposes (LSP) refers both to teaching and research of language taking into account the communicative needs of speakers in a particular environment, be it professional or academic, or relating to one's workplace (Basturkmen & Elder, 2004, p. 672). Basturkmen and Elder regard this concept in the context of speakers of a second language – however, the realm of LSP also extends to foreign language teaching and training. The 1980s and the beginning of 1990s saw the publication of several major works that laid the foundation stone for the theory of English for Specific Purposes (ESP), and ultimately for the wider realm of LSP (e.g., Hutchinson & Waters, 1987; Robinson, 1980, 1991; Swales, 1985, 1992). These developments gave rise to language-related interest in many subject fields – sport being one of them. It was in 1949 that Parke Cummings published *The Dictionary of Sport* – an extensive work of more than 570 pages containing terms from the most popular sports in the United States. It was not the first and certainly not the oldest dictionary of sport-related terms in the world, but it was one of the most comprehensive ones. Interestingly, the oldest publication whose title was included in the sample in this research – *Los anglicismos en el lenguaje deportivo chileno* written by Lidia Contreras and published in the journal *Boletín de filología* – dates back to 1952 (only three years after the publication of the aforementioned dictionary). The text was in Spanish and in it the grammatical representation was followed by a list of 404 items – loan words (from English) in sport-related Spanish terminology. Interestingly, only three years later – in 1955 – after extensive work in the early 1950s on the then existing terminology and glossaries (Kingscott, 1998, p. 14), Wüster published the *Bibliography of monolingual scientific and technical glossaries. Volume 1. National standards* which contained about 10,000 entries. The third reason for the increase in the incidence of the language of sport-related research is the remarkable growth of academic publishing in general. Research has shown that the number of academic journals has grown significantly since the 1950s (Gu & Blackmore, 2016; Tenopir & King, 2009), particularly after the onset of the *publish-or-perish* frenzy. Finally, online publishing became possible not only for journals but for books as well. Concurrently, the number of conferences, i.e. symposia, congresses, fora, meetings, etc. as places of hands-on networking aimed at the exchange of scientific information also increased strikingly. As a result, academic research and the delivery of research perceptions

increased in all scientific disciplines, thus also in applied linguistics that started to pay more and more attention to various subjects matters in different subject fields, kinesiology with all its sub-domains not being an exception to this rule.

The subject matters addressed in the analysed body of research ranged from terminology-related ones, discourse-specific topics, to communication in sport-related domains and ultimately to teaching in relation to sport-specific vocabulary. While the category termed *general* covered the topics from the vast area of language of sport-related application, the topics to be found under the common denominator *discourse* ranged from the analyses of sports journalism, promotion in sports (e.g., commercials), figurativeness of language (e.g., the use of metaphors), nicknaming (teams, individual athletes), the language of sports fans, etc. to name only a few. Still, it seems that the obtained results point to the fact that certain areas need to be investigated even more. Hence, although the number of terminology- and teaching-related publications significantly increased in the 21<sup>st</sup> century, it might be conjectured that more publications of this type seem to be necessary. Namely, despite covering many different topics like loanwords, designation of key concepts, collocations, word-formation, dictionaries, translation equivalency, etymology, etc., due to the fast development of science and technology in all domains of human life, terminology develops rapidly, and consequently learners should be taught more and more specialized vocabulary to be able to respond to the continuously expanding demands of living and working in a modern society. In other words, more research into terminology- and teaching-related subject matters should be precipitated to be able to keep up with the continuously growing demands of modern life and constantly advancing work-related innovations. Therefore, research into these two domains – terminology and teaching, should deservedly be prioritized and considered imperative. Another perception addresses the frequency of research reported at various conferences, symposia, etc. In spite of the fact that nowadays academic journals are considered to be crucial in terms of knowledge dissemination, direct communication of experts at events of that kind is undoubtedly valuable and contributes to the exchange of ideas and perceptions on a large scale. Consequently, it seems that organization of such events should be encouraged.

## Conclusion

The body of research into the language of sport has significantly grown in the last several decades and has proved to be abundant and manifold. The analysis of the ways of disseminating the research results and the thus produced knowledge has shown journal articles to be the dominant vehicle of research output. Further, discourse matters and terminology-related concerns appeared to be the predominant foci of interest of researchers. Future developments in sport as a global subject field and a more extensive future research of its language in a variety of aspects are expected to yield possible new insights into this permanently growing subject field of interest. Consequently, future scrutiny is expected to contribute more to the comprehension of this subject matter as a whole.

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## ROLE AMBIGUITY IN ATHLETES: IMPACT OF COACH COMMUNICATION SKILLS

Özden Tepeköylü Öztürk<sup>1</sup>, Orhan Deymeci<sup>1</sup>, Mümine, Soytürk<sup>2</sup>

<sup>1</sup>*Pamukkale University, Faculty of Sport Sciences, Turkey*

<sup>2</sup>*Manisa Celal Bayar University, Faculty of Sport Sciences, Turkey*

**Introduction:** The fact that the messages sent and received in the sports environment are correlated, the perceptual outcome that appears at the end of the communication process corresponds with the first state of the message, and the accurate achievement of the duties and responsibilities. In this context, the communication skills of the coaches, who undertake the role of a guide and trainer in the athlete-coach relationship, are fundamental.

**Objective:** This study aims to examine the predictor effect between the role ambiguity of athletes and coach communication skills defined according to the perceptions of athletes. Besides, the relationship between role ambiguity and the age of the athlete, the age of athletics, the number of years he has participated in the competitions, the time he spent in the same team, and with the same trainer were also investigated.

**Method:** The research is a correlational and descriptive study examining the predictor effect between two variables. In the research applying quantitative techniques, 414 ( $X_{age}=20.64\pm 3.89$ ) athletes participate who are players in volleyball, basketball, handball, or football branches. "Role Ambiguity Inventory", "Coach Communication Skill Scale" and "Personal Information Form" were employed as data collection tools. The data were examined using correlation and regression techniques.

**Findings:** Coach communication skills recognized by athletes significantly predicted the role ambiguity of athletes. In this context, the shift in role ambiguity is explained by coach communication skills at 8%. When the course of the relationship is analysed, it is seen that role ambiguity decreases as coach communication skills improve. Still, there were different factors linked with role ambiguity. Role ambiguity reduced as the athlete's calendar age, athletic age, and competition experience developed. The time spent in the same team and the time of training with the same coach was not linked with role ambiguity.

**Conclusion:** The fact that the coach, who began the communication process in the athlete-coach relationship, has practical communication skills is one of the decisive factors for the accurate comprehension of the team duties. Still, role ambiguity is lower in older and/or experienced athletes.

**Key words:** *Athlete, coach, interpersonal communication, coach-athlete relationship*

## THE IMPACT OF ELITE SPORT ON THE FAMILY

Miriam Palomo-Nieto<sup>1,2</sup>, Luis Miguel Ruiz Pérez<sup>2</sup>, Donald N. Roberson Jr.<sup>2</sup>

<sup>1</sup>*The Faculty of Sciences for Physical Activity and Sport, The Technical University of Madrid, Spain*

<sup>2</sup>*Faculty of Physical Culture, Palacky University, Olomouc, Czech Republic*

### Abstract

The purpose of this study has been to determine the negative impact on mothers while providing support for their child to become a top athlete. The negative impact associated with this support from mothers is called 'emotional investment.' We applied a qualitative, inductive and interpretative methodology following the procedures and techniques of grounded theory. The research involved interviews with 17 mothers and their 20 top athletes sons and daughters. At the end of it, we formulated a theory which we call Mothers' Negative Emotional Investment in their Children's Sporting Excellence. Our theory relies on three main themes: 1. Pain, fear, and anxiety of the mother, 2. Negative impact on the family, 3. Sacrifice, renunciations, and effort on the part of the mother. These three themes are not only interrelated and hierarchically arranged, but also show a dynamic evolution along with the child's athletic and personal development.

*Key words: Family, sacrifice, anxieties, emotions, grounded theory*

### The impact of elite sport on the family

The enormous demands of competitive sport and the constant training sessions of young athletes require a great deal from the family and have a considerable impact on normal family life (Bloom, 1985; Coakley, 2006; Côté, 1999; Gould, Lauer, Rolo, Jannes and Pennisi, 2008; Holt and Dunn, 2004). Parents have different levels of commitment to their children's road to excellence which involve sacrifice, effort, fear, and apprehension (Wolfenden and Holt, 2005). While a lot of attention has been paid to the support given by families to young athletes in the literature, very little attention has been focused on the impact of that support on the family itself. As we will see, the burden on the family increases along with the age and level of the sporting activity of the child (Kay, 2000).

For a family, participation in sport of one of the children entails a series of economic, psychological, and emotional resources. These resources and the corresponding time consumed have important consequences on the cohesion and development of family life, both on and away from the sports field (Trussell, 2009). The highly demanding and multi-faceted support given by parents to their children involved in sport is frequently accompanied by negative consequences for the whole family (Thompson, 1999). The literature has shown various negative issues concerning the focus on top athletes, this includes sacrifice of time, impact of finances, and the role of emotions.

### Method

This study was conducted from a qualitative perspective. The procedures and techniques applied for the determination of the negative emotional investment, made by the mothers in the development of their children's sporting excellence, are those from an interpretative analysis. Within this interpretative analysis, our approach stresses theory construction, or Grounded Theory (Glaser and Strauss, 1967). In our study we interviewed 20 athletes and 17 mothers, all of them Spanish nationals resulting in 37 interviews. Table 1. shows the social and sporting details of the participants. As can be seen, the study concentrates on participants who are competing at top levels.

### Results

From the analysis of the data there emerged a theory which we called the Mothers' Negative Emotional Investment. The theory provides a description of the negative impact associated with the help provided by mothers throughout their children's top level sports career. This is displayed in Figure 1. The theory relies on three main categories: 1. Pain, Fear and Anxiety of the Mother; 2. Negative Impact on the Family; and 3. Sacrifice, and Effort of the Mother.

## Discussion

The male character of sport, traditional ideologies concerning sport, and the need and predisposition of mothers to care for their children, regardless of whether they are aiming at being top-level athletes, help us answer this question (Brooke, 2006; Thompson, 1999). However, the literature deals little with the sacrifices made by families for the sake of their children's sports activities. There is still a serious lack of evidence concerning the concepts, which have emerged in this research, such as job-related sacrifices or psychological wellbeing.

Research has also revealed other negative impacts on the family because of children's sports activity when they reach high level standards. Not only does that activity change the time schedule of family meals and sleep, it also affects when housework is done and the social life of each of the members of the family (Brooke, 2006; Haufler, 1978; Thompson, 1999), in line with the sacrifices which emerged from our participants. Likewise, Haufler (1978) revealed that the sports activity of the children may have a negative impact on the family and cause a breach between the father and the mother, or between the parents and the young athlete, but it may also have a positive impact and become a reason for family cohesion.

We saw from our interview that although top-level sport and the road to excellence may provoke conflicts in the family, it is usually the mothers who make the greatest contribution to the positive effect of the experience and work hard to reduce the negative effects. Mothers of top Spanish athletes explain how they did not let their children leave home at an early age to live in a hall of residence and that not to have done that would have had very negative effects on the whole family (Rodríguez, 2011).

As a result of this study, we can conclude several points. First mothers are primarily responsible for carrying for the athlete. Second, the mother bears the greatest amount of the sacrifice. Although, seemingly negative, this unique part of one's life, draws the mother and the child closer. It would be helpful to understand why are the renunciations made by fathers and mothers for the sake of their children so different?

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## RELATIONSHIP BETWEEN EXPOSURE TO SEXUAL VIOLENCE AND ATTITUDES ABOUT GENDER EQUALITY IN SPORT

Jelena Pavičić Vukičević<sup>1</sup>, Sara Antonini<sup>2</sup>, Sara Čavrag<sup>3</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Aurora Theta - psihološka praksa i neurofeedback, Croatia

<sup>3</sup>Hrvatski Telekom, Croatia

### Abstract

Athletes are exposed to various forms of violence, from verbal, physical, psychological, and socio-economic to sexual violence that can be verbal, non-verbal and physical. As part of the project “Youth, Violence and Sports: A Comparison of Croatia and Slovenia”, a survey was conducted on a sample of 135 Zagreb athletes in team and individual sports and this paper presents the results of a descriptive analysis of the gender equality in sport. A correlation analysis was conducted and the positive association of exposure to sexual violence with certain attitudes about inequality between men and women in sports was confirmed. Although it is not possible to talk about a cause-and-effect relationship, the research results suggest that the atmosphere of gender inequality, degradation of women’s achievements and competencies in sports is associated with a greater presence of sexual violence.

**Key words:** *sexual equality, sexual violence, sports*

### Introduction

The problem of violence is present in sports as well as in other areas of social life, and the problem of aggressiveness of players on the field during a competitive match or violence by fan groups is most often discussed. Such violence is exposed in the media, but there is also violence that does not happen in front of the cameras and in front of the fans, but in the locker rooms, in training, on trips, when the athlete is isolated and unable to defend himself. The perpetrators of such violence against athletes are most often their coaches and other members of the athlete’s entourage, i.e. medical and administrative staff, physiotherapists, counsellors, but they can also be athletes’ teammates and other strangers (Fasting, Brackenridge and Sundgot-Borgen, 2003; UNICEF, 2010). Athletes can be exposed to verbal, physical, psychological, socio-economic and sexual violence (Council of Europe, 2019), and given the least research on sexual violence, this study examines the exposure of Zagreb athletes to this type of violence and the relationship of this variable with the respondents’ attitudes about gender equality in sports (such as the perception of the inferior value of women’s sports and women’s achievements and competencies in sports, in the role of athletes and in the role of coaches).

World Health Organization defines „Sexual violence encompasses acts that range from verbal harassment to forced penetration, and an array of types of coercion, from social pressure and intimidation to physical force” (WHO, 2012) or “any form of unwanted verbal, nonverbal or physical conduct of a sexual nature occurs, with the purpose or effect of violating the dignity of a person, in particular when creating an intimidating, hostile, degrading, humiliating or offensive environment” (Council of Europe, 2019: 26). In the same publication we can find verbal examples of sexual harassment (making sexual comments about a person’s body, making sexual comments or innuendos, asking about sexual fantasies, preferences or history, asking personal questions about someone’s social or sex life, making sexual comments about a person’s clothing, anatomy, or looks, repeatedly trying to date a person who is not interested, telling lies or spreading rumours about a person’s sex life or sexual preferences; examples of non-verbal harassment (looking a person up and down (‘elevator eyes’), following or stalking someone, using sexually suggestive visuals, making sexual gestures with the hands or through body movements, using facial expressions such as winking, throwing kisses, or licking lips), instances of physical harassment (giving someone a massage around the neck or shoulders, touching another person’s clothing, hair, or body, hugging, kissing, patting, touching or rubbing oneself sexually against another person) (Council of Europe, 2019: 26).

Research on sexual violence against athletes has found that it affects respondents around the world. A survey on Norwegian female athletes found that 28% of female athletes were victims of sexual violence (Fasting, Brackenridge and Sundgot-Borgen, 2004) and that 34% of female athletes and 17% of male athletes from the United Kingdom were victims of sexual violence (Alexander, Stafford and Lewis, 2011).



Sport is an activity in which men traditionally predominate, and with a different perception of men and women as athletes, they are also assessed differently as coaches. Given that the role of coaches is dominated by men, women entering the coaching profession are approached with resistance and doubt in their coaching competencies, especially in sports dominated by male athletes (Messner and Sabo, 1990). Also, as athletes' success increases, the number of female coaches decreases, there are far fewer of them, and female coaches also have lower status, lower salaries, and less power than their male counterparts (Fasting and Pfister, 2000).

## Methods

The research project "Youth, Violence and Sports: A Comparison of Croatia and Slovenia" was conducted in 2016 in cooperation with the Sports Association of the City of Zagreb. The research was conducted on a sample of a total of 135 adult athletes (74 male athletes and 61 female athletes) of individual and team sports of the City of Zagreb. Data on the age of the participants were not examined because of the potential risk of compromising their anonymity. Due to potential cultural and social differences between Croatian and Slovenian athletes, and due to the lack of space to examine potential differences between the two countries, this paper focuses only on a sample of Croatian athletes. In addition, research interest is focused on examining the prevalence of sexual violence in the Croatian sample, as well as examining the attitudes of Croatian athletes about gender inequality in sport. A total of 74 athletes of both sexes in the sample are engaged in team sports, and 61 in individual sports. The largest share of athletes in this research belongs to the senior category (82.2%), followed by the junior category (11.1%), and the smallest share of non-competitors (3.7%) and veterans (1.5%).

The survey questionnaire as a research instrument examined the attitudes of participants about gender (in)equality in sports in a way that participants assessed their agreement with the statements used on a five-point Likert scale (1 - I do not agree at all, 5 - I completely agree). An example of a statement that describes gender (in)equality in sports is: "The achievements of male athletes cannot be compared to the achievements of female athletes."

In addition, participants assessed the extent to which they encountered different situations in training which depict different forms of sexual violence: gestures with sexual content, adults stripping in front of children, touching, forcing and coercing into sexual activities, visual sexual harassment, inappropriate squeezing, touching and kissing, and inappropriate jokes about sex and sexuality. The frequency of encountering these situations was assessed on a five-point scale (1 - never, 2 - rarely, 3 - occasionally, 4 - often, 5 - very often). In order to obtain a composite variable that indicates the total exposure to sexual violence, a new variable was created that represents the average of all particles that point to different forms of sexual violence. Before creating the composite result, an exploratory factor analysis was performed by the method of principal component analysis, the results of which indicate the existence of one factor in the background of items related to sexual violence. The total values on the new variable range from 1 for those who have never been exposed to any of the examined forms of sexual violence to 5 for those who have very often been exposed to all examined forms of sexual violence.

## Results and discussion

Before examining the relationship between athletes' total exposure to sexual violence and attitudes about gender equality in sport, it is necessary to determine, on the basis of descriptive indicators, the extent to which athletes are exposed to sexual violence in training and the extent to which they agree with different gender equality claims. The results are shown in Table 1.

Table 1. Descriptive indicators for variables of athletes' total exposure to sexual violence and attitudes towards gender equality in sport

	Minimum	Maximum	Arithmetic mean (M)	Standard deviation (SD)
gestures with sexual content	1	5	1,57	1,079
adults stripping in front of children	1	5	1,60	1,033
touching	1	5	1,36	0,833
forcing and coercing into sexual activities	1	5	1,22	0,677
visual sexual harassment	1	5	1,33	0,830
inappropriate squeezing, touching and kissing	1	5	1,21	0,648
inappropriate jokes about sex and sexuality	1	5	1,63	1,053

Athletes' total exposure to sexual violence	1	5	1,41	0,659
The achievements of male athletes cannot be compared to the achievements of female athletes	1	5	1,81	1,363
Men's sports are more valuable than women's sports	1	5	1,63	1,183
Females must be trained in the same way as males	1	5	3,38	1,440
Martial arts are not an appropriate sport for females	1	5	1,79	1,134
Criticism offends women more than men	1	5	2,84	1,257
Female coaches provide better support to female athletes in competitions than male coaches	1	5	2,87	1,266
I do not care if I am coached by a female coach or a male coach	1	5	3,96	1,309
Women are just as good as coaches as men	1	5	4,13	1,155

The results shown in Table 1 indicate that athletes are generally not exposed to sexual violence ( $M = 1.41$ ,  $SD = 0.659$ ), i.e. on average they state to a greater extent that they were not exposed to sexual violence or were less frequently exposed to it. The minimum value indicates that there are athletes who have not experienced any of the examined forms of sexual violence, while the maximum value indicates that there are athletes who have frequently experienced several different forms of sexual violence. Of all the forms of sexual violence examined, it is evident that inappropriate jokes about sex and sexuality ( $M = 1.63$ ,  $SD = 1.053$ ) and adults stripping in front of children ( $M = 1.60$ ,  $SD = 1.033$ ) were the most common forms of sexual violence, while athletes were the least exposed to inappropriate squeezing, touching and kissing ( $M = 1.21$ ,  $SD = 0.648$ ), and forcing and coercing into sexual activities ( $M = 1.22$ ,  $SD = 0.677$ ).

Athletes give a wide range of answers to statements about gender equality attitudes in sports, i.e. there are athletes who strongly disagree with the statements, but also those who completely agree with the statements. It can be seen that athletes mostly agree with the statements that refer to gender equality in sports, i.e. they mostly think that women in the role of coaches are just as good as men ( $M = 4.13$ ,  $SD = 1.155$ ), that they do not care if they are trained by women or men ( $M = 3.96$ ,  $SD = 1.309$ ) and that females must be trained in the same way as males ( $M = 3.38$ ,  $SD = 1.440$ ).

In contrast, athletes generally disagree with the claims that suggest inequality between men and women in sports, i.e. they generally do not think that men's sports are more valuable than women's sports ( $M = 1.63$ ,  $SD = 1.183$ ), that martial arts are not appropriate type of sport for women ( $M = 1.79$ ,  $SD = 1.134$ ) and that the achievements of male athletes cannot be compared with the achievements of female athletes ( $M = 1.81$ ,  $SD = 1.363$ ). In addition, it is evident that athletes do not have a clear position on whether criticism offends women more than men ( $M = 2.84$ ,  $SD = 1.271$ ) and whether female coaches better understand the problems faced by female athletes and provide them with better support in competitions than male coaches. ( $M = 2.87$ ,  $SD = 1.266$ ).

Therefore, we conclude that athletes are more inclined to believe that men and women require equal treatment in sports, i.e. that they should participate in the same sports, that their achievements should be equally valued and that they should be treated equally in training.

To determine whether there is a statistically significant correlation between athletes' total exposure to sexual violence and attitudes about gender equality in sport, a correlation analysis was performed and the results are expressed in the form of the Pearson correlation coefficient shown in Table 2. As can be seen, each item examining gender equality in sport is correlated with the overall score on the scale of exposure to sexual violence.

Table 2. Correlations between athletes' total exposure to sexual violence and attitudes towards gender equality in sport

	Athletes' total exposure to sexual violence
The achievements of male athletes cannot be compared to the achievements of female athletes	,340**
Men's sports are more valuable than women's sports	,220*
Females must be trained in the same way as males	-,162
Martial arts are not an appropriate sport for females	,302**
Criticism offends women more than men	-,085
Female coaches provide better support to female athletes in competitions than male coaches	-,070
I do not care if I am coached by a female coach or a male coach	-,126
Women are just as good as coaches as men	-,255**

Remark:  $p < .01$ \*\*;  $p < .05$ \*

Correlation analysis suggests that athletes' exposure to sexual violence is statistically significantly associated with four statements describing attitudes toward gender equality. Specifically, athletes who report greater exposure to sexual violence largely agree with the claims that the achievements of male athletes cannot be compared with the achievements of female athletes ( $r = .340, p < .01$ ), that men's sports are more valuable than women's ( $r = .220, p < .05$ ) and that martial arts are an appropriate sport only for men and not for women ( $r = .302, p < .01$ ). Accordingly, athletes who report being more exposed to sexual violence agree to a lesser extent that women as coaches are just as good as men ( $r = -.255, p < .01$ ).

Athletes' total exposure to sexual violence is not statistically significantly related to the view that females should be trained in the same way as males; that criticism offends women more than men; that female coaches provide better support to female athletes than male coaches, and that they do not care if they are coached by a male or a female coach.

The results of the research confirm the positive correlation between exposure to sexual violence and certain attitudes about inequality between men and women in sports, such as attitudes about unequal value of men's and women's sports and achievements in sports, appropriateness of sports for both sexes, and coaches' competencies depending on their gender. It can also be concluded that the athletes' attitudes indicate a tendency to equally value women's and men's sports and achievements in sports, as well as to equally value men's and women's coaching abilities. Given that this is a correlation analysis, it cannot be talked about a cause-and-effect relationship, but this result suggests that the atmosphere of gender inequality, degradation of women's achievements and competencies in sports, is associated with a greater presence of sexual violence. On the other hand, a climate in which sexual violence is tacitly supported, a climate in which no steps and measures are taken against such behaviour, and where perpetrators go unpunished, is a fertile ground for the development of sexual prejudice and disparagement of women's achievements.

## Conclusion

Research on athletes' exposure to all forms of violence, including sexual violence, is important for detecting, preventing, understanding and helping athletes, because violence in sports leaves serious negative consequences on the athlete's physical and mental health. Sexual violence can lead to poorer athletic performance and sport abandonment, and has also been linked to psychosomatic illnesses, anxiety, depression, addictions, self-harm and suicide. Victims of violence feel as if sexual violence is legal and socially acceptable and that they are helpless to fight it (International Olympic Committee, 2007). Therefore, it is necessary to change attitudes in society in general, starting from the family to the wider community, towards sports and women in sports, because it is evident that attitudes about gender inequality are associated with greater exposure to sexual violence. The positive aspects of playing sports can be achieved only if all athletes are treated with respect and if there is zero tolerance for all forms of violence in sports.

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## MANAGEMENT OF REFLECTIVE AND STRATEGIC LEARNING IN HYBRID SPORTS SCIENCES E-LEARNING ENVIRONMENT

Danica Piršl<sup>1</sup>, Samir Ljajić<sup>2</sup>, Tea Piršl<sup>2</sup>

<sup>1</sup>University of Niš, Faculty of Sport and Physical Education, Serbia

<sup>2</sup>University of Niš, Faculty of Philosophy, Serbia

### Abstract

**Purpose** of the paper is to investigate the relations of strategic learning and e-learning environment at the tertiary level. **Introduction:** Thinking is intrinsically tied to language production thus teachers must foster students' critical and reflective thinking skills. This is especially true for sports students since they represent the ambassadors of conveying through sport a positive impact on students, institutions, and the society at large. **Methods:** Around 170 PE students of the Faculty of sport in Nis, Serbia were surveyed about their learning strategies and styles in the hybrid e-learning environment. Their answers reflected varied approaches to the teaching assignments and their group dynamics in problem solving. They were also subjected to tailored think aloud protocols during face-to-face teaching sessions. **Results:** Tertiary institutions should adopt a more equitable cultural and moral values-based curriculum to reflect changing awareness about gender, class, race, ethnicity, and a more developed higher-order thinking in PE students. Since 30% of the PE students are already international coaches or personal trainers, the need was observed for fostering critical thinking abilities and a strategic approach rooted in the pedagogy and practice of multicultural education and insights in cognitive sciences. The hybrid e-learning environment that the Faculty offered only accentuated this need. **Conclusion:** If we teach our students just sports-related concepts to enhance their sports profession expertise, they will be ready for the labor market, but they will lack multicultural education, cognitive capabilities, reflective and strategic competencies to understand different cultural perspectives, various group dynamics, as personal trainers, or coaches.

**Key words:** *reflective thinking, strategic competence, PE students, hybrid e-learning, sports sciences*

### Reflective thinking and self-directed learning

The university level study requires students to transfer their learning strategies and styles to a higher level and to accept a transition to independent learning. Students have to face a new responsibility for their own learning, to tackle with self-directed strategies, to decide on the focus of their attention, to set short- and long-term goals, to learn time management, and finally to understand that learning takes place both inside and outside the classroom. This transition may be especially difficult for international students that we host in our classrooms due to their expectations of more supportive relationships with their teachers at the university. The teacher's role is to explain the process-oriented learning so that students gradually become aware of their responsibility for the new learning styles in their new learning setting, whether it be conventional or a distance learning one. PE students being adaptive and responsive to new challenges readily accept to play a more active role in their own learning process and show greater self-motivation and self-organization while learning. Therefore, it is important that this pivotal concept of independent or more autonomous learning is explained to students immediately upon taking a course so that they know what to expect in sport sciences.

Metacognition, or being fully aware of your actions and bottom-line processes, starts with a conscious awareness of what it is you know and what is lacking in your cognitive domain. It is a critical step in beginning to decide what it is you need to learn. PE students already come to classes with the initial professional knowledge, self-discipline, determination, persistence, and a wish to understand the sporting skills and abilities from a more scientific point of view. These are all great assets. Bringing them to a more conscious awareness of what their learning process is like is the first step. Once you open your mind to an awareness of what you need to learn, you reach the second part of metacognition and that is identifying strategies that would help you learn more effectively. Strategies encompass motivation, acquisition, retention, and performance. The third part of metacognition focuses on how effective the strategies you apply are actually working for you. Students evaluate themselves whether the applied strategy was effective or not, often saying that one successful strategy led to the use of another such as comprehension reading about kinematic chain of movements led to better seminar paper writing on the similar topic. Thus, they reinforce the use of these effective strategies, or they might try some other like interactive chatting and composing a mutual essay on a guided topic combining different opinions and different approaches. Regardless of their learning styles and strategies students will prove and repeatedly use highly effective ones,

but they will also consciously discard some detrimental ones as well. Motivation can enhance or inhibit learning aspects of each of the categories below. Brown (2000) claims that integrative and instrumental motivations are not exclusive but complementary. When sports language is in question students cite different types of motivation, for example, to enhance their communication worldwide, to become more recognizable internationally, to pursue further study opportunities, some of them to teach at sports academies as professional elite athletes. We can corroborate Brown's claim since we have international students learning English for specific purposes but they also want to become an integrative part of the people and culture of the country they are studying in. Acquisition incorporates understanding new information being learned. Successful students claim that intensive reading, note-taking, questioning the old and new piece of information, and asking inner questions or self-talk about the teaching material help them learn better. If demotivation occurs no knowledge is acquired. Consequently, students cannot retain the knowledge and cannot use it, or transfer it onto other new learning situations. Retention may take different forms or strategies such as time management, note-taking, study-reading, writing and rewriting, memorizing, and varied vocabulary learning strategies. Students also claim that visual imagery helps them safe keep the acquired information. They practice a lot, review lessons, try to understand the essence of the core, and chat and discuss given assignment topics through their forums on e-learning platforms. The performance involves retention, test-taking, and anxiety-reduction strategies.

### Metacognitive strategies and writing in ESP

It was Kaplan (1966) who advocated L2 students writing instruction stressing that "the teaching of reading and composition to foreign students does differ from the teaching of reading and composition to American students and that there are cultural differences in the nature of rhetoric... asking for different teaching approaches" (Kaplan, 1966, p. 1). He also declared the adversary effect of a belief that "writing adequately in a native language equals writing adequately in a second language" (p. 3) as rhetorical structures differ among cultures. He suggests several activities meant to raise the students' awareness of the rhetorical patterns of English compositions. It was scientifically proven that L2 authors texts "vary from those produced by native speakers across almost every imaginable dimension (e.g., lexical variety, syntactical choices, cohesion and coherence, global rhetorical structure)" (Silva, 1993). Thus, the question of intensive and overall instruction of the L2 writers in for example, rhetorical patterns, different styles, cohesive devices, discourse and metadiscourse markers created problems for the instructor calling for L2 students general and specific purposes language writing mechanisms. However, such a one-size tailored approach to writing instruction raised doubts whether the knowledge on a complex area of writing could be passed down actually to the learners in such a way to enhance them to complete their writing tasks successfully (Devine et al., 1993).

### Learning Strategies

Learning strategies can best be defined as "specific actions taken by the learner to make learning easier, faster, more enjoyable, more self-directed, more effective and more transferable to new situations" (Oxford, 1990, as cited in Baker & Boonkit, 2004, p. 300). A further defining quality of a learning strategy is that it has to be employed deliberately by the learner in order to achieve a goal (Wellman, 1988, as cited in Carrell et al., 1998, p. 97). In regards to writing, Baker and Boonkit (2004) set forth that strategies involve the "particular techniques or methods by the writer to improve the success of their writing" (p. 301) and list six sets of learning strategies: • memory strategies • cognitive strategies • compensation strategies • metacognitive strategies • affective strategies • social strategies. It is important, however, to note that a high level of declarative (what it is) and procedural (how to use it) knowledge of learning strategies does not mean that the task will be successfully completed; simply knowing a strategy and how to put it into practice does not mean that a learner will enjoy success with that strategy. A study by Anderson (1991, as cited in Carrell, 1998) highlights that "the use of certain reading strategies does not always lead to successful reading comprehension." To make it more vivid, PE students possess professional knowledge and good L1 reading strategies. However, when solving the problems of L2 reading comprehension these strategies failed and they reported the use of numerous new strategies such as similar words recognition, transfer of domain knowledge to L2 contents, etc.

### Application of Metacognitive Strategies and Strategic Learning to Writing Instruction

All writers enter the writing process with some metacognitive knowledge as Devine et al. (1993) claim "all writers (L1 and L2) could be characterized as having a metacognitive knowledge base which contributed to their cognitive model of the writing process (p. 213) but they also needed to apply strategic learning. PE students as Kasper (1997) and Chien (2004) would assert, correlate their metacognitive strategies and their writing performance because they through discussion topics consciously learn from the other students' experiences about coaching, biomechanical factors, socio and psychological role of a coach, sports management and sports marketing. Wenden (1998) and Schraw (1998) emphasize the overall use of both cognitive and metacognitive strategies modeled by a teacher as well as the peers. A study by Chien (2006), though limited in sample size, found a strong correlation between metacognitive reflection and achievement among Chinese ESL students. We could also claim that PE students, high achievers in writing assignments



participated more in reviewing, editing and evaluation of a given writing task than students low achievers. It turned out that hybrid e-learning environment has revealed positive and negative sides of the same coin. While conducting face-to-face teaching it was obvious that 67% of PE students regularly took active participation in the in-class assignments and the out of the classroom tasks as well. When switching to the Moodle platform distance learning mode and the Zoom, or using all available social networking media and tools, that percentage got higher up to 75%. Students showed more interest in handing in their homework assignments, were ready to cooperate, share information, and in the last instance were highly motivated to do additional activities such as preparing short videos promoting their sports.

Reflective tasks sensitized students to write for specific discourse communities (Hirvela, 1997). Moreover, MA students used a genre approach, expressing purpose for their writing either about sports injuries, or gender related topics, creating and dealing with stereotypes about athleticism, which is in line with Badger and White, 2000. Typically, a genre-approach will begin with an analysis of authentic examples of the target text. Thus, MA students profiling in physiotherapy analyzed treatments of injuries or balneotherapy. Linguistically, macrostructures of the text were first discussed, then the use of the cohesive devices in the text, as well as the writer's choice of grammar and vocabulary (Thornbury, 2005). It is interesting to note that scientific English MA students are taught corresponded with the contents of the Research Methods course they were taking simultaneously. 82% of students found it useful and transferable since they were obliged to read a lot of literature in English, and to write simple scientific papers. Thus, the students had explicit focus on the purpose of the writing and were more motivated to complete their tasks. Similarly, some coaches internationally based offered to discuss their lectures as they were also acting as lecturers in the sports academies abroad. This way students did not have to imitate texts, instead they had authentic texts of lectures which they recognized as most useful. Out of the whole sample of nearly 170 students we could say that their opportunity to express their opinions on the curriculum offered, the ratio of the theory and practical classes, the courses offered as opposed to their expectations from the Faculty of sport, were mostly cited as a motivational factor to join the discussions, to reflect on the topics and to offer solutions. Generally speaking, metacognitive strategies with intermediate-level students in ESP courses and the efficiency of these strategies in ESP classes can be summarized in students' comments: 1. I feel I am more active and focused while reading because I am not reading just with my eyes. 2. After previewing I can decide how I will deal with any particular text, and which other strategies I am going to follow to have better comprehension. 3. The strategies you applied made me conscious and active I used to read a text word for word until then, being afraid to misunderstand the contents. Now I'm not reading every possible word although I know the text is unfamiliar to me. I am thinking of everything I know about this topic regardless of the fact that I have already had quite extensive knowledge on it. 4. There are many positive aspects of using predictions. Firstly, immediately thinking about the topics help us to understand contents of articles. Secondly, I am reading faster if I visually predict the following contents. Thirdly, we can associate our knowledge we have concerning the topics and it can help to make our learning much easier. 5. Finding key words in any text was an interesting technique. I think relying on Key words is more helpful than relying on the structure in reading a text. 6. I think it is easier to ask question when I read something I have prior knowledge with because I have something to base in to ask question. 7. Now, I am aware of the reading process and I can use my background knowledge.

## Conclusion

Having analyzed research data and having reviewed relevant literature following conclusions could be drawn:

1. When teaching students how to apply their metacognitive strategies we enable them to self-evaluate and question the teaching contents thus creating a dynamic, interactive environment on several levels: between student and teacher, learner and learning, learning and knowledge, and knowledge and action.
2. Students are taught through role-play and role model how to use reflective strategies and reflective thinking thus promoting strategic learning and learners' autonomy, and learners' responsibility for their actions.
3. Reflective thinking should be encouraged by the teacher, by the peers and the whole academic community.
4. Learning diaries, journals, portfolios are the best techniques to help students foster their reflection and metacognitive awareness.
5. There should not be too much teacher's intervention in the learning process since well-designed and structured studies lead students to less responsibility and discourage their reflection.

To sum up, there are several methods which can be used to raise students' metacognitive and reflective awareness in the classroom. Firstly, teachers should explicitly model both their cognitive and metacognitive thought processes for their students. Secondly, students should be given explicit instruction into the demands of the writing tasks in question. This will finally aid the students in their attempts to self-monitor their whole learning process.

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## EMOTIONAL REACTIONS OF PARENTS WATCHING THEIR CHILD COMPETE

Rebeka Prosoli<sup>1</sup>, Marc Lochbaum<sup>2</sup>, Renata Barić<sup>1</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology

<sup>2</sup>Texas Tech University, Department of Kinesiology and Sport Management, USA; Vytautas Magnus University, Education Academy, Lithuania

### Abstract

There is growing interest in investigating parents in youth sports. Studies are at the beginning stages concerning a more profound understanding of the complexities of the parents themselves. Therefore, the purpose of this study was to document emotional reactions of parents before, during and after their child's sport competition while interpreting all thoughts through an Achievement Goal Theory (AGT) lens. The participants were one pair, mother and father, of a female taekwondo adolescent athlete who participated at the Croatian taekwondo junior national championship. Parents filled the ESP-40 questionnaire 9 times during 6 days. In addition, they completed two open-ended questions, one before and one after the tournament. Before the event, the father stated strong emphasis on entering the final fight while the mother answer focused on providing unconditional support to her daughter. Emotional profiling suggested that the father experienced more unpleasant than pleasant emotions during the competition while mothers' emotions were the reverse. On non-competition days, both parents experienced mostly pleasant emotions. As an answer to an open-ended questionnaire after the competition, the father reported feeling disappointed while the mother reported feeling overall relaxed during the whole day as well as dissatisfied because she could not help her daughter in managing her mood. In summary, parents are necessary in the youth sport domain. A more complete understanding of parents will only serve to enhance youth sport worldwide. These data help move research to a more complete understanding of youth sport parent experiences.

*Key words:* achievement goal theory, youth sport, combat sport

### Introduction

Youth sport has lately been the interest of a growing number of studies focusing on not only athletes and coaches but also the parents, since Gould and his colleagues (Gould, Dieffenbach & Moffett, 2002) suggested that they play a critical role in their child's sport participation. However, supporting their child at sport competitions can be very demanding and stressful for sport parents (Harwood & Knight, 2009). They also reported experiencing very intense emotions connected to their child's sport experiences (Omli & LaVoi, 2012; Dorch, Smith & McDonough, 2009). Researchers suggest parents need to utilize numerous interpersonal, intrapersonal and organizational skills to provide adequate support to their child in sport including properly managing emotional demands of the competition as well as their own emotional reactions (Harwood & Knight, 2015). Numerous studies of emotions are in sport. The IZOF (Individual Zones of Optimal Functioning) model (Hanin, 2000) represents a popular framework for their investigation. From the IZOF model, there are two factors, hedonic tone and functionality, which make four global emotion categories: pleasant and functionally optimal emotions (P+) and unpleasant and functionally optimal emotions (N+), pleasant and dysfunctional emotions (P-), and unpleasant and dysfunctional emotions (N-). P+ and N+ are logically more prominent and salient than P- and N- during successful performances.

In the youth sport literature, researchers indicate parents should focus on their child's effort and progress rather than result or outcome (Gould et al., 2008). The dichotomous Achievement Goal Theory (AGT) purports two distinct orientations, ego and task, both at the individual and environment levels (Nicholls, 1984). An ego orientation and performance climate emphasizes winning and demonstrating superior ability. On the other hand, a task orientation and mastery climate emphasizes personal improvement and self-comparison. The results from meta-analysis suggest that task orientation is correlated with desired achievement correlates (e.g. positive emotions) while ego orientation seems to be related to undesirable variables (e.g. negative emotions) (Harwood et. al., 2015; Lochbaum et. al., 2016). However, research concerning parents' emotions while surrounding and during their child's sport event within an AGT are non-existent.

Therefore, the purpose of this study was to document the emotional reactions of parents before, during and after their child's sport competition while trying to get the insight into their expectations and overall experience. Based on the AGT as well as existing literature about emotions in sport, we expected that a higher expectation of winning and focus on the result will be associated with more negative emotional reactions.

## Methods

Participants in this study were two parents, a mother and a father of the same female adolescent. The data collection occurred during the Junior Taekwondo Croatian National Championship. The athlete had one fight that she lost. During data collection, the mother was 54 years old and the father 48 years old. To gain better understanding of parents' emotional reactions before, during and after their child's competition both parents filled the ESP-40 (Emotion State Profile, Hanin, 2010, translated to Croatian by Bosnar & Prot, 2010) questionnaire 9 times with the instruction to think about how they feel regarding their daughter's competition. ESP-40 consists of 10 items in each of the four emotion categories from IZOF model (N-, N+, P+, P-). Participants rank each item on a four-rank scale within each row (10 rows of 4 columns) with 4 marking the emotion which best describes their experience, and 1 marking the emotion with least describes their experience. Subtotal scores come from adding scores within each category of emotions (range from 10 to 40). The competition occurred on Saturday and the parents filled the questionnaire 4 times on that day (1) before competition (2) before the fight (3) after the fight (4) after competition. In addition, they filled the same questionnaire once on (5) Wednesday, (6) Thursday and (7) Friday before the competition as well as (8) Sunday and (9) Monday after the competition. Furthermore, to gain better understanding of their overall experiences, both parents answered two open-ended questions (Lochbaum, Prosoli & Barić, 2017): one before ("Please give a short description of your expectations regarding today's competition") and one after the competition ("Please describe your day, give us some thoughts about today's competition, and describe how you felt during today's competition").

## Results

Table 1 as well as Figure 1 (father) and Figure 2 (mother) contain the ESP-40 questionnaire from 9 measurements during 6 days results.

Table 1. Results on the ESP-40 questionnaire

	Emotions father				Emotions mother			
	N-	N+	P+	P-	N-	N+	P+	P-
Wednesday	14	18	36	32	18	21	34	27
Thursday	21	19	25	35	28	28	25	19
Friday	28	17	22	33	18	16	27	39
Saturday before competition	16	30	34	20	12	19	32	37
Saturday before 1 <sup>st</sup> fight	36	32	17	15	14	21	30	35
Saturday after 1 <sup>st</sup> fight (lost)	37	32	19	12	25	22	25	28
Saturday after competition	32	26	18	24	26	16	26	32
Sunday	19	14	28	39	22	19	28	31
Monday	25	16	22	37	17	15	32	36

N-(unpleasant and dysfunctional emotions); N+(unpleasant and functionally optimal emotions); P+(pleasant and functionally optimal emotions); P-(pleasant and dysfunctional emotions)

Visually, it is clear that both parents experienced more pleasant than unpleasant emotions on the first day of the measurement, 3 days before the competition as they predominantly reported feeling P+ emotions (motivated, purposeful, alert).

During the next two days, the father reported feeling predominantly P- emotions (satisfied, happy, calm). However, on Friday he also started to feel more N- emotions (tired, reluctant, distressed). On the other hand, mothers' emotions inverted on Thursday compared to her emotions on Wednesday with unpleasant emotions becoming the most prominent (reluctant, worried, nervous). On Friday, her emotional profile changed again and pleasant emotions were again higher than unpleasant ones. She predominantly reported feeling P- emotions (pleased, comfortable, content).

On the day of the competition before the competition started, the father predominantly reported experiencing P+ emotions (confident, purposeful, enthusiastic) followed by N+ emotions (tense, intense, nervous). Mothers' emotions on the day of the competition stayed overall pleasant, and she predominantly reported feeling P- emotions (joyful, pleased, comfortable, relaxed).

As a fight became closer, the fathers' N- emotions (sluggish, reluctant, doubtful, upset, worried) became the most prominent and the P- emotions (relaxed, content, calm) continued to decline, becoming the least prominent. Also, his P+ emotions (energetic, confident, motivated), which were the highest in the morning of that same day, dropped a lot just before the fight and were second to last. Furthermore, his N+ emotions (tense, angry) increased slightly and stayed the second most prominent. On the other hand, mothers' emotions just before the fight stayed almost the same as her

emotions at the beginning of the day with a little decrease in pleasant and increase in unpleasant emotions compared to earlier measurement. Compared to her husbands' emotions during the same timeframe, hers were overall more pleasant than unpleasant while his were more unpleasant than pleasant.

The emotional profile of the father remained almost the same after the fight as it was before the fight. On the other hand, mothers' emotions changed again in comparison to the previous two measurements. Her P- (relaxed, calm) emotions stayed the most prominent with an obvious decline in values compared to previous two measures. The same decline was visible in the P+ emotions (energetic, motivated, enthusiastic) as well. Furthermore, her N+ emotions (tense, dissatisfied, irritated) become the least prominent with slight increase in values compared to the last two measures. This increase was also visible in the N- emotions (sad, unhappy, worried). Visually, it is obvious that mothers' values in four emotional categories were very similar immediately after the fight, suggesting feeling mixed emotions. Further, evidence of feeling mixed emotions is visible from her P+ and N- values being the same immediately after the fight as well as at the end of the day on Saturday.

Only at the end of the Saturday, fathers' P- emotions (relaxed, happy, pleased), which were the lowest in the last two measurements, began to rise becoming again the most prominent during Sunday and Monday. Furthermore, fathers' unpleasant emotions began to decrease on Saturday after the competition and continued that way on Sunday as well. However, on Saturday evening he still predominantly reported feeling N- emotions (tired, sad, reluctant). On Monday father had a similar profile as he had on Friday with P- emotions (relaxed, content, comfortable) being the highest followed by N- emotions (distressed, reluctant, tired). Mothers' emotional profile after the competition stayed the same as her profile after the fight, with increase in P- (relaxed, comfortable) and decrease in N+ (tense, angry, irritated) emotions. She continued to feel predominantly relaxed, calm and satisfied on Sunday and Monday. Her emotional profile on Monday was similar to the one on Friday and Sunday.

The father's answer to the open-end question filled before the competition regarding his expectations for the day was the following: "That my daughter is satisfied with her performance. Personally, I wish for the final fight." After the competition, he commented on his overall experience: "Bad. My daughter lost 25:12. Amount of invested effort matches the result. I am deeply convinced that she can and knows better. Overall... disappointed."

Before the competition mother wrote "No expectations like usual, satisfied no matter what but cheering for her with my whole heart." After the competition, she summarized her day: "Day started very comfortably and relaxed. My daughter was free first round, so we had to wait a very long time, which was pretty exhausting. As the day went on, we were more and more tired. I am sorry that my daughter had a negative attitude towards the fight from the very morning. With this same energy, she fought in the match, which she lost. During the day I felt overall calm but also a little dissatisfied because I wasn't able to lift my daughter's mood and fighting spirit."

From AGT perspective, the father expressed an ego goal orientation by putting the emphasis on his daughter entering the finals (result) and feeling disappointed after her defeat. Mother expressed having no expectations but focusing on supporting her daughter no matter the result. After the competition she reported feeling dissatisfied because she couldn't help her daughter prepare for the fight and from her answer, we can see that she was more focused on the process and giving support than on the result. This suggests having the task goal orientation.

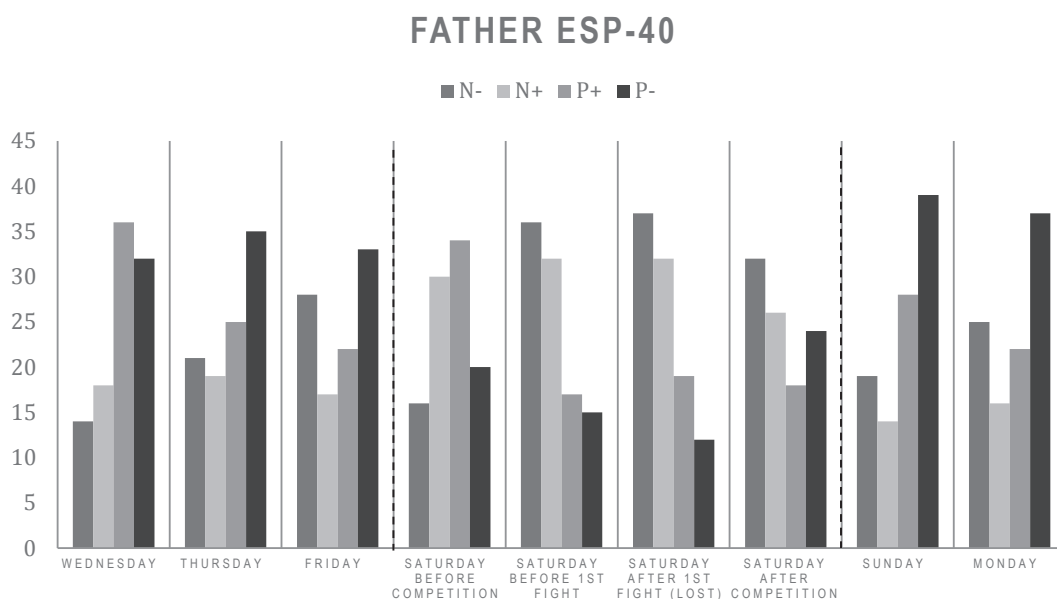


Figure 1. Fathers' results on the ESP-40 questionnaire



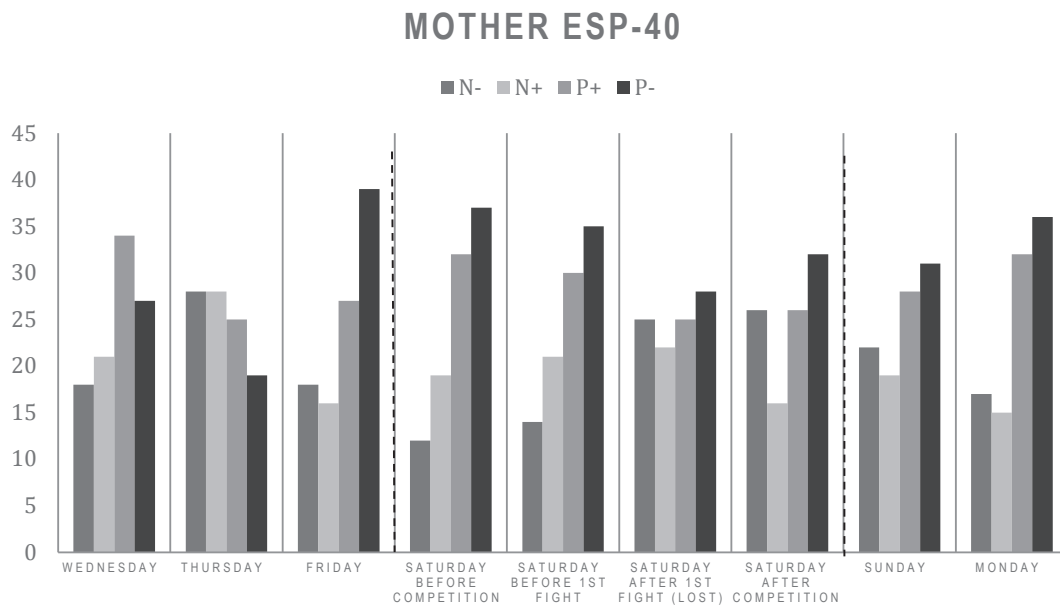


Figure 2. Mothers' results on the ESP-40 questionnaire

## Discussion

With this study, we wanted to expand the existing research base by documenting emotional reactions of parents before, during and after their child's sport competition. Additionally, we investigated their expectations and reactions before and after the competition.

Emotional reactions of mother and father were somewhat different with most differences visible on the day of the competition. The day before as well as two days after the competition both parents felt predominantly relaxed, happy, satisfied, calm etc. On the competition day, mothers' emotions remained pleasant through all the measurements as she reported predominantly feeling pleased, comfortable and relaxed but also reporting feeling mixed emotions after the fight and until the end of the day. On the other hand, father felt predominantly confident, purposeful and enthusiastic but also tense, intense and nervous before the competition started. Minutes before the fight, his emotions were overall unpleasant as he reported feeling sluggish, reluctant, doubtful, upset and worried as well as continuing to feel tense and angry. He had the same emotional profile immediately after the fight and his emotions remained overall unpleasant until the end of that day. When we analysed the father's answers to the open-ended questions, we concluded expressed an ego goal orientation because he emphasized the result. The negative/unpleasant emotions father expressed are consistent with previous meta-analytic research results, which reported that ego goal as well as ego climate, correlate with negative emotions (Harwood et al., 2015; Lochbaum et al., 2016). Studies on young athletes and coaches suggested that they believe parents should emphasize children's effort instead of focusing on the result and remain positive and supportive during and after the competition (Gould et al., 2008; Knight, Boden & Holt, 2010).

Having only one pair of parents and analysing only one fight is one of the main limitations of this study. However, these results are new in the youth sports literature and suggest a fruitful area for more research. More studies on multiple parents in different sports as well as different levels of participation of their children would help further understand emotional patterns across their competition experience. Only repeated measures across different competitions with many parents will answer such questions.

## Conclusion

It is important to investigate the experiences of parents and consider their well-being while supporting their child's sport participation. Sport competitions can be very emotionally demanding for parents and this research provides insight into their emotional profile days before and after the competition, as well as during the event. This research connects those reactions with their explanations and expectations using the AGT framework. Future studies including more than one pair of parents are crucial in understanding these experiences. This could potentially lead to creating interventions and education for parents participating in youth sport.

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## THE INFLUENCE OF GIVING DIFFERENT FEEDBACK ON THE LEVEL OF LEARNING IN ARTISTIC SWIMMING

Josipa Radaš<sup>1</sup>, Jasmina Parlov<sup>2</sup>, Gordana Furjan-Mandić<sup>1</sup>, Darko Katović<sup>1</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Špoljarić Sinkro Klub, Croatia

### Abstract

Previous studies suggest that some aspect of information feedback influences the performance, retention and transfer of motor skills. At the artistic swimming training, feedback is given according to what the coach sees outside the water and what he sees below the water. The aim of the present study is to examine the effectiveness of four information feedback conditions on the level of learning of the four new position in artistic swimming. Artistic swimming belongs to a group of conventional sports that contain aesthetically shaped and choreographed acyclical motion structures defined by the FINA rules for evaluation. Judges are evaluating only what they see outside the water, but the movement done outside the water is result of what is being done inside the water. Participants were artistic swimmers (N=15) aged 10 to 12. All participants participated in four different experimental groups in learning of four different figures with four different feedbacks (videotape feedback, demonstration feedback, verbal feedback and without feedback) about their mistake. Repeated Measures ANOVA was used to evaluate if there is a statistically significant differences between analysed feedback information. Results show that younger artistic swimmers will better understand the mistakes if the coach told them verbally rather than just showing them by video or demonstrating them. Since, this is a first research about examination of effectiveness of different kind of feedback in artistic swimming, the results would enable the trainers and the expert team better communication with their athletes to achieve the best results.

*Key words: performance, information, figures, young artistic swimmers*

### Introduction

Artistic swimming is a hybrid water sport which includes swimming, dance and gymnastic performing a synchronized routine of elaborate moves in the water, accompanied with music (Mountjoy, 1999). It belongs to a group of conventional sports that contain aesthetically shaped and choreographed acyclical motion structures defined by the FINA rules for evaluation. Competitive success in artistic swimming are judged by judges by awarding their subjective judgment. Judges are evaluating only what they see outside the water, but the movement done outside the water is result of what is being done inside the water.

Many experiments have been directed at how some aspect of information feedback influences the performance, retention and transfer of motor skills (Young & Schmidt, 1992; Kernodle & Carlton, 1992; Starek & McCullagh, 1999; Menickelli, 2004; Cutton & Landin, 2007). An additional source of feedback for motor activities (information about the way the movement is produced) has received increasing attention over the last 20 years. At the artistic swimming training, feedback is given according to what the coach sees outside the water and what he sees below the water (position of the body and swimmers work with hands). If the task is not well learned, improvements in performance sometimes occur over periods of practice with delayed feedback, but these improvements are often gradual and small (Smith, 1966). Research and empirical evidence involving videotape feedback in instructional settings have shown specific positive outcomes resulting from its use. Summarized from the literature, the benefits of videotape feedback include: videotape feedback can highlight the most difficult aspects of specific movement pat-terms (Schmidt & Wrisberg, 2008) and also can highlight associated cognitive processes (e.g., self-talk, anxiety) that has influence at performance (Jambor & Weekes, 1995). The main goal of this research would be to examine the effectiveness of four information feedback conditions on the level of learning of the four new position in artistic swimming. Another goal would be to help coaches and expert team in better communication with their athletes to achieve better results.

## Methods

**Participants:** Participants were artistic swimmers (N=15) from the artistic swimming club ŠASK Zagreb aged 10 to 12. All participants are competitors in artistic swimming, and they started participation in the research from the same level of learning. All participants participated in four different experimental groups in learning of four different elements of artistic swimming with four different feedbacks about their mistakes.

**Procedure:** The participants participated voluntarily with the parental permission, exclusively for research purposes. The study was conducted at the swimming pool complex Svetice in Zagreb. The participants done four figures which are prescribed by the International artistic swimming federation for the year 2017-2021. The participants did the figures after the main part of training. The figures were: *Minerva*, *Catalina reverse*, *Dalecarlia* and *Beluga* (FINA artistic swimming rules 2017-2021). At the beginning of the research, the participants were received the initial information for each figure with a video, and after that they had 5 days to rehearse them with different feedback (videotape, verbal, demonstration feedback and no feedback information). Last day, the participants performed the figure one by one three times and after each attempt they received grade from 1 to 5 from each expert, who evaluated participant's performance. The entire figure was performed, but only the transitions in the figure that were new for the participants were rated. For the figure *Minerva* they received feedback with video, which they needed to spot their mistakes and make the following attempt to correct them. For the figure *Catalina reverse*, they received verbal feedback after each of three performance attempts, while feedback was provided to the figure *Dalecarlia* by demonstration. The demonstrator is the top artistic swimmer and member of the national team, who demonstrated to each participant their performance mistake. The last figure performed by participants was *Beluga*, which was done without feedback information.

**Measurements:** The participants received videotape feedback after every performance of figure *Minerva*. A Go-pro 3 camera in coordination with a Phillips Smart TV (50" Smart 4K Ultra HD HDR LED TV) was used for recording and playback of figures. Artistic swimmer (demonstrator) who is a member of the national team did demonstration feedback for *Dalecarlia* figure. The participants received a verbal feedback after performance of *Catalina reverse* from the experts of artistic swimming who are active judges. All experts finished Faculty of kinesiology.

**Statistical analysis:** For the purpose of this research, the data have been processed R system for statistical computation and graphics (ver. 3.6.2). Basic descriptive parameters were calculated for all variables (arithmetic mean, standard deviation, minimum, maximum, skewness and kurtosis), and distribution normality was checked using the Shapiro-Wilk normality test. Cronbach and Standardized Alpha were used as a measure of objectivity as determined by the internal consistency method. Repeated Measures ANOVA was used to evaluate if there is a statistically significant differences between analysed feedback information. Multiple pairwise paired t-tests between feedback levels were used to determine the magnitude of differences between the feedback methods.

## Results

The objectivity of the judges was determined by the internal consistency method and the Cronbach and Standardized (Alpha) coefficient of objectivity were calculated which indicate the high objectivity of the judges' ratings (Table 1.).

Table 1. Objectivity of the judges

Feedback method	Cronbach alpha	Standardized alpha	Average inter-item corr.
VTFB	0.930	0.935	0.964
VFB	0.966	0.966	0.906
DFB	0.970	0.971	0.904
NFB	0.971	0.972	0.920

The average correlation between judges' ratings further indicates high homogeneity of judges' ratings.

Table 2. shows that normality assumption was checked by computing Shapiro-Wilk test for each feedback method.

Table 2. Shapiro-Wilk test of normality

Feedback method	W	p
VTFB	0.956	0.630
VFB	0.970	0.858
DFB	0.978	0.953
NFB	0.911	0.143

The feedback method grades were normally distributed at each feedback method, as assessed by Shapiro-Wilk's test ( $p > 0.05$ ).

The Assumption of sphericity was automatically checked during the computation of the ANOVA test using the R function `anova_test()` [rstatix package]. The Mauchly's test is internally used to assess the sphericity assumption, and the Greenhouse-Geisser sphericity correction is automatically applied to factors violating the sphericity assumption.

Table. Repeated Measures ANOVA results

	DFn	DFd	F	p
Feedback method - ANOVA	3	42	14.484	0.000

Arithmetic mean positions (Figure 1) show that the VFB (verbal feedback information) was the most effective for learning figures in young artistic swimmers, while the DFB (demonstration feedback) and VTFB (videotape feedback) had similar results. A figure that was performed without feedback information got the worst performance.

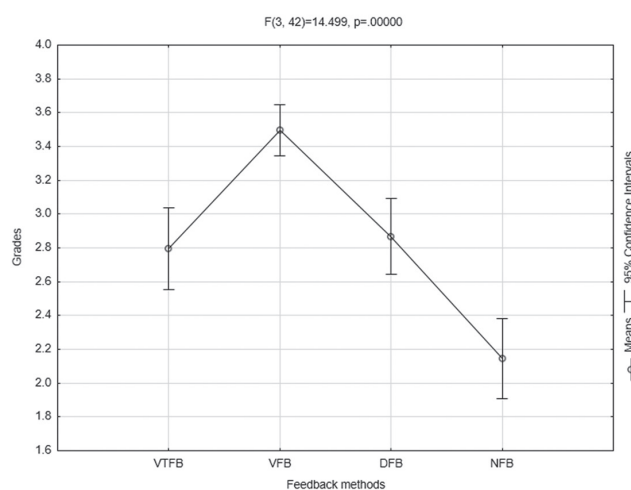


Figure 1. Mean and Confidence Intervals differences between the feedback methods

Multiple pairwise paired t-tests (Table 4.) between the levels of the within-subjects factor (Feedback methods) were conducted. P-values are adjusted using the Bonferroni multiple testing correction method.

Table 4. Multiple paired t-tests between feedback methods

Paired t-tests		t	p	p.adj
DFB	NFB	3.499	0.004	0.021
DFB	VFB	-3.461	0.004	0.023
DFB	VTFB	0.340	0.739	1.000
NFB	VFB	-6.163	0.000	0.000
NFB	VTFB	-2.698	0.017	0.104
VFB	VTFB	4.212	0.001	0.005

A repeated-measures ANOVA determined that mean grades differed significantly across four feedback methods ( $F(3, 42) = 14.499, p < 0.01$ ) (Table 3). A post hoc pairwise comparison using the Bonferroni correction showed that differences between the demonstration feedback (DFB) and video-tape feedback (VTFB) grades were not statistically significant ( $p = 1.000$ ). Also, differences between non-feedback method (NFB) and video-tape feedback (VTFB) grades were not statistically significant ( $p = 0.104$ ).



## Discussion

To our knowledge, this is the first research about feedback information in artistic swimming and also so far most studies have focused on adult artistic swimmers (Alentejano et al., 2012; Bante et al., 2007; Gabrilo et al., 2011; Naranjo et al., 2006; Peric et al., 2012; Sajber et al., 2013), but for the feedback information in learning method is important to concentrate in younger artistic swimmers. It was expected that the verbal feedback information would prove to be the best in young artistic swimmers, since at that age the relationship between coaches and children is very important because children do not have a perception of what they are performing. Children of that age are not aware of their body in space and so it is important that they are getting feedback from the coaches about what they are doing or not doing well. During the research, participants received feedback immediately after the performance because it turned out that delayed visual feedback degrades perceptual-motor tracking performance (Kao & Smith, 1978; Morikiyo & Matsushima, 1990; Smith & Smith, 1962). Throughout the researches, the benefits of videotape in learning are outlined, especially as technology advances day by day, so it would be useful to combine videotape feedback with verbal feedback.

## Conclusion

This research has been used to examine whether and how different feedback is affected by complex motor skills (new figures in artistic swimming). Since this is a first research about examination of effectiveness of different kind of feedback in artistic swimming, the results are enable the trainers and the expert team better communication with their athletes to achieve the best results. For the younger age category in artistic swimming, feedback with videotape is not as effective as for the older age category. Younger artistic swimmers will better understand the mistakes if the coach told them verbally rather than just showing them by video or demonstrating them. It would be best to combine verbal feedback with demonstration and video. Artistic swimming is a specific sport because feedback is given for whole body (inside and outside the water), while the judges are evaluating only what they see outside the water. The movement seen outside the water is the result of what is being done inside the water, so this is a reason why this research is needed in this specific sport. In future researches should be include the sample of participants of different age categories and involve all clubs in Croatia.

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## PARENTS AND THEIR CHILDREN'S SPORTS

Aleš Sekot

*Faculty of Sport Studies, Masaryk University, Czech Republic*

### Abstract

An essay is rooted in the exploration of broader complex context of the phenomenon of physical motion and sportive activities in contemporary sedentary society. It is at that time the topical problem of pointed parenting styles that is freshen and enliven in the context of educational support aiming to active life orientation, including regular sportive activities. The specific accents and educational methods of parenting are playing crucial role in this respect at the level of authoritative, authoritarian, liberal and neglecting styles (Sekot, 2019). Parenting styles prefiguring motivation of children to regular sportive activities and responsible attitude to life. And such process is going under way of socialization factors and impacts, bringing up to date the sociological links and context of mutual relation to motivation of children and youth to sport also in the context of organizational sportive activities out of the family. Nowadays we face forming socially and culturally determined relation child – parents – trainer (coach). Like this relation yields in the context of the climate of consumerist postmodern society adoring top elite athletes. Such cultural milieu forms potential conflicts of interests of motivation, experience and pointing separate participants of such 'triangle'. Given situation aim our effort to the crucial topic of parental responsibility as well as to growing educational and socializational importance of trainers and coaches. During the synergic process are pervaded practical aspects of the importance of age and motivation; but parental role is in this respect utterly essential and indispensable. Parental role is growing when parents play modeling role by way of mutual sportive activities with childrens. Thus, as it is in the essay substantiate with relevant research pieces of information and empirical data on parental role in motivation of children to regular physical activity and sport.

**Key words:** *parenting, sport, physical activity, trainer, sedentary*

This text addresses the broader context of the phenomenon of exercise and sports activities in contemporary sedentary society, in which the determined education of children by their parents to adopt an active approach to life is becoming increasingly important, and regular exercise forms an integral part of it (Sekot, 2015). The issue of parenting styles is relevant, since whether the style adopted is authoritarian, authoritative, liberal, or neglectful, it has influence on children's and young people's motivations for doing sport. This takes place within the concurrent process involving socialisation factors; thus, updating the sociological contexts of young people's relationships with sport, in particular the context of motivation for sports activities outside the family framework, in an organised sporting environment. Hence a new, socially, and culturally conditioned relationship is created between the child, the parents, and the trainer, which – in a consumer society climate and its adoration of elite sportspeople – brings possible clashes of motivations, experiences and directions of the actors involved in this triangle. This focuses our attention on both the issue of parental responsibility and the growing educational and socialising importance of the trainer. In a synergic process, linked issues emerge that are connected with the importance of age and motivation for the purposeful guidance of the child towards sports, where the influence of the parents is absolutely essential and irreplaceable, and strong also in these cases where parents influence their children by undertaking regular joint sports activities with them. This is shown in the book's empirical findings about parental approaches to children's and young people's sports.

Sport is inescapably linked with the culture of society. It is thus an expression of specific notions, ideas, values and perspectives, through which people assume their positions in the world, seek their place in it, explain its workings to themselves and measure the importance of the things around them. They consider what is and what is not right and natural; what is advantageous and disadvantageous; what can bring a material profit and what 'merely' brings joy from healthy exercise. In itself, sport is usually not the cause of particular changes in character, attitudes or behaviour. It is always involved in a coaction with the influences exerted by the specifics of the given social and cultural environment, in the broader context of socialisation and education processes (McElroy, 2002).

The topic of *parental education* and authority for the *motivation*, intensity, level, direction and, last but certainly not least, *adherence* of children to sporting and physical activities is certainly directly or indirectly linked with the cultural and social climate. Thus, we face in our society the issue of substantial cultural change that generates fundamental shifts in the sphere of value orientations of socially and economically differentiated groups, layers or classes of the population. This change is substantially stimulated by the culturally revolutionary phenomenon of a *consumer society*, reflecting the

essence and the ethos of its modern or post-modern characteristics, accompanied by a number of ambiguous or crisis-generating processes, exposing masses of people to transformations in individual consumption, the existence of mass culture and a growing tendency to consumerism and economic egocentrism. Viewed through the prism of the situation and developmental trends in sporting and physical activities, one of the most serious indirect consequences of consumerism for both the individual and society is a process that has been described with a global perspective as *sedentarism*. It is a phenomenon concurrent with a technologically advanced, consumer and materially rich society, where the need for physical exertion gradually disappears and so does, subsequently, the level of regular physical activity in the everyday lives of masses of people. Thus we speak of *sedentary society*, in which in consequence of the dynamic development of technology in all areas of social life the traditional demands placed on people in terms of physical exertion decrease, particularly in three areas that concern practically everyone: in the majority of employments, that is in the field of *work*, in the *home* and in the *individual forms of transport*. Instead of physically strenuous activities, most people in our cultural sphere today are placed, especially at work and in individual transport, in sedentary activities, which are characteristic of a sedentary consumer society. In this and other contexts, the issue of *insufficiency of physical activity* is thus grounded in the elementary question: Why is physical activity important? The answer is clear and fundamental: Because humans are genetically programmed for physical activity and a sedentary way of life is detrimental to them, being an unnatural form of physical passivity and accelerating the progress of civilisational diseases such as heart attacks, diabetes, and high blood pressure (McElroy, 2002).

This creates a situation where regular healthy physical and mental development, supporting regular physical activity, becomes a matter of individual choice, personal will and perceptiveness towards the socialising and educational influences of the environment. This updates in a specific way the educational role of the family and parents as the primary opinion leaders, who are able powerfully to form and influence the values of their children and thus to contribute to the relations they create for themselves towards physical activities, which in our cultural sphere largely take the form of sports, in activities often undertaken outdoors, in participation in sporting games and leisure-time activities linked with physical exertion and movement.

If we study the process of how an individual's values are formed, then in our culture in particular two highly stimulating processes are acting together on children and young people. *Socialisation* is a life-long, all-pervading, and spontaneous process by which individuals or groups adjust themselves to the world around them, adopting its fundamental values, norms, rules, habits, customs and cultural patterns in everyday life, especially in contact with other individuals and groups. Unlike socialisation, *education* is a purposeful action on an individual by parents, the wider family, teachers, educators, trainers and institutions and organisation, with the aim of influencing the development of the individual and their personality.

*Family* plays a key and decisive role in the purposeful upbringing of children. In line with their cultural, educational, economic, and social level, parents influence their children, and theory distinguishes four parenting styles. A parenting style here means a theoretical construct reflecting the fundamental and characteristic strategies and methods used by parents primarily to form the lives of their children. The quality and importance of these educational activities are usually amplified by the amount of time parents spend with their children. This is particularly so when at least one of the parents shares leisure-time activities with their child, thus persuasively demonstrating to them their interest in and care for them. A parenting style is thus an expression of a *special behaviour of parents towards children*, which reflects the broader conception and strategy of parental educational practices. Diana Baumrind was the pioneer in conceiving a typology of parenting styles. Her research has established a basic three-step model of parenting styles (authoritative, authoritarian and permissive), which was then developed further by other scholars, usually into four-step models. Baumrind's research was informed by two bipolar fundamental constituents – responsiveness vs non-responsiveness and demandingness vs non-demandingness – that generate the forms of parenting styles (Baumrind, 1967, p. 43–88). Current theoretical models of parenting styles tend to distinguish four of them: authoritarian, authoritative, liberal (or permissive) and neglectful.

*Authoritarian*: Parents emphasise unconditional obedience and discipline, and this is enforced by punishment. They pursue the principle that the child needs to be overseen, not heard out or even have their worries and problems empathetically shared. Authoritarian parents prefer the use of punishment over the child's inner adoption of discipline and fail to appreciate the irreplaceability of the feedback between their decision-making and their child's feelings and opinions.

*Authoritative*: Positive relations between parents and the child are created, and binding precepts and rules that cannot be overstepped are asserted. There is an emphasis on creating positive values and an active approach to life. Parents always take care to create a positive, friendly relationship with their child; they not only emphasise the necessity of respect for rules and order, but also consider the child's inner life and derive their parental authority in part from respecting the opinions, feelings and needs of the child. They seek to prevent problems in upbringing rather than dealing with them in an authoritarian manner. Where parents are consistently demanding yet perceptive of the child's values, a beneficial form of cultivating the child is gradually created, giving the child in later life a greater chance of being a successful, well-received, magnanimous and competent independent individual, one able adequately to determine and co-create their active life path. Generally speaking, this parenting style is considered the *optimal* way to bring up responsible adults who freely express their opinions and actively approach the challenges and obligations of life (Spera, 2005).

*Liberal:* This style is based on not enforcing respect for the code of family life and the rules of desirable behaviour and actions, in line with the principle ‘children are just children, let them have freedom’. Although the rules that have been established may often be strict, they are not always consistently enforced and respected. Coercion is only used in extreme cases of truly serious problems. A liberal, permissive style of parenting that is not based on giving orders is characterised by a low expectation threshold as far as the following are concerned: the child’s behaviour and aspirations, the satisfaction of their basic needs and creation of life-long stabilising values. As such, this parenting style does not lead systematically to an inner awareness of correct behaviour. The adequate parental role slips into that of ‘friendship’ or ‘camaraderie’, lacking the vital function of natural authority and ‘opinion leadership’, remote from fixed, irreplaceable rules, rewards, and punishments. However, under certain circumstances this can open the way for an independent - or perhaps self-sufficient - development of the child in adulthood.

*Neglectful:* Under this style, parents entirely fail to inculcate in their child the fundamental positive values of life, disregarding not just their needs and interests, but also education and professional training, ignoring the rules of healthy eating habits and an active lifestyle. Parents show no interest in their child’s school duties and do not consider it necessary to be informed about where or with whom their child spends their leisure time. The child lacks sufficient adequate counsels, impulses, and *stimuli* to create the preconditions for a meaningful and responsible life in adulthood; lack of parental interest frequently also affects the areas of nourishment and hygiene habits. Often there is a significant gap between the parents’ interest in their child and the energy needed to satisfy their needs, often including their fundamental needs.

Naturally, in many actual cases there is an overlap between these academically constructed categories, or their boundaries become blurred. Evidently, however, one thing is true: the building and maintaining of a *positive* relationship with the child and the stabilising of a natural and healthy *parental authority* demonstrates most clearly a correct and positively directed parenting style and is of cardinal importance for the bringing up of children (Sekot, 2019). It is important to note that in the creation of parenting styles factors such as the child’s temperament and medical condition and especially the cultural level of the parents often play crucial roles. Parents who provide adequate care to their children lead them to healthy dietary habits, emphasise the importance of personal responsibility for health, while allowing for an adequate measure of independence and decision making, create good conditions for the establishment of life-long social competencies and an active approach to life. This form of *positive parenting style* is also beneficial for the ability to maintain solid interpersonal relationships.

*Leisure time* is an important platform for a wide spectrum of activities that importantly affect people’s lives, the maturing of their values and their physical development. It is therefore also irreplaceable, providing a unique basis for the creation of feelings of life satisfaction and personal welfare, for the cultivation of a healthy and actively thinking and acting personality. For children and young people, this may on the one hand mean increasing consumption of their leisure time ‘permanently connected’ to electronic media; but on the other it opens the options for active leisure, especially via sports and other physical activities; cultivating the ability consistently and systematically to maintain good health and peak physical and mental condition. Beyond its fundamental educational functions, aimed at purposeful influence over the child’s values, the family is usually also intimately linked with the process of *socialisation*, that is the adjustment of a person to the habits, customs and norms of the surrounding world, the given cultural environment. As a rule, parents seek within their own norms and values for their child to become an independent, sovereign adult. The participation of children and young people in sports activities is generally influenced by the availability of opportunities, support given by family members, friends, opinion leaders and role models, the closest community and finally also the perceptiveness of the potential child participant in sports activities (Stassen et al., 2011, p. 273–278).

The study of the broader frames of socialisation, education and leisure time focuses on its two forms: organised leisure and non-organised leisure. Participation in organised activities is generally seen as a factor in the development of an individual’s strong traits in the sense of their healthy maturing towards the ‘ideal adulthood’; while socially focused activities taking place out of the sight of adults are, by contrast, seen as a context for potential multidimensional involvement in risky or delinquent behaviour. Multiple involvements in *organised forms of leisure* potentially increase the educational and socialisation effect that contribute to comprehensive personal development (Campioni & Smetana, 2014).

These effects are made stronger still by the *breadth* of the wide spectrum of organised leisure activities (for example, a combination of sport with an interest in artistic activities), their *intensity* (for example, time spent in sports training), *internally grounded interest* (for example, looking forward to training time or a family cycle trip at the weekend) and *duration* (for example, persistence in football or athletic training). Thanks to parental authority, such efforts stand the greatest chance of initiating and developing children’s leisure time activities, their focus, intensity, and aspirational expectations. With age, the participation of adolescents in organised leisure time under adult supervision gradually decreases, as, for example, intensive training in competitive sports might become remote from the original desire for victory and performance. Furthermore, other options for self-actualisation are open to young people, especially in the field of professional training. However, young people usually carry the valuable assets of activeness, respect for authority, purposefulness, life-long friendly relationships, and collective cooperation from the arena of organised leisure activities into their future lives. These are compatible with the demands of the contemporary world, necessitating not just the pursuit of personal ambitions but also an ability to adjust and be flexible (Amato & Fowler, 2002, p. 703). In extreme cases,



permanently or largely unstructured, *non-organised leisure* tends to be typical of a non-stimulating family environment. Leisure time spent without proper supervision by, or even lack of interest from, parents may lead to often aimless after-school-hours meetings with friends and peers and directionless loafing around, producing feelings of futility, pointlessness, and obliviousness. Patterns of behaviour are adopted that are in sharp contrast to the ethos and the principles of an active approach to life. Overall, active participation in organised leisure time activities under the leadership or supervision of adults can be seen as a suitable environment for the healthy personal development of adolescents in the context of extracurricular forms of socialisation and educational activities, where *forms of parental motivation* usually play a primary initiating role (Telama, Yang, Vikari, et al., 2005). An unmistakable, and in fact irreplaceable, source of relevant information in this area of sports – that is, the uncovering and investigation of many colourful influences of parental models of behaviour in the environment of the organised sports of their children – are the trainers, coaches, teachers, managers of sports grounds and organisers of sports events for young people. Despite this fact, the voices of the trainers and young people's sports organisers are not heard loudly enough. Scholars in this field are therefore increasing their efforts to describe and understand the role of *trainers* in the context of the often-colourful attitudes and behaviour of parents, which reflect parents' educational methods or styles that they apply in a promising ambitious environment, dynamically developing the potential sporting career of their child. An adequate degree of parental encouragement, to achieve a higher level of ability and performance, and the sharing of joy from participation in sports, certainly help to create harmonic educational and socialising effects. By contrast, unrealistic parental demands and expectation can be a source of stress and fear of failure, thus weakening the natural enjoyment of sports, causing children a loss of faith in their own abilities and deteriorating self-confidence. Parents do not always well understand, or are willing or able adequately to share, the sporting experiences of their children. The evaluations of participation in sports by parents on the one hand and children on the other can differ considerably, even if there are cases where the child outwardly declares motivations and objectives that are identical with the parents'. Such impulsive positions on sport can be moderated and compensated for by interactions with trainers, who with their expert insight can contribute towards adequate harmony between parents' and children's positions, especially in the field of organised sports' meaning and objectives, which can often be problematic (Côté & Hay, 2001).

Here, the optimal educational style, appropriately supporting the sporting career of the child, is that where the parents provide suitable, appropriate and effective logistical, financial and emotional support. By contrast, a sustained critical approach on the part of the parents, impatiently awaiting the fulfilment of high aspirations, tends to be counterproductive. Such an approach overestimates the value of victory and creates inappropriate pressures on targets being met that have been set by the parents, but which neither the children involved in sports, nor their trainers have fully identified with. Highly *negative expressions* of the parental relationship with their children's sports include, first of all, complaints about the progress and outcomes of sports training, pursued in a manner that undermines the authority of the trainers, and in many cases also the relations between parents and children (Gould, Lauer, Rolo, et al., 2006a, b). Examples include such protests – they are not necessarily rare and are often tactless – against alleged underrating of the sporting child in team nominations, or concerning the quality of the training, or even questioning the abilities of the trainers themselves, who might be accused of incompetence or unwillingness to accommodate methods conducive to an effective increase in sporting performance. The child's confidence or trust in their own ability to enter and establish themselves in the field of sports depends on a number of everyday experiences: the family environment, school, the time spent shared with peers and, more recently, the perception of sports in the media as the most popular form of mass culture. In cases where the parents in their education methods emphasise the value of performance that is grounded in learning, enjoyment of the result and directing the child towards the management of tasks and achieving victory, there is a greater likelihood of the child inclining towards sporting and physical activities, which by their very nature are associated with endurance, performance and victory ((Ross, Mallett, & Parkes, 2015).

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## AGRESSIVE RHETORIC AND RITUALS IN SPORTS AND INTERFERENCE WITH COMMUNICATION AND MOTIVATIONAL ASPECTS OF TRAINING

Nikša Sviličić<sup>1</sup>, Tajana Obradović<sup>2</sup>

<sup>1</sup>*Sveučilište Sjever, Croatia*

<sup>2</sup>*Funditus, Croatia*

### Abstract

Given that the basic elements of sport are in many ways related to the elements of combat, survival and continued existence as well as the communication structures of military hierarchies, this paper examines the perception and reception of sport through media reports in newspapers and news portals.

The analysis of the case of “Haka phenomenon” simultaneously examines the influence of rituals in the training and competitive process, as well as the influence and importance of spoken words and gestures in the physical conditioning as well as motivational preparation of athletes.

**Key words:** *sport, communication, warrior rhetoric, sport ritualism, motivation, physical conditioning of athletes, Haka*

### Introduction

It is interesting to observe that in all Germanic languages, and not only in them, the word for play regularly serves to describe even the most serious armed combat. (Huizinga, 1992) In addition to stating, “The game is a fight, the fight is a game.”, Huizinga further reinforces this semantic link with the Old Testament example from The Second Book of Samuel - when Abner says to Joab: “Let the young men now arise, and play before us” (...), and “there came twelve from each side (...) and they fell down together, and the place where they fell was henceforth called the Field of the Strong.” and concludes that there can be no question of “poetic licence.” (Huizinga, 1992). Furthermore, far before the play bound by rules, or before the advent of sport, man left traces of the connection of sport, play and life using “drawings depicting sports scenes from hunting and various cultural and religious ceremonies” (Šiljak, 2007: 19). Bearing in mind the connection between play, that is to say sport with combat, war and ritualism, this work comparatively segments, by means of a content analysis method, the warrior terms used in sports news headlines published in Novi list (Stolac, 2003 and 2014) and on the portals of Sportske novosti / Jutarnji list, as well as and Vecernji list and 24 sata (Obradović, 2019), which are then deductively associated with the motivational structure of the training process. At the same time, the paper explores the combination of non-verbal and verbal communication, motivation and physical conditioning and, through a case study of the Haka phenomenon, analyses the relevance and stimulating potential of spoken words and gestures as a motivational (meta) element in the physical conditioning of athletes but also as a motivating, cohesive influence on the audience and connects them to sports results.

### The phenomenon of the play and its connection to warrior rhetoric

Research to date on the meta-phenomenology of sport proves that sport and sporting activities have rhetorical and semiotic elements comparable to war and war activities. Consequently, sports and sports journalism also share a warrior’s vocabulary. The analysis shows that the most obvious example of this word is: victory, defeat, win and triumph and their derivatives that are fully domesticated and officially recognized in sports event reporting. The research of Diana Solac (2003), which notes the pronounced “combativeness” highlighted in the headlines of Novi list “That is, a series of lexemes that are primarily part of military terminology.”

“The military profession and military terminology taking up the first place (...).”

In her paper of 2014 Stolac stresses: “It is stated that the vocabulary whose components of meaning are directly or indirectly related to the concepts of violence, combat, war, derogation and other abstract conceptual domains of negative content and associations can be clearly distinguished.” and that reports on sport activities refer to the military vocabulary: a decisive five minutes, siege, burst of machine-gun fire, duel, crush, defeat to the ground

She states: “An analysis of the headlines of the sports sections of the Novi list daily, conducted in 2000 on a corpus of 1,300 titles (...) showed a high percentage of isolated vocabulary and phraseological expressions, as well as corresponding syntactic constructions that convey messages from the conceptual sphere of warfare.” More recent analyses show that this tendency is on the rise. (Stolac, 2014). The increase in the representation of linguistic discourse in the field of warfare and war activities is also indicated by the results of a study by the author of this paper, conducted on a representative corpus of 4402 titles related to sports events on the news portals of Sportske novosti / Jutarnji list, Vecernji list and 24 sata in the period from 15 November 2017 to 26 January 2018. (Obradovic, 2019). In addition to the already stressed words “win” and “defeat”, which are common in media coverage of sports, it is interesting to discover that the affirmative word “achieve” is almost no longer in use when referring to records in titles - they “collapse” or “fall” in Croatian.

But with records in newspaper headlines, athletes, clubs, and cities also “fall”, when authors want to evoke their defeat in a sports match, and “a fall / to fall”, while stylistically evoking the vocabulary of war losses vividly - “they bravely fell.” Or “they fell without a ‘fired bullet’, “Serbia fell in the Hell Spaladium Arena (...), It is also interesting to note that in the research period, the word “achieve” also replaced the word “score”. In addition to warrior terminology, there are also lexemes that directly allude to death, for example: “‘the executioner’ of Suba“. From the communicological point of view, applicable in the training process of athletes, the title of the coverage from the training of the Croatian handball team on the eve of the 2018 European Handball Championship - “A feature story/coverage from the training - Lino as Balthazar, a handball court as a military training ground and Pero that kills” is also interesting. Such a title directly affects the emotional charge of the reader and the desire to follow the championship, but the effect on the athletes who follow the media coverage of their sport should neither be neglected.

Trifonas also reinforces this thinking by considering Eco’s views on semiotics, football, society and fans (Eco, 2002) - which are applicable to a wider range of sports (author’s comment) - warning us that: “Media apparatus - lexical and visual - actively frames the way football signs are perceived. The cues are constructed in order to affectively target motivated reactions. We could say that they are deliberately directed to realise the ideal of ‘receptivity’ (e.g. surprise, tension, drama (...), thus stimulating emotional associations. Therefore, no image of the play - whether experienced directly or indirectly - can be accessed in its pure form, that is, by itself, without the ideological predispositions of the viewer, influenced by the action of the media or socially constructed reaction”. With Eco’s considerations in mind, it can be proved that the feedback between the audience, the perception of the play or sport and satisfying the need for excitement and having fun, ultimately reflects positively on both the athlete’s perception of self-worth and their performance potential and athletic progress. Trifonas thus states that “what Eco describes as football is not just a sport but a kind of semiotic guerrilla warfare. The systems of signs surrounding this play construct a symbolic field of fan affiliation, communicating an economic value to participants and viewers through media representations” (Trifonas, Eco, 2002). A 2018 study showed that the warrior rhetoric of the authors of headlines in the most widely read Croatian daily news portals does not stop at the abovementioned lexemes, but the Croatian reader follows the “fight”, “skirmish” and even “invasion”, “revolution”, “march” “occupation” and “battle.”

In addition to the term “bomb”, the authors of headlines at Sportske novosti also use the words “bomber” and “to bombard” in their figures of speech - for example “to bombard” from afar... “. Although rarely, the authors of the headlines also use the words: “landmine,” “rocket,” “destroyer,” “missile,” “torpedo,” and “dismantle,” and the word “war”, which appears in its various derivatives (war, warfare, warrior / warriors, cold war, war spectacle) is on the same frequency with “bomb”. The lexemes: “soldiers” / “army” and “colony” have also found their place in the rhetoric of sports headlines.

## **The power of spoken words as a motivational (meta)element of physical conditioning training**

When looking at the history, and also the media-mediated present of the phenomenon of sport, we come to the conclusion of a series of connotative meanings, of a series of codes and signs that make it potent for semiotic readings and studies. Various semioticians throughout history have produced different definitions of both semiotics and sign. Here we shall focus on Peirce, who defines a sign as consisting of “a triple bond between the sign (in the narrow sense) ‘thing signified’ and ‘cognition produced in the mind’ (Nöth, 2004) and sports semiotician Umberto Eco, who states that semiotics “deals with anything that can be considered a sign”. A sign is anything that can be considered to replace something else in a characteristic way. That ‘something else’ does not necessarily exist, or indeed exist, at the moment when the sign indicates it.” (Trifonas, Eco, 2002).

Contemplating the definitions of sign and the presented semiotic-semantic infusion of sport with warrior terminology, the authors have investigated the communicological-semiotic elements of motivational outcomes in the physical conditioning training and competitive process. The aim was to see whether the manner, nature, type and outcome of communication between the coach and the athlete should be the same as the media-presented warrior semantics, if the final result in the form of motivational potential justifies such an approach.

Sport and its media presence are interspersed with myths, and the language of sport abounds in its own semiotic codes. By watching sporting events, we witness a kind of metalanguage of each team before, during and at the end of a sporting event that has a strong motivational effect on the team. The Haka phenomenon is one of the most striking, globally recognised examples of such an effect. New Zealand's Rugby Team is the team with the highest winning percentage (80%) among all rugby teams in the world since the very beginnings of the rugby competition. (<https://www.walesonline.co.uk/sport/rugby/rugby-news/best-rugby-teams-ever-20-7336351>).

The question arises as to the elements of motivation and their effect on the success of New Zealand rugby players, with the often mentioned Haka ritual.

The demonstration of Haka motivation before the match between New Zealand's National Team with France's National Team at 2011 Rugby World Cup titled *The greatest haka EVER?* ([https://www.youtube.com/watch?v=yiKFYTFJ\\_kw](https://www.youtube.com/watch?v=yiKFYTFJ_kw)) recorded 46,039,112 views of the video clip from the upload on 18 June 2015 to 5 February 2020, which confirms the sought-after viral status or huge interest in the content that semiologically goes deep in the sphere of ritual and warrior rhetoric in a broad sense. It is also worth mentioning that the result of a study by Tatiana Dobrescu (2014), which emphasises that personal methodically articulated verbal, non-verbal and paraverbal communication enhances the effects of training because it directly affects the motivational-cognitive awareness of athletes, which indirectly forms the communication basis of the Haka effect.

### The Haka phenomenon and its relation to training and results

The Haka phenomenon has roots in Maori culture and ritual, and although Haka has become known worldwide as a sporting phenomenon, but apart from being used prior to the start of sporting events, it is also used in New Zealand as a motivational element in a wide variety of social situations.

Research have shown that in primary and secondary schools that had Haka as an experimental part of the school curriculum resulted in a stronger connection between primary school students, which was particularly evident from the VLN Primary School example (<https://hail.to/vln-primary-school/article/xtJ08fa>).

Research show that "In the recognition of HAKA power it is obvious that Māori added value to New Zealand's unique identity; the embedding of Māori values (e.g. whanaungatanga, ako, tuakana:teina); increased confidence gained from 'performance'; an appreciation of the different dimensions that contribute to holistic well-being (hauora); an enhanced ability to communicate meaning through visual language eg action songs and haka; physical stamina, fitness and coordination; cognitive stimulation due to the demands of recitation, repetition and memorisation; a sense of solidarity from being in a collective, as part of a team; self-discipline and commitment; exposure to leadership opportunities and role-modelling; personal growth and development; improved confidence and self esteem; enhanced motivation for learning (including reading, writing and visual language through action songs and haka); more positive feelings about school life; improved results in standardised tests." (<https://hail.to/vln-primary-school/article/xtJ08fa>).

In the world of sports, the Haka phenomenon articulates through a verbal and non-verbal communication structure the positive outcome of a sports fight, with the aim of intimidating opponents and personal motivation to achieve maximum results (victories). Elements of the movement were taken from Maori custom rituals before battles, while at the same time a proportion of the semiotic code of tribal rituals and myths carries significance.

The myths "provide interpretive archetypes for deciphering the meaning of the life-world we inhabit by looking at the present through the past. Mythology enlivens reality, translates it and naturalises it, permeating it with levels of ideological significance." (Barthes via Trifonas, 2002) And while Barthes sees myth as a danger because myth allows for the accumulation of layers of meaning within one's own representations of culture and encourages non-reflective practices." (Trifonas, Barthes, 2002), New Zealand's Rugby Team relies on the Maori ritual dance Haka, that has its roots in the myth of the Sun God and his summer wife, for the purpose of motivation before the start of a sports match. <https://teara.govt.nz/en/1966/haka>).

The structured choreography of the Haka elements is called Kapa O 'Pago Haka, and it is especially written and choreographed for New Zealand's Rugby Team. ([https://www.nzherald.co.nz/nz/news/article.cfm?c\\_id=1&objectid=10342926](https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10342926)) The author is dr. Lardell, ethnologist, an expert in Maori customs and psychologist of New Zealand's National Rugby Team. (<https://www.eit.ac.nz/staff/derek-lardelli/>)

Choreography, verbal and non-verbal communication calls for raising awareness of the power and strength of players and their dominance in the play (battle), and it is performed in trainings (abbreviated version with modified parts) and before matches.



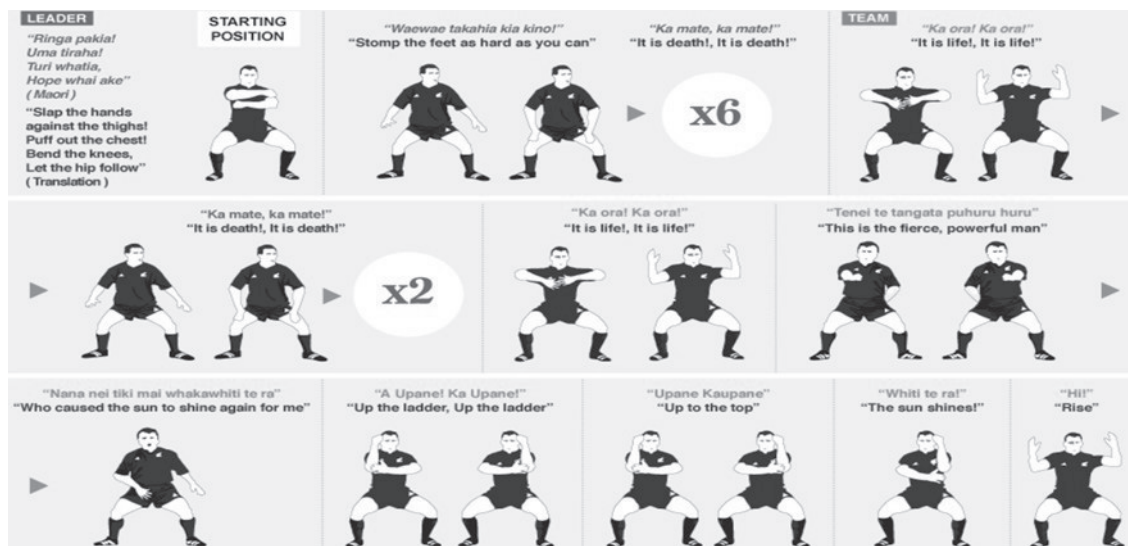


Figure 1. Illustration of the Haka ritual performance

## The key to Haka's effectiveness

Research shows that Haka, in its communicational and presentational articulation, inspires and motivates those who perform it, but the question is whether Haka's ritual rests on improvised or structured verbal and / or non-verbal protocol. In Haka's words (<https://medium.com/new-zealand-thoughts/kapa-o-pango-af120e0b22ad>) it is evident that warrior rhetoric is prevailing, which abounds in the phrases of life, death, last breath, passion, freedom, supremacy, domination, inspiration, desire for a better future... Haka's motivational structure rests on the pronounced congruence of ritual with verbal and non-verbal communication, while the motivational reach of the spoken messages is multiplied. Since its appearance in the world of sports, Haka has been accompanied by numerous controversies regarding the ethics of Haka content and war, that is war choreography: "However, the biggest controversy surrounding the Haka in recent years came in the early uses of the Kapa o Pango, which finishes with a gesture described by some as 'throat-slitting.'" (<https://www.dailymail.co.uk/sport/rugbyunion/article-6368721/How-know-Blacks-haka.html>)

The basis for applying this motivational method and simultaneously the theoretical basis for semiotic elements in the ritual motivational dance of New Zealand's National Rugby Team can be found in the reflections of Tena Marinić on sport. Martinić (1994) suggests that to the already mentioned "ludic" aspect of sport "the desire to improve, try and / or compete should be added immediately." (...) "A play that allows us to freely indulge ourselves in experiencing our own possibilities, physical as well as mental, forms the base of a sporting act and belonging to a group. "The other (...) is always stimulating because he/she urges one to persists in doing. From these indications of the basic determinants of a sporting act, a striking duality is evident: what becomes a play can become a compulsion, the group can turn into a gathering that becomes a threat, and the desire to excel could then turn into a need to undo the other. "At the same time, an example of the phenomenon of purposefully created Haka choreography for New Zealand's National Rugby Team shows that the group conformity of the ceremonial ritual enhances the certainty of top sporting achievements. The Haka phenomenon, by its rhythmic ritualism, leads to the joint elation of the group, which raises the metaphysical component of the belief in the success of the group. The motivational influence of the Haka ritual has a disheartening effect on the opponents of New Zealand's National Rugby Team, which is reflected in: „The New Zealand All Blacks, by far, are the most consistently successful sports team in history over the past 100 + years. Over the past 4 years they have maintained a winning percentage of 94,44 %. Their winning percentage since 1903 is 77.09 %... yes that is a winning percentage of 77.09% over a period of 112 years“. (<https://www.thetoptens.com/best-sports-teams/>)

## Conclusion

Sport has been imbued with symbols, signs, rituals, myths and as such makes a suitable material for reading, study and research in communicology and semiotics, from its beginnings to today's contemporary professional and commercialised sport. Also, Haka-like motivational techniques such as Shadow fighting / non verbal (martial arts) or PETTLEP imagery / non-verbal motivation in high jump have long been part of the programmes of motivational techniques for top-level athletes. Further research into the effects of these motivational techniques as part of the physical conditioning process to improve athletic performance and athletes' final achievement in both team and individual sports may contribute to new scientific insights that would influence the guidelines in the physical conditioning of athletes.

Research shows that war rhetoric and gestures are widespread in the perception of the motivational structure of physical conditioning. Studies of the Haka phenomenon and other mentioned motivational techniques in sport show that both verbal and non-verbal elements of ritual communication further mobilise the quality of sports performance and indirectly exert a positive influence on the final result. Also, it is logical to conclude that the motivational elements in the training structure are largely based on the communication and presentation skills of coaches or professional teams of athletes, and that knowledge of the personality, habits, desires, passions and fears of athletes is a prerequisite for a structured approach in coach-athlete communication. That is to say, knowledge of the personal habits and value system of the athlete gives the physical conditioning coach the opportunity to optimally choose the communication and presentation approach to physical conditioning.

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## FRANJO BUČAR'S ADMISSION TO INTERNATIONAL OLYMPIC COMMITTEE – CAUSES AND CONSEQUENCES

Dario Škegro, Zrinko Čustonja

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

The aim of this paper is to show the pathway of Franjo Bučar, the most prominent person in foundation of Croatian Sport movement and Olympism, to International Olympic Committee. With his cheer, friendly and communicative spirit he easily made new acquaintances, and this was one of his main advantages in his public work. It is shown how political situation and sporting diplomacy were crucial and decisive factors in Franjo Bučar's admission to IOC. Bučar's work in development of Olympism in Croatia can be divided to International and domestic actions. His international reputation was impeccable but due to the political situation in Croatia, and generally political circumstances at that time he couldn't achieve his main goal in his pre-world war one era to ensure appearance of Croatian athletes at Olympic games independently.

*Key words: Franjo Bučar, International Olympic Committee, Olympic games, Croatian athletes*

### Introduction

Today International Olympic Committee (IOC) is well known and in modern society highly appreciated institution. During the developing years at the end of 19<sup>th</sup> and at the beginning of 20<sup>th</sup> century IOC was struggling with numerous problems to achieve set goals within their agenda. First Olympic games, held in Athens in 1896 were very successful in sporting manner especially if we consider "indescribable spectacle", as Coubertine stated, writing about first ever marathon race won by Greek Spiridon Louis. This was encouraging commencement for the young Olympic movement, and the news on this sporting spectacle quickly went all around the World (Kidd, 2013). Despite starting enthusiasm Olympic movement, in his formative years, was dealing with variety of problems. One of the main preoccupations for Coubertine and his associates, especially at the beginning, was to attract as many people from as many countries to promote Olympism, organize, and send athletes to Olympic games. To paraphrase statement of Canadian swimming champion Richard Pound we could say that Coubertine and his associates provided the steak and members of the IOC from all around the world provided the sizzle.

The aim of this paper is to describe and review the path of Franjo Bučar to membership in IOC achieved in 1919. The "road" to IOC for "Father of sport" in Croatia was very interesting and intriguing filled with international and domestic problems and impediments. It is shown how political situation and sporting diplomacy were crucial and decisive factors in Franjo Bučar's admission to IOC. Also, since there are too few research papers in general, investigating his historiographical role in formation of Croatian sport (Čustonja & Škegro, 2017) this is a good opportunity for further investigations.

### Embracing the Olympic idea

In early 1890-ies Franjo Bučar was sent to Stockholm at Royal Central Institute of Gymnastics to bring Swedish gymnastics to Croatia. He was sent to Stockholm from political reasons since Croatia was, at that time, part of the Austro-Hungarian state and threatening Sokol movement was not desirable tool for implementing growing awareness on physical activities in general but especially in public schools. Having in mind that Sokol was valued as national, liberal and emancipation movement (Pavlin & Čustonja, 2018) promoting ideas on poor status of Croats in Austro-Hungaria, development of national awareness it is understandable why official government tried to remove Sokol from public schools.

Bučar's visit and stay in Stockholm was his first step towards Olympism and his future effort in promotion of Olympism. Since Franjo Bučar was openminded and very communicative person very soon he made lots of friends. Luckily, regarding his future engagement within the Olympism he met in Stockholm Jiri Guth-Jarkovsky, Victor Balck, and general Butkovsky all future members of soon to be established IOC. These acquaintances enabled him to receive fresh information on happenings related to IOC and preparation of first modern Olympic Games in Athens in 1896. As soon as the IOC is founded, Franjo Bučar started to write newspaper articles on Olympism and Olympic idea that made him first promotor of Olympism in Croatia (Jajčević, 1991). Numerous newspaper articles and public interest for Olympic idea, and especial modern Olympic Games are evidence that Bučar and some of his colleagues successfully brought

Olympic ideas to Croatia. Still, being part of Austro-Hungaria, Croatia was not independent state and did not get a chance to participate at the Olympic games in Greece. Although, it was great opportunity to seize the membership in IOC while it was establishing, and every nation was more than welcome to take part.

After comeback to Croatia in 1894, Franjo Bučar organized two-year course for Secondary School PE Teachers in Zagreb. This was the first PE College in Croatia and this part of Europe. Course was scheduled from 1894 till 1896. In four semesters 30 elementary school teachers were obliged to take 16 theoretical and practical subjects (Čustonja & Škegro, 2015). After political interventions and resignation of Isidor Kršnjavi, the Principal (Minister) of the Department of Religious Affairs and Teaching of the Country Government of Croatia, Slavonia and Dalmatia, Course was suddenly ended after three semesters, and Franjo Bučar was entering disappointment phase of his young career. In one of his memoirs, after sudden end of the Course, he wrote in disappointment "I was victim of this accident, because my supervision is not going to happen" (Bučar, 1927). This, along with his quarrel with the members of Sokol organization resulted in distancing from gymnastics and sport. In the next period Franjo Bučar was dedicated to private affairs and was absent from public exposure. This goes along with his omission to participate at the Olympic Congress in Le Havre in 1897 despite official call from his friend Jiri Guth-Jarkovsky. It is possible to conclude that this was the first opportunity for Croatian athletes to gain right to participate at the Olympic Games.

### The Olympic Games appearance struggle

Since the first modern Olympic Games were great success and Franjo Bučar regained his interest in sport and Olympism he continued to promote Olympic idea and conception of participation of Croatian athletes at the Olympic Games. Anyway, not much was accomplished to participate at the Olympics held in Paris in 1900. In this period few newspaper articles are documented with information on program of upcoming event in Paris. Due to the complicated political situation in Croatia newspapers that were informing Croatian public on Olympism were abolished and, in that period, there was no more articles related with Olympism (Jajčević, 1991). After the Olympic Games in Paris in 1900, and Olympic games in St. Louis in 1904 Olympic movement was in crisis, and Greek Olympic committee used this situation to organize Olympic games in 1906 as a celebration of 10<sup>th</sup> anniversary of the first modern Olympic Games. This was also a "fresh start" of the Olympic movement that continued at the London Olympics held in 1908 (Beck, 2012). Intercalary Olympic Games in Athens were great opportunity for Croatian developing Sport system to continue with its struggle for sport independence. Franjo Bučar wrote preliminary application to the Greek Olympic Committee and at first answer was positive and encouraging for Croatians. At the same time, since Bučar was clever, he wrote also to Guth-Jarkovsky to ensure support from Czech Olympic Committee to strengthen Croatian odds in foundation of Croatian Olympic Committee and consequently enable international appearance for Croatian athletes (Jajčević, 1991). His friend Guth-Jarkovsky supported and encouraged him in his intentions but complicated political situation in Austro-Hungarian empire was obstacle for further positive development for Croatia. Namely, since preliminary answer from Greece was positive, Bučar sent application for financial support to Greek Olympic Committee and to Croatian government. Hungarian Olympic Committee reacted via Greece embassy in Vienna and warned the organizers that Croatian athletes are part of the Austro-Hungarian Empire and that they should seek their path to Olympic Games through their organization. After this reaction Greek Olympic Committee denied Croatian application and instructed Croatians to contact Hungarian Olympic Committee for all further information regarding the participation at the Olympic Games (Radan, 1966). As mentioned before, this was turbulent period in political life of Croatia in terms of frequent conflicts between Croatia and Austro-Hungarian Empire mainly due to the oppression of the Croatian people, low level of civil rights, imposition of Hungarian language etc. so it was to be expected that this situation will affect relations in the field of sport. After the intervention of Hungarian Olympic Committee organizers instructed Croatian applicants to contact Hungarians since they already received financial support and Croatia is part of Austro-Hungarian Empire. Hungarian Olympic committee offered to Croatians one vice-presidential post in their organization and proposed for athletes to participate at the elimination competitions for the Olympics and to travel to Greece as part of Hungarian team and to perform under their flag. Croatian athletes did not accept these terms and again failed to participate at this great sport event. In Croatian newspaper "Sokol", as the reason of failure Bučar stated "Greek Organization Committee invited to Greece only states and not their national gymnastics organizations" (Bučar, 1906).

Struggle for inclusion of Croatia into International Olympic movement continued in years to come. The most prominent role in this sense again had Franjo Bučar because of his great international reputation.

### Pre-world war I period

After the Intercalary Olympic Games and their great success, many sport journalists and sport workers, including Croatian Franjo Bučar, thought that Greece will permanently remain host of future Olympic Games (Jajčević, 2007). But International Olympic Committee and Pierre de Coubertin continued with the diversification strategy and already planned next Olympic Games in homeland of modern sport and its capital London in 1908. These games were turning point for the Olympic movement in the world since they were great success. Organizing Committee of 1908 London Olympics



built “world’s first purpose-built Olympic facility” and Coubertin himself had only words of praise (Beck, 2012). Political situation in Croatia in this period was still complicated and relations with Hungary were overburdened with problems. In year 1907 there was political change in Croatian government and Hungarian Aleksandar Rakodczay is enthroned as Croatian Ban, so nor sport nor Olympism weren’t important during that period, and not much could be done to improve international status of Croatian Olympism.

Still Franjo Bučar continued to exploit his international reputation and tried to cut in Croatia to International Olympic Committee. During the celebration of 35<sup>th</sup> anniversary of French Gymnastics Federation in Paris in 1908 he spoke in person with Pierre de Coubertin who promised to help Croatia. His proposed that Croatian Sokol Federation should officially sent application for admission to International Olympic Committee (Bučar, 1908). Application was officially sent in 23<sup>rd</sup> of May 1909 but it is received too late, and it was not the part of the official program of Olympic Congress in Berlin held on 27<sup>th</sup> of May 1909. This request was not the part of future Olympic Congresses in 1910, and 1911 either. Turbulent discussions at Olympic Congresses should nations without their own states participate at the Olympics were probable reason that Croatian application was not considered. Olympic games in Stockholm in 1912 were again opportunity for new “negotiations” with Coubertin but since Croatia was not independent state failure was inevitable. This confirms the hypothesis that politics was strong factor in development of International Olympic movement at the beginning of 20<sup>th</sup> century.

### Admission to IOC and conclusions

During the World War One Franjo Bučar was president of Croatian Sports Federation and after creation of new European map and establishment of new states Croatia was part of Kingdom of Serbs, Croats, and Slovenes. This momentum was turning point for Bučar’s admission to International Olympic Committee. Encouraged by Czech Olympic Committee he initiates foundation of Yugoslav Olympic Committee, and indeed the committee was founded in Zagreb on 14<sup>th</sup> of December 1919. Franjo Bučar became first president of newly founded committee and his pathway to International Olympic Committee was defined. Having in mind his previous activities in international sport affairs, his acquaintances in International Olympic Committee and his international reputation admission to IOC was a matter of formality. He became member by unanimous decision during the 1920 Olympic games in Anwers, Belgium. This was the beginning of new chapter in Bučar’s life since despite the newly founded state political problems were still present and it affected intensively the area of sport and Olympism.

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## “SPORTS” CITIZENSHIP

Suzana Šop

*Sport Association of the City of Zagreb, Croatia*

### Abstract

“Sports” citizenship is a legal institute that represents the connection of athletes with the state they represent and for which they participate in sports competitions. The right of foreign athletes to play for sports clubs in the Republic of Croatia is regulated by national legislation and acts of national sports federations. Citizenship of athletes is one of the key presumption for the participation of athletes in various sports activities, but also other legal relations in sports.

*Key word: citizenship, athlete, sport*

### Introduction

The increasing mobility of athletes raises a number of questions related to their citizenship and privileged citizenship status. The right to citizenship becomes an integral part of modern codifications of international law with the adoption of the 1948 Universal Declaration of Human Rights, which guarantees everyone the right to citizenship, emphasizing that no one shall be arbitrarily deprived of his citizenship nor may he be denied the right to change his citizenship (Lulić, Muhvić, 2012). Croatian citizenship, the preconditions for its acquisition and termination are regulated by the Croatian Citizenship Act. Croatian citizenship is acquired by origin, birth on the territory of the Republic of Croatia, birth and by international agreements. The Anti-Discrimination Act, Article 9, prohibits discrimination in all its forms. An exception exists in the approach to sport, if a certain action is objectively and reasonably justified by a legitimate aim and if the means used are appropriate and necessary to the aim to be achieved.

The fundamental rights of individuals and citizens of the European Union are regulated by the provisions of the Charter of Fundamental Rights of the European Union, the Treaty on the Functioning of the European Union and the Treaty on European Union. Citizens' rights are being edited by Articles 39-46 of the Charter of Fundamental Rights of the European Union. Freedom of movement and residence is guaranteed to every citizen of the European Union in a way that he has the right to move freely and reside in the territory of the Member States. Freedom of movement and residence can be, in accordance with the Treaties, assigned to third-country nationals which legally residing in the territory of a Member State (Article 45). Athletes should be allowed to choose the country they intend to represent as professional athletes in order to prevent “buying citizenship”. The Olympic Games, through the past, have been used as “a surface for the inscription of narratives of nationhood and a rather noisy arena of citizenship politics (Kostakopoulou, Schrauwen, 2014.). Athletes' achievements for the national country serve as a means for promotion of national identity and affirmation of national affiliation. Citizenship is a key presumption for participation in various sports activities and legal relations in sports. The European Parliament considers “European sport” to be an inalienable part of European identity, European culture and citizenship. Sport has a special role in society and is considered an instrument of social inclusion and integration (Freeburn, 2009). This article indicates the fundamental determinants and the meaning of citizenship in the field of sports and the relationship with athletes.

### Overview

Citizenship means a legal connection between the state and a natural person - athlete, on the basis of which he acquires certain rights and assumes obligations regardless it is located in the territory of that state or not. Citizenship is a relationship between the individual, social groups, civil society and the state. Citizenship as a concept has a formal and substantive meaning. Formal means membership in the country, and marks the individual as a citizen of a particular country. Substantive citizenship means membership in a community, that is, the possession of numerous rights and duties in a particular state (Zlatković Winter, 2001). Nationality as a term differs from citizenship in that nationality means the affiliation of an individual to a particular nation. The Constitution of the Republic of Croatia protects the rights and interests of citizens of the Republic of Croatia who live or reside abroad and promotes their ties with the homeland. Article 9 of the Constitution of the Republic of Croatia stipulates that the acquisition and loss of Croatian citizenship is regulated by law. The same article regulates the fundamental right of a citizen of the Republic of Croatia not to be expelled from

the Republic of Croatia, he can not be deprived of citizenship and can not be extradited to another state, except when the extradition decision has been taken in accordance with international law or European Union law.

Articles 18-25 of the Treaty on the Functioning of the European Union regulate the rights of non-discrimination and citizenship of the Union. Within the scope of the Treaty, any discrimination on grounds of nationality is prohibited. According to Article 9 of the Treaty on European Union, the Union respects in all its activities the principle of equality of citizens, to which its institutions, bodies, offices and agencies pay equal attention. Every citizen of a Member State is a citizen of the Union. Citizenship of the Union is added to, but not replaced by, national citizenship. Citizenship of the European Union is not of the same nature as national citizenship. A citizen of the European Union retains the rights and obligations arising from his national legislation, but also establishes a specific relationship with the European Union through citizenship of the European Union (Glibo, 2013). The rights of citizens of the European Union are acquired by acquiring the citizenship of a Member State of the European Union, that is, they are derived from the nationality of a Member State. The notion of citizenship as an institution of public law is particularly important in the context of sports law in relation to the athlete. Legal theory points out that the acquisition of citizenship in states is based on one of three basic principles, namely the principle of blood relationship or origin (*ius sanguinis*), the principle of area (*ius soli*) and the principle of residence (*ius domicili*) (Borković, 2002). Various combinations of citizenship are evident in sport in situations where the athlete has performed for three or more different countries. In such cases, we are talking about the so-called "Citizenship for sale" because there are no previous connections between the athlete and the country for which he performs and whose citizenship he has (the athlete and his ancestors were not born in that country). In these cases, the policy of the state whose citizenship the athlete obtains is expressed, and based on the acceptance of citizenship and money as a reward, the athlete and his performance for its national team are expected to make some progress and win medals. The Republic of Croatia allows for changes in the status of citizenship through its regulations, so that citizenship can be acquired through naturalization, loss of citizenship and restitution of citizenship that a person previously had (reintegration).

Given the role of sport through the promotion of national identity, the acquisition of "sports" citizenship should be given considerable attention. Many European citizens are not aware of most of their rights and freedoms arising from European Union citizenship. Citizenship of the European Union, according to many scholars, looks like a symbolic institution that brings little novelty to the existing rights to free movement and residence of European citizens (Apostolovska-Stepanoska, Tase, 2016). The regulations on the citizenship of athletes who can compete for the national team are included in the regulations of national and international sports federations, and for the Olympic Games in the regulations of the International Olympic Committee and national Olympic committees. In the development and acquisition of "sports" citizenship an essential role with the provisions of the Olympic Charter to which athletes foreigners can not compete for a national sports team states in official international competitions if they are not nationals for the reason that athletes who perform for the national team, playing for the country of their citizenship. Every competitor at the Olympic Games must be a citizen of the state whose National Olympic Committee is registering him for the Olympic Games. With regard to the nationality of a competitor participating in the Olympic Games under the provisions of the Olympic Charter, the competitor must be a national of the country of the National Olympic Committee applying for it. All issues related to determining the country that a competitor may represent at the Olympic Games are decided by the Executive Board of the International Olympic Committee. However, a competitor who is a national of two or more countries at the same time may represent only one country, of his choice. Having represented one country at the Olympic Games, continental or regional games and world or regional championships recognized by the gossiping international sports federation, a competitor may not represent another country until he meets the conditions laid down for persons who have changed citizenship or acquired new citizenship. National clubs "buy" players from other countries, while national legislation provides for the possibility of naturalizing foreign athletes through citizenship regulations. It is an increasingly common practice for countries to select excellent athletes by granting "appropriate" citizenships, knowing that such athletes, by winning medals and sporting success, will contribute to the promotion of the country in the world. Trend Olympic citizenship represents an increase of calculated approach to citizenship in which preference is given to people with extraordinary abilities or talents (Shachar, 2011).

According to the Sports Act, Article 62, a foreign citizen may participate in a sports competition for a domestic legal entity that performs the activity of participation in a sports competition under the conditions determined by the relevant national sports federation. A foreign citizen is not considered a citizen of the Member States of the European Union and other countries of the European Economic Area. It is often the case that athletes take the citizenship of one of the Member States of the European Union in order to more easily transfer to some of the European clubs. Athletes who have dual citizenship and athletes who acquired citizenship through naturalization have the biggest problem. Croatian sports federations generally regulate the right of foreign athletes to perform in Croatia by registration regulations, and their right to participate in international competitions is decided by the governing bodies of the federation. Free transfer of players is limited by the fact that most international sports federations stipulate the obligation of the consent of the home sports federation for the participation of an athlete who is a citizen of that country in competitions in the area of competence of another sports federation. A foreign athlete cannot play for the national sports federation because he does

not have the citizenship of the state that the sports federation represents (Mintas Hodak, 2009). States which provide for changes in the citizenship of athletes they regulate this procedure with their national citizenship regulations in such a way as to allow for a simpler procedure for the naturalization of foreign athletes, if this is in the national interest. Croatian legislation regulates this issue in such a way that an alien whose acquisition of Croatian citizenship is of interest to the Republic of Croatia may acquire Croatian citizenship by birth, although it does not meet the requirements set out in Article 8, paragraph 1, items 1-4 of the Croatian Citizenship Act.

An application for the acquisition of Croatian citizenship by an athlete whose admission to Croatian citizenship would be of interest to the Republic of Croatia shall be submitted in person to the police administration or police station. Exceptions are persons with disabilities who can submit a request through a legal representative or an authorized representative. The application is considered complete if the applicant for Croatian citizenship in accordance with the Croatian Citizenship Act submits a privileged opinion on the existence of the interests of the Croatian Olympic Committee, the national federation of the subject sport and the sports club in which it is necessary to explain the Republic of Croatia's interest. of the athlete in question into Croatian citizenship under the facilitated conditions prescribed by Article 12 of the Croatian Citizenship Act and for what reasons such interest could not have been achieved without his acquisition of Croatian citizenship (<https://mint.gov.hr/cesta-pitanja-i-odgovori-21721/21721>, 30.4.2021.). According to Article 3 of the Sports Act, the National Sports Council, as the highest professional and advisory body responsible for the development and quality of sports in the Republic of Croatia, gives a preliminary opinion on the existence of interest in Croatian citizenship in a sports system that is a foreign citizen. and at the request of the state administration body responsible for sports.

## Conclusion

Rules governing the nationality of an athlete through international and national committees require that an athlete who has acquired the nationality of a particular country has the right to compete for that country's national team. An athlete who has participated in international competitions for the national team of a country of which he is a national shall, as a rule, not be eligible to compete for the national team of another country even though he is a national of that State. Athletes who have acquired citizenship by naturalization and athletes with dual citizenship are a special category of athletes who often face elements of discrimination despite the fact that there are regulations prohibiting discrimination on the grounds of nationality. National legislation does not sufficiently regulate the area of citizenship status of athletes, so the regulation of this area is mostly the responsibility of national and international sports federations. Cases of naturalization of foreign athletes are not only a phenomenon in the Republic of Croatia but also in the world. The trend of "buying" players is current in order to strengthen sports clubs and national teams in order to achieve the best possible results. Top athletes agree to change their citizenship to the citizenship of the state sports club, which provides him with better conditions for the development of a professional sports career, but also which enables him better financial and economic stability and security. Cases of naturalization of foreign athletes are not only a phenomenon in the Republic of Croatia but also in the world. The trend of "buying" players is current in order to strengthen sports clubs and national teams with the purpose of achieving the best possible results. Top athletes agree to change their citizenship to the citizenship of the state sports club, which provides him with better conditions for the development of a professional sports career, but also which enables him better financial and economic stability and security.

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## CASCADED CNN FOR PLAYER DETECTION AND AN ADAPTIVE TEAM MEMBERSHIP CLASSIFICATION APPROACH IN ICE HOCKEY GAMES

**Kuan Tao, Tianxiao Guo, Qingrui Hu, Yanfei Shen**

*Beijing Sport University, China*

Accurate player detection and adaptive team membership recognition are important in broadcasting video analysis of ice hockey games. In this paper, we present a minimum cascaded convolution neural network (CNN) and an adaptive team membership classification method for these two tasks, respectively. Our cascaded CNN model contains two-phase classification branches to detect players in the first place and a color-based team membership classification method is used to recognize team memberships of detected players. Experiments were conducted on ice hockey broadcasting videos and the results demonstrated that our cascaded CNN model could accurately detect ice hockey players and our team membership classification method could recognize memberships of players adaptively without extra annotation and artificial process. Our models can also be applied to track ice hockey players in real time and we are confident that this would enhance the player performance as a technological and artificial intelligent approach during training.

**Key words:** *Player detection; Team membership classification; Ice hockey; Deep learning on sports area*



## ANALYSIS OF THE PSYCHOSENSORY STATUS OF PRESCHOOL CHILDREN BY USING TESTS OF THE NTC SYSTEM OF LEARNING

Dario Vrdoljak, Mirjana Milić

University of Split Faculty of Kinesiology, Split, Croatia

**Introduction:** The most important period for brain development and development of cognitive skills is up to the age of twelve, but the first few years of life are especially important. Some studies (Diamond et al., 2006) have shown that cognitive skills depend on the number of synapses, which are mostly formed by the age of five (50%), seven (75%), and twelve (95%). Children carry a great potential for the development of the neural network, but the environment and early stimulation are crucial factors. Early physical activity has a positive effect on intellectual, motor, and health development of a child. One of the indicators of children's current health status is the percentage of obese children and adolescents, which, according to the World Health Organization, has increased from 4% in 1975 to 18% in 2016 (WHO, 2016). Without play and early physical activity, children can develop serious problems in their development. This study was conducted on children, with the aim of analyzing fine motor skills through several easy tests. The importance of this study is in its results, which should serve as an incentive for people in a child's environment to influence and strive to improve the anthropological characteristics of children. The aim of the study was to determine the psychosensory status of preschool children by using tests of the NTC system of learning.

**Methods:** The study was conducted on a total sample of participants (N=50) which included 29 girls and 21 boys attending 4 preschools in Kaštela, divided into two age groups: 4-5 years (N=25) and 5-6 years (N=25). For this purpose, a measuring instrument for monitoring the conditions and elements of psychophysical development of children was applied (Nikola Tesla Center-system of learning; Rajović, 2009).

**Results:** The results of the study showed poor motor skills in preschool children. Of the total sample of participants (N=50), 14% of participants succeeded in performing the test of lifting the index finger and the ring finger (2nd + 4th finger). Furthermore, in the tying shoelaces test, the relative value of successfully performed tests was 24%. In the psychosensory test of catching a ball, 40% of participants had a below-average result, with 7 or fewer balls caught. Significant differences according to gender and age were found in the psychosensory test of tying shoelaces, with the level of significance at  $p \leq 0.05$ .

**Conclusion:** Future studies should increase the number of participants and include a larger number of psychosensory tests in a longitudinal study of motor skills after applying the NTC system of learning. This study emphasizes the importance of early psychophysical stimulation of children.

**Key words:** *early stimulation, psychophysical development, synapses, boys and girls, differences*

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## ANALYSIS OF BASKETBALL PERFORMANCE OF SCREEN SWITCHING IN THE NBA TV BROADCAST

Qiong Wang<sup>1</sup>, Zhongchun Bi<sup>2</sup>, Feng Li<sup>3</sup>

<sup>1</sup>*Department of Physical Education, Beijing University of Posts and Telecommunications, Beijing*

<sup>2</sup>*Chinese Basketball College, Beijing Sport University, Beijing*

<sup>3</sup>*University of Zagreb Faculty of Kinesiology, Croatia*

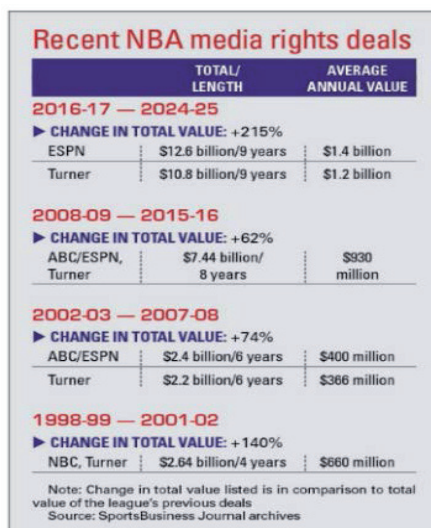
### Abstract

NBA TV broadcast plays an important role in promoting the commercial value, global influence, and the development of basketball. It is one of the main features of the NBA TV production with its excellent broadcast skills, especially in the aspects of presenting the players' techniques, offensive and defensive rhythm of the game. The aim of this study was to observe the advantages of the NBA broadcast and provide references to basketball broadcast staff. The methods of interview, video observation and content analysis were conducted for observing the relationships between the screen switching and the characteristics of basketball tactics in the production of the NBA TV broadcast. The results of this study showed that the "live ball" screen switching after a player scores follows the offense and defense rhythm of the game. In the case of a fast break, transition and pressure defense, in order to prevent the omission of game information, the director does not usually switch screen; following the principle of tactical integrity in the scene of sideline and baseline ball switching, the director displays complete throw-in tactics with the No.1 main camera. This study provides the advantages of NBA broadcast to the staff, enhancing the professionalization of basketball TV broadcasts.

**Key words:** *NBA, TV Broadcast, basketball tactics, switching*

### Introduction

In the United States, five major professional sports events have become an economic benefit chain, and the NBA, which we are the most familiar with, is also one of the most influential professional sports events in the world. While the NBA is not the most watched league in North America, it is the most global and influential professional sports league in the world. The NBA broadcasts games in 215 countries and territories in 43 languages, and fans in more than 200 countries and territories can watch the games on TV or networks (CNBC, 2019). Michael Jordan, Shaquille O'Neal, Yao Ming, Kobe Bryant, Stephen Curry, LeBron James, Kevin Durant and other NBA stars are almost household names. The NBA's annual several billion dollars income not only creates a lot of wealth for its 30 teams, but also generates nearly 3 billion dollars in foreign sales revenue in the United States, among which the television rights (international and national) account for the largest share. Graph 1 shows that the total value of NBA TV rights increased by 215% from 2016-2017 to 2024-25 (ESPN, 2021). TV presents the connotation of NBA culture and basketball through the package of picture art, so more audiences are intoxicated with it. There is no denying the great success of NBA marketing and promotion, but the excellent TV broadcast production team is behind it, the world-class TV production. The professionalization of basketball in television broadcast production is one of the factors that has made NBA television so successful and has followers globally (Fortunato, 2001). In the 1990s, when the close-up switch after a player scored became the mainstream switch mode, the famous



(Resource: Sports Business Journal Archives)

Figure 1. Recent NBA media right deals

CBS executive producer Brian McIntyre said, “If television ignores the rules of the basketball game, it is unreasonable to switch the logic of the game mechanically regardless of the situation after the player scored. When there’s a fast break and a full-court press, people want to see a complete offense.” (Lever and Wheeler, 1993). Since then, the NBA production teams have focused on the application of basketball techniques and tactics in TV broadcasting. (Fortunato. J A,2001). This study aimed to analyze the professional performance of basketball in TV screen switching in different scenes in basketball games.

## Methods

**Interview with experts:** (1) In-depth face to face interviews and letter consultations were conducted with experts from the ESPN production team of NBA TV regarding the production concept, overall process, and practical operation methods in the production process of the NBA TV broadcast. The information from the experts interviewed by ESPN is shown in Table 1. Targeted visits were made according to different positions.

Table 1. Interview information

Name	Position	Broadcast company	Note
Sue Stratton	Director	ESPN	Starting in 1970s as the Lakers' director in the NBA, more than 30 years of work experience
Matthew Kwok	Producer	ESPN	NBA TV Producer
Mitch Riffin	Replay Producer	ESPN	NBA TV Replay Producer
Christina Mixon	Graphics Producer	ESPN	NBATV Producer and Graphics Producer

(2) In order to more accurately grasp and deeply analyze the presentation of basketball specialization in the NBA TV broadcast production, the authors start from the perspective of professional basketball, sending letters of inquiry to domestic basketball experts. The main contents of the interview include professional opinions on basketball skills, tactics and rules presented in the production of the NBA TV broadcasts. The interview information from the basketball experts is shown in Table 2.

Table 2. Interview Expert Information of basketball (n=6)

Name	Position	Affiliation	Note
Li Yuanwei	Senior consultant and doctoral tutor of Chinese Basketball Association	Chinese Basketball Association	Former director of the National Basketball Administration Center
Chi Jian	Vice President, Doctoral Supervisor	Beijing Sport University	Former President of Beijing Sport University
Xu Limin	Coach	Chinese Basketball Association	Head coach of the Chinese National Women's Basketball Team
Yu Zhenfeng	Professor	Capital Institute of Physical Education	Former President of the College of Competitive Sports
Li Sunnan	Doctoral Supervisor	Beijing Normal University	Head coach of women's basketball team at Beijing Normal University
Yang Maogong	Professor	Chinese Basketball Association	Vice Chairman of the CBA Referee Committee

**Content analysis:** the study uses scene as the unit of analysis, observation unit by shots, across different scenes, to analyze the combination switch of basketball rules and plays. The analysis scene codes are shown in Table 3. Coding reliability test adopts inter-coder reliability test using Scott Pi coefficient. The test coefficient value is 0.83, which is greater than the acceptable reliability coefficient of Scott Pi coefficient 0.7.

Table 3. The switching codes table of the basketball specialization rendering scene

Code	Switching scene	Offensive and defensive state after scores	
①	Switching after scores	①A	Switching during Fast break
		①B	Switching during Full-court press
		①C	Switching during Leading defense on the ball handler
		①D	Switching during fast-transition
		①E	Switching No defense in the back-court
②	Switching during base/sideline-throw	②A	Players at the edge of the baseline after the referee submits the ball
		②B	Players at the edge of the sideline, after the referee submits the ball

Based on the qualitative observation of 218 NBA Finals videos, 5 NBA Finals from seasons 2010-2018 were selected by probability sampling. In order to comply with the standards of consistent analysis, the Final Cut software was used to accurately mark the game pictures, and record the switching content, timing, and elements of players in different scenes in the NBA TV broadcasts.

## Results

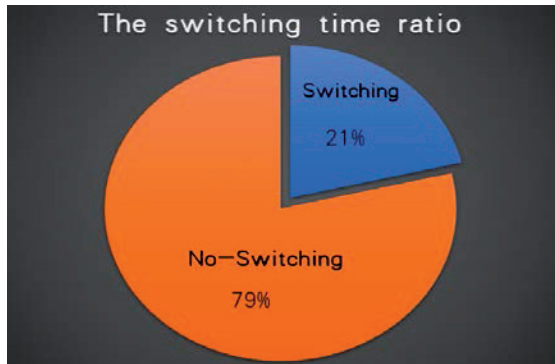
### Switching and professional performance of basketball game rhythm and tactics

The presentation of the NBA television broadcast attaches great importance to the fluency and integrity of the game, which is mainly showed in the sideline and baseline play during the “dead ball” after the “live ball” scores. For the scene of “live ball”, the switching time of players after scoring is divided into five sub scenes for quantitative analysis (Bi Zhongchun,2007), so as to further verify the relationship between the choice of switching time of scenes and the professional presentation of basketball games.

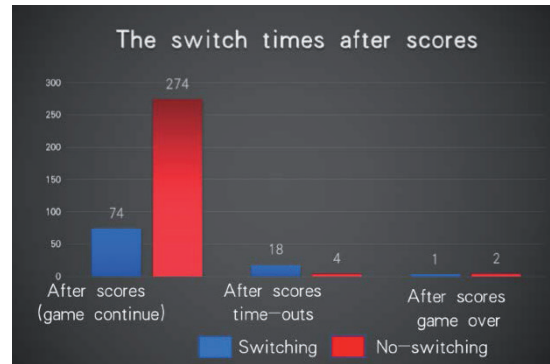
### Close-shot switching and offensive and defensive scenes of the game after players score in the scene of “live ball”

#### (1) The choice of switch-timing after scores

As can be seen from Graphs 1 and 2, switch-timing occurred after scores with a total of 348 times, among which 74 switching times and 274 non-switching times, accounting for 21%. For further analysis, as shown in Graph 3, through the comparison of the data, the back-court undefended scene occupied the main time of switching, which is 69 times.

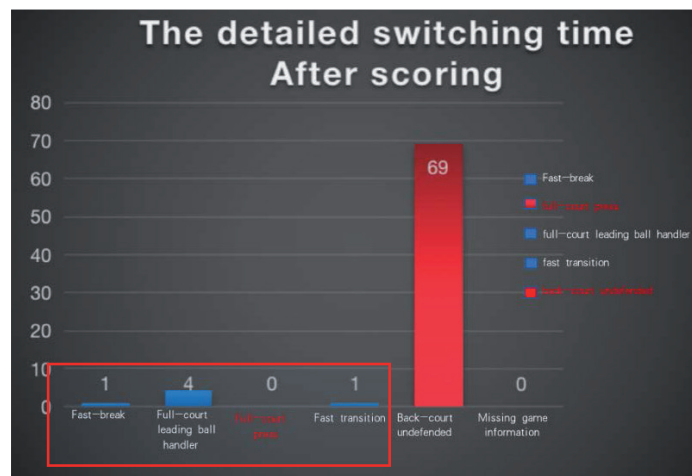


Graph 1. The switching time ratio



Graph 2. The switching times after scoring

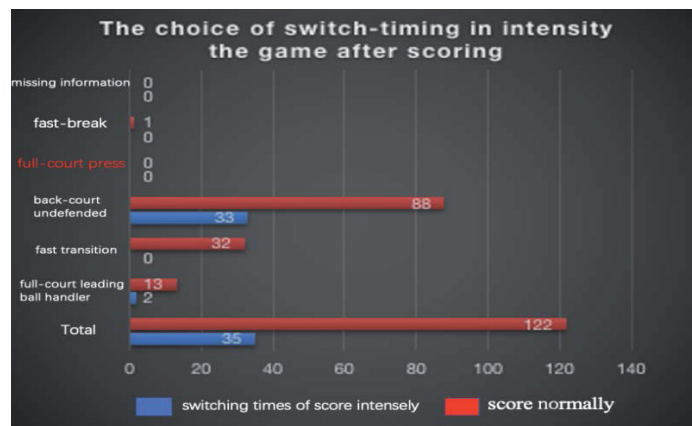
When there are fast breaks, full-court press and fast transitions, the director hardly makes a switch. Only four switches were made during the full-court leading defense scene, and there was no missing information caused by the switch.



Graph 3. The detailed switching time after scoring

**(2) The choice of switch-timing in the intensity of the game after scoring**

As shown in Graph 4, the red column represents the switching times in the normal game, while the blue column represents the switching times in the intensity game. Switched times of five scenes during the games can be seen from Graph 4. During fast attack, full-court press, full-court leading defense or fast transition occur, the director barely switches the screen. Switching 35 times in intense scenes is significantly less than 122 times without switching. When the game was not intense, there were a total of 122 switches, including 88 times undefended in the back court, 2 times fast transition, and 1 time fast break. In the case of fierce competition and fast game tempo, the director also leads the game in a non-switching way to ensure the fluency and integrity of the game.

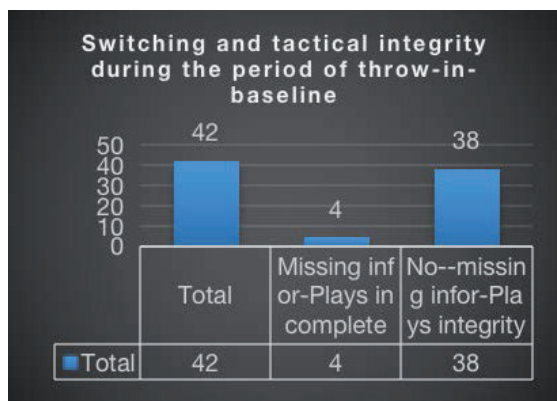


Graph 4. Switching in the match scene during competition

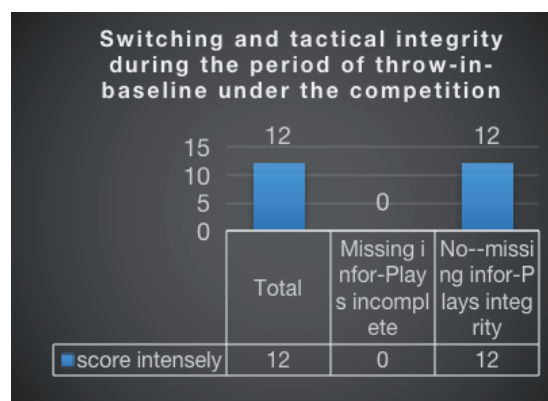


## The relationship between screen switching and the tactical integrity when a team executes out-of-bounds plays (baseline)

As shown in Graph 5, it is found that only 4 times the switches lead to incomplete game information, accounting for 9.5%, while the other 38 times are dominated by complete tactical information, accounting for 90.5%. On the whole, the screen switch shows the complete tactical information of the game.



Graph 5. Switching and tactical integrity during the period of throw-in-baseline



Graph 6. Switching and tactical integrity during the period of throw-in-baseline under the competition

As can be seen from Graph 6, the tactical integrity rate of baseline ball switching is 100% in the tie score scene, and there is no loss of information caused by baseline switching.

## Discussion

We find that the frequency ratio of non-switching in the scene after the score is made, for the following two reasons: first, the smooth presentation of the game should be considered, in order not to affect the viewing experience of the audience due to excessive switching; second, if one team launches a fast break, transition and full-court press, the director generally does not switch in order to avoid the omission of important information in the game (Wang Qiong, Tang Hanlin, Li Zheng, 2017). Otherwise, it is found that the director generally does not switch when the offensive team enters the front-court. The main reason is that once the offensive team moves the ball to the front-court, the players begin to execute plays. Most importantly, the fierce confrontation level between both teams will upgrade. Considering the intensity of the competition, and the fluency of the complete display, at that time the director does not do any screen switch.

For the throw-in-baseline switching, the TV broadcast mainly presents half-court full-shot by using No.1 camera, with few close-shot switches. It is worth noting that baseline plays an important role for team to score directly because it is closer to the basket. When defending the baseline plays, the players have a greater defensive intensity to running without the ball, so the accuracy of the switching is required to a high standard. In a fierce game, therefore, the director is more cautious about the timing of screen switching. Switching-timing of throw-in-baseline plays data reveals that the NBA TV broadcast timing of the switching is in strict accordance with the rules, offensive/defensive tempo and focuses on the integrity and fluency of basketball tactics.

## Conclusions

1) The “live ball” switching scenes after players score abide by the rhythm of the game. In the case of a fast break, transition and tight attack and defense, the director does not usually switch in order to keep the integrity of game information; 2) Following the principle of tactical integrity in the scene of baseline ball switching, No.1 main camera displays complete throw-in tactics. Following the above production methods, the NBA TV broadcast team can not only ensure that the audience receives complete information and wonderful skills and tactics of the game on TV, but it also enhances the professionalization of basketball TV broadcasts.

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## ACCEPTABILITY ASPECT OF RIGHT TO EDUCATION AS A PROVIDER FOR TEACHER SKILLS IN PHYSICAL EDUCATION

Ana Žnidarec Čučković, Katarina Ohnjec

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

Teacher development is a process whereby teachers' professionalism and/or professionalism may be considered to be enhanced (Evans, 2002). To put it more precisely, the process of teacher development includes both the status and the attitude towards the profession. Professionalism refers to the status of the profession and in that regard, it focuses on development of teachers' status professionally. In this paper we will discuss the opinions of PE teachers working in primary schools in Croatia (N=340) regarding skills needed for the performance in PE classes. Emphasis is placed on the skills that support the Right to Education in its acceptability as one of four indicators. The teaching profession needs not only to have the qualities but also strive to maintain them. Teacher professional development is the acquisition of different perspectives and ideas, and the incorporation of a wider vision of what teaching involves, like assuring protection and the development of the Right to Education. Results of the analysis showed that participants in the study do not see skills (as part of competence) as a unique collection of specified skills, but that there is a tendency towards quite independent assessment of the four groups in the incidence of skills, where management skills largely explain complex construct skills of PE teachers.

**Key words:** *PE teachers, indicators of the Right to Education, management skills, instruction skills, motivation skills, curriculum skills*

### Introduction

The aims of education change are depending on the demands of an era requiring more capability. These demands directly affect educational system and teachers are responsible for operating that system with the need of strong and efficient professional competencies. 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." Indicators of the Right to Education most commonly hold a purpose to explore at the macro level with the aim of monitoring some individual segments of this large area at the state level. So, as a fundamental human right, education promotes individual freedom and empowerment and yields important development benefits (Žnidarec Čučković & Ohnjec, 2017). It should be directed at the full development of human personality and the strengthening of respect for human rights and fundamental freedoms. The questionnaire for the assessment of minimum quality of the educational process and general teachers' competences (UPminKOOP) is designed to assess then recognition of the quality of educational processes through indicators of acceptability as one of the aspects of the right to education (Žnidarec Čučković & Ohnjec, 2017). In addition to the acceptability, the right to education is reflected in three other 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). Currently there is an abundant knowledgebase to inform us that in schools teachers play a critical role in students' learning and achievements. Competencies are the skills and knowledge that enable a teacher to be successful. To maximize student learning, teachers must have expertise in a wide-ranging array of competencies in an especially complex environment where hundreds of critical decisions are required each day (Jackson, 1990). This paper explores skills, precisely teachers' skills necessary for conducting the educational process in primary schools. Research confirms this common perception of that link and reveals that of all factors under the control of a school, teachers have the most powerful influence on student success (Babu & Mendro, 2003; Sanders & Rivers, 1996). Across the European region, the quality of PE teacher preparation is diverse and uneven. As Hardman's (2002) research has shown, in Europe, the degree of teaching and qualification of graduate studies is acquired at universities, pedagogical institutes, national sports academies or specialized sports institutes. For primary school teaching, qualifications are usually obtained at pedagogical institutes or universities, while for secondary education, the qualifications are generally obtained at university institutions, including academic and university. In approximately half of the countries, graduates and teachers of physical and health education are qualified

to teach at least one other subject. There is abundant research to support the notion that teachers play the critical role in improving students' achievements in schools. What teachers do in the classroom is crucial in this process. The breadth of high-quality research accumulated over the past 40 years offers educators a clear picture of how to maximize teacher competency. The general framework regarding teacher competencies were explained in nine different dimensions as field competencies, research competencies, curriculum competencies, lifelong learning competencies, social-cultural competencies, emotional competencies, communication competencies, information and communication technologies competencies and environmental competencies (Selvi, 2010). Teachers' competencies affect their values, behaviours, communication, aims and practices in school and also, they support professional development and curricular studies. Thus, the discussion on teachers' competencies to improve the teaching-learning process in school is of great importance.

## Methods

Data for this pilot study was collected in 2015 throughout county education expert council's professional development programs. 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 340 PE teachers in Croatia, consisting of 150 women and 190 men of the average age of 43.

The questionnaire for the assessment of minimum quality of the educational process and general teachers' competences (UPminKOOP) (Žnidarec Čučković & Ohnjec, 2017) was applied. Final version of the questionnaire consisted of 139 items (9 qualification items and 130 items about the application of individual quality indicators). 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 refers 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.

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 sensitivity of items and the total result of the questionnaire was analysed by descriptive statistical parameters: arithmetic mean and standard deviation, and the 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* (Figure 1). 58% of the total variance of questionnaire items were explained by significant main components, of which 30% ( $\lambda=6.18$ ) by the first main component, 12% ( $\lambda=2.58$ ) by the second, 9% ( $\lambda=2.03$ ) by the third and 7% ( $\lambda=1.42$ ) by the fourth.

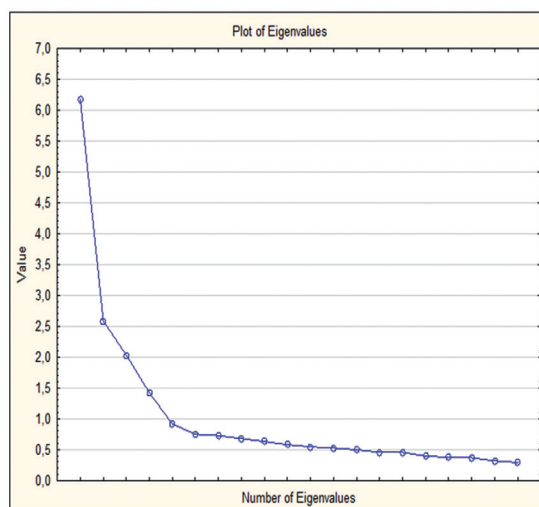


Figure 1. Variances of main components defined by the factorial item analysis (Scree plot)

The rotation of 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 0.53 to 0.81 for the first factor, from 0.61 to 0.77 for the second factor, from 0.58 to 0.81 for the third factor and from 0.61 to 0.72 for the fourth factor (Table 1). The results of the analysis of questionnaire's sensitivity (descriptive statistic) have also been shown in Table 1.

Table 1. Descriptive statistic parameters, factorial structure – factorial set matrix

	Item	Descriptive statistic				Factor			
		M	S.D.	Skw	Kur	1	2	3	4
S1	I believe that PE teachers are fully trained after graduation to work in the classroom	1,89	0,89	1,25	1,37	0,04	0,61	0,13	-0,04
S2	I believe that PE teachers have well-developed athletic skills	1,89	0,69	1,11	2,81	0,00	0,71	0,21	-0,13
S3	I believe that PE teachers have well-developed motivational skills	2,07	0,83	0,91	0,92	0,09	0,73	0,03	0,03
S4	I believe that PE teachers have well-developed organizational skills	1,86	0,78	1,04	1,54	0,09	0,75	0,02	0,22
S5	I believe that PE teachers have well-developed teaching skills	1,96	0,87	0,91	0,43	0,23	0,74	0,07	0,10
S6	I believe that PE teachers have well-developed communication skills	2,08	0,92	0,94	0,64	0,08	0,77	0,07	0,23
S7	I think that a PE teacher should be linguistically literate	1,21	0,49	3,50	19,48	-0,04	0,13	0,28	0,61
S8	I think that a PE teacher should have developed numerical skills	1,60	0,67	1,04	1,33	0,27	0,10	-0,06	0,72
S9	I think that a PE teacher in their work should be focused on solving problems	1,49	0,59	0,90	0,77	0,33	0,17	0,15	0,66
S10	I think that a PE teacher should master oral and written skills	1,37	0,53	1,50	5,03	0,04	0,07	0,41	0,68
S11	I think that a PE teacher must meet the minimum educational standards (university degree)	1,21	0,50	3,06	13,27	-0,14	0,07	0,58	0,48
S12	I believe that the objectives of PE classes support the development of critical thinking	1,93	0,87	0,93	0,84	0,77	0,11	0,09	0,13
S13	I think that in his work, PE teacher develops awareness and capabilities of the local environment	1,82	0,77	1,06	1,77	0,67	0,17	0,07	0,20
S14	I think that in his work PE teacher develops awareness of the importance of health and healthy habits	1,27	0,55	2,68	10,24	0,39	0,01	0,62	0,09
S15	I think that in his work PE teacher develops awareness of sexual and reproductive rights	2,45	1,01	0,49	-0,32	0,76	0,11	0,03	0,04
S16	I think that in his work PE teacher uses methods for the development of critical thinking	1,97	0,88	0,96	0,86	0,81	0,05	0,17	0,06
S17	I think that in his work PE teacher uses strategies of cooperative learning	1,73	0,70	1,42	4,75	0,53	0,00	0,41	0,14
S18	I think that in his work PE teacher supports the students in the creative expression of one's opinion	1,72	0,77	1,08	1,39	0,57	0,18	0,44	0,07
S19	I think that in his work PE teacher uses strategies of non-violent conflict resolution	1,37	0,58	1,76	4,20	0,44	0,04	0,63	0,04
S20	I think that in his work PE teacher develops a competitive spirit among students	1,29	0,51	2,25	8,99	0,18	0,06	0,77	0,10
S21	I think that in his work PE teacher develops fair play and mutual respect	1,18	0,44	3,22	17,47	0,04	0,18	0,81	0,15

The reliability of the total results of the questionnaire have 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 0.87, standardized coefficient was 0.88 and average intercorrelation of items was 0.26.



## Discussion

The first 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 and capabilities of the local environment”, “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 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 must meet the minimum educational standards (university degree)”, “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 fourth 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”, and “I think that a PE teacher should master oral and written skills”.

The items have been grouped in four sub-factors: management skills (including skills and the ability to apply ideas in specific situations and solving complex situations), motivation 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), instruction skills (knowledge and skills specific to the profession) and curriculum skills. Results of the analysis showed that the participants in the study do not see skills (as part of competence) as a unique collection of specified skills, but that there is a tendency towards quite independent assessment of four groups in the incidence of skills to the previously mentioned division, where conceptual skills largely explain construct complex skills of PE teachers.

Participants in this research agree or completely agree with the statements in the questionnaire (AS 1.18 to 2.45), with very small variations in the estimates of individual particles (SD 0.44 to 1.11). While such results are awaited, low arithmetic mean and standard deviation (in the direction of complete or partial agreement) indicate low sensitivity.

## Conclusion

This study was conducted on a heterogeneous sample of PE teachers from primary schools in Croatia. After conducting the pilot studies and establishing the measurement characteristics of the questionnaire, we used this questionnaire on a pattern of PE teacher in primary schools in Croatia that allows us 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. Unique set of circumstances in modern classroom is bound to transform through time as education itself does. Recommendation for future research lies in deeper exploration of skills detected within research such as: online collaboration, adaptability, time management, tech fundamentals, patience, teamwork, organization, creativity, constant learning and healthy parent communication. Research limitations are noticed throughout lack of previous studies in the research area, so the depth of discussion provides scope for a certain point focused on the most contemporary and evolving research problem.

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# Sports Recreation

## 9<sup>th</sup> INTERNATIONAL SCIENTIFIC CONFERENCE ON KINESIOLOGY

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# DIFFERENCES IN MORPHOLOGICAL CHARACTERISTICS, MOTOR ABILITIES AND FUNCTIONAL CAPACITIES BETWEEN STUDENTS OF FOOTBALL AND RECREATION SPECIALIZATION AT THE FACULTY OF EDUCATION IN OSIJEK

**Hrvoje Ajman, Josip Cvenić**

*Juraj Strossmayer University of Osijek Faculty of Kinesiology, Croatia*

## Abstract

This study was carried out with the aim of determining the differences in the morphological characteristics, motor abilities and functional capacities students of football and recreation specialization who were full time students at the Faculty of education in the school year 2017/2018. The sample of 30 subjects was divided into two sub-samples: the Football specialization, which numbered 15 subjects, all of students had participated in specific football based education and the Recreation specialization, which numbered 15 subjects, who had participated in specific recreation based education. The sample of variables consisted of age, body height, body weight, body mass index, fat percentage, muscle mass percentage, 1500 meter running, maximal pull up number, bench press and squat repetitio maximum. By using the T-test for independent samples we obtained results which indicate that the students of Football specialization differ significantly from the students of Recreation specialization in morphological characteristics and functional capacities.

**Key words:** *students, morphological characteristics, strength, functional capacities*

## Introduction

It is well known that physical activities and sports have a positive impact on health, physical development and functional capabilities (Morris, Froelicher, 1991; Vadasova, Balogha, 2012) in the adult and university students population. Evidence also suggests that the link between the society and the individual has a significant effect on health and the health habits of youth (Davison, Lawson, 2006; McNeill, Kreuter, Subramanian, 2006). The main goal of experts in kinesiology is to positively affect increasing the physical fitness level of the population and decrease the negative effects of a sedentary lifestyle. A high level of motor abilities is one of the main predictors of successful participating in kinesiology education programs at the Faculty of education. Basic motor skills and functional capacities are the base for the realization of all the specific kinesiology programs. According to that selection criteria for participating in university programs are conducted and the selection process has been provided. Sport and recreation specific program requires student's optimal level of morphological characteristics, motor abilities and functional capacities. Through the program, the students learn and demonstrate a great number of motor patterns and sport and recreation specific movements and skills. In the literature review the great number of studies are focused on morphological and motor development of Croatian student population (Sporiš et al. 2005; Sporiš, Tomić, Ujević, 2004; Mašina, 2019; Cebić, Habuš, Vidranski, 2011). According to previous studies, the main aim of this study was to investigate the physical fitness of kinesiology students measuring and testing morphological characteristics, motor abilities and functional capacities and differences between two groups, football and recreation specialization.

## Methods

The participants were students of Football and Recreation specialization who were full time students at the Faculty of education in the school year 2017/2018. The sample of 30 male subjects was divided into two sub-samples: the Football specialization, which numbered 15 subjects, all of students had participated in specific football based education and the recreation specialization which numbered 15 subjects, who had participated in specific recreation based education.

The sample of variables consisted of morphological characteristics: body height, body weight, body mass index, fat percentage, muscle mass percentage, motor abilities measured by: maximal pull up number, bench press and squat repetitio maximum and functional capacities measured by 1500 meter running.

Statistical data processing was conducted using a software package Statistica ver. 10.0 for Windows. The basic descriptive statistic parameters were calculated (mean, standard deviation, minimal and maximal score) for all variables. Distribution normality was tested using the Kolmogorov-Smirnov test. Statistically significant differences between groups



of different study specialization were tested using the T-test for independent samples. All analyses were calculated at statistical significance level of 0,05.

## Results

Results of Kolmogorov-Smirnov test indicated that all variables in the study are normally distributed. Basic descriptive parameters and results of the T-test for independent samples for all variables are presented in Table 1.

Table 1. Basic descriptive parameters and differences between subject groups

	Football specialization				Recreation specialization				t	df	p
	Mean	SD	Min	Max	Mean	SD	Min	Max			
BH	181,75	5,64	170,60	192,00	183,60	7,05	170,40	196,90	-0,79	28,00	0,43
BW	77,03	7,77	67,80	96,90	82,32	8,92	68,20	99,00	-1,73	28,00	0,09
BMI	23,25	1,55	20,80	26,30	24,37	1,85	20,80	27,30	-1,80	28,00	0,08
FAT	16,88	4,21	8,00	23,30	20,93	5,23	12,80	30,20	-2,34	28,00	<b>0,03*</b>
MM	41,91	2,47	37,60	47,00	39,69	2,94	33,50	44,50	2,24	28,00	<b>0,03*</b>
AGE	19,87	2,03	18,00	26,00	20,67	1,88	18,00	25,00	-1,12	28,00	0,27
1500m	5,28	0,38	4,54	6,12	5,83	0,42	5,08	6,32	-3,74	28,00	<b>0,00*</b>
PULL UP	9,33	3,44	5,00	18,00	10,33	3,15	5,00	17,00	-0,83	28,00	0,41
SIT UP	66,07	3,53	60,00	72,00	63,13	5,04	57,00	79,00	1,85	28,00	0,08
BENCH	79,50	12,35	62,00	100,00	83,80	11,51	67,00	110,00	-0,97	27,00	0,34
SQUAT	114,60	9,83	100,00	130,00	119,40	14,13	90,00	151,00	-1,08	28,00	0,29

BH- Body height (cm), BW- Body weight (kg), BMI- body mass index, FAT- fat percentage (%), MM- muscle mass percentage (%), AGE- participants age, 1500m- running test (min), PULL UP- maximal pull up repetitions (reps), SIT UP- maximal sit up repetitions in one minute (reps), BENCH- bench press maximal repetition (kg), SQUAT- squat maximal repetition (kg)

Results indicated significant differences between groups in variables percentage of body fat, muscle mass percentage and 1500m running. There were no significant differences in motor abilities between two groups of participants.

## Discussion

The results of this study indicate significant differences between groups in variables, percentage of body fat, percentage of muscle mass and 1500m running. Students who participate in football specialization program have a lower percentage of body fat, a higher percentage of muscle mass and better result in 1500m running functional capacities test than students of recreation specialization program. These results are expected because students who participate in football specialization program are mainly still active football players on a different level of competition. Football specific program group is active in football training or in football coaching, which requires a lot of running activities with and without the ball and many contact activities with the opponent player. Training with incorporated high intensity running activities is in high correlation with lower body fat percentage (Smith-Ryan, Melvin, Wingfield, 2015) so it is expected that football specialization group has lower values of body fat percentage than recreation specialization group.

Hoff (2005) has concluded that elite football players using a maximal strength training at high loads, with the emphasis on fast mobilization of force in concentric actions, has resulted in a good training response in terms of aerobic endurance, due to improved running economy as well as improvements in sprinting and jumping height. Also, Kumar (2016) in his study on male subjects from the Department of Physical Education has determined that the Circuit training had significantly improved the speed, leg power, arm power and agility of subjects. The results of this study are confirming these conclusions because football specialization group has higher values of muscle mass percentage than the recreation specialization group.

Differences in functional capacities between groups are also expected because the football is high intensity sport with specific aerobic-anaerobic demands and football specialization program group is significantly better in the test of functional capacities. Mcmillan et al. (2005) have determined a higher level of maximal oxygen intake and running economy in youth football players after 10 weeks program which was based on aerobic interval training sessions twice per week. In this study, no significant differences in motor abilities between groups have been determined. Finally Mythri (2019) observed arm power, leg- power and agility variables between Football and Handball Bangalore university players but these were insignificant. It was found that Football players are better in speed, leg power and agility whereas Handball players are superior in arm power.



It has also concluded that sport-orientated students are on a higher level in physical fitness than other university students. These findings are not in match with the results of this study the reasons can be found in a similar basic programme of kinesiology students in Faculty of education in Osijek.

## Conclusion

Students from the football specialization program differ from the student's recreational specialization at a statistically significant level in body fat percentage, muscle mass percentage and functional capacities. Football program group is still or was in the past engaged in high intensity running activities which are in high correlation with lower body fat percentage. Also, because of the great number of contacts with opponent's, high intensity training and specific strength and power training muscle mass percentage of football specialization group is greater than the recreation specialization group. Football is a high-intensity sport with significant running mileage and because of its specific training program football specialization group performed better in the functional capacities test.

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## THE HISTORY OF SPORTS TOURISM AT THE “RIVIERA” IN POREČ AT THE TIME OF SOCIALIST YUGOSLAVIA

Loris Benassi<sup>1</sup>, Hermina Maras Benassi<sup>2</sup>

<sup>1</sup>*Juraj Dobrila University of Pula, Faculty of Educational Sciences, Croatia*

<sup>2</sup>*Juraj Dobrila University of Pula, Faculty of Interdisciplinary, Italian and Cultural Studies, Croatia*

### Abstract

This paper presents the development of sports tourism at the *Riviera* in Poreč from its foundation up to 1990, on the basis of archive sources, the press of the time, other literature etc. Tourism in the Poreč area, like most coastal towns in Istria, developed intensively in that period, especially in the 1970's and 1980's, when it became the prime mover of the municipal economy. At that time *Riviera*, as one of the largest tourist and hospitality organizations in the country, devoted a great deal of attention and financial resources in providing sporting and recreational facilities, becoming the top provider of selected forms of tourism in Yugoslavia.

**Key words:** *sporting activities, sporting and recreational facilities, Riviera, the Poreč area, Socialistic Federal Republic of Yugoslavia*

### Introduction

Tourism and sport are the two greatest social phenomena of the 20<sup>th</sup> century (Relac, 1979). At the beginning of the 1950's, the development of contemporary tourism was characterised by very dynamic changes, both in the realm of the offer for tourists, and in the realm of tourist demand. In this regard, the new role which sports and recreation played in contemporary tourism must also be considered (Čavlek, 1999: 93). From the middle of the 20<sup>th</sup> century, the function of sport in tourism gradually took on a new, more humane and focused purpose. “These were sporting activities that became an integral part of tourist services, which enriched the tourists' stay and gave them the possibility of an active vacation, being involved in different activities than their usual work.” (Relac, 1979). As a result, in contemporary tourism sport became not only one aspect of a stay, but also frequently the main motive for travelling to a specific tourist destination. Selective forms and types of tourism rely precisely on the reason why people travel to specific destinations. Amongst these specific forms of tourism, for the needs of this paper, we can mention recreational, health and sports tourism in particular, where sport is the main motive for travel and stay by a tourist (Bartoluci, 2003). The paper will emphasise in particular two forms of sports tourism, that is, summer sports and recreational tourism, and competition sports tourism.

The tourist entities in the Poreč area, in contrast to many other coastal tourist centres in Yugoslavia, recognized from their very foundation, and especially during the 1960's and 1970's, the many advantages of investment in the provision of sport and sports infrastructure in good time. There was targeted investment in recreational sports facilities, which would be of interest and accessible to a wide range of users.

At an international conference on the economic value of recreational sport in tourism, organized in Poreč in 1971, the sports journalist Hrvoje Macanović wrote: “Poreč can be an example to many. Its natural beauty and the material facilities that have been built left a very powerful impression on all the participants in the international symposium. Sport and recreation are included in the tourism life of Poreč in such a way that in that sense it is almost unique.” Hakija Pozderac also chose his words when writing about Poreč. He was the president of the Physical Education Association of Yugoslavia and when opening the federal games of the Social Accounting Service in 1976, he said, amongst other things, “I am very proud to greet you on the soil of our beautiful Istria in the most sporting tourist town in Yugoslavia ...” (Barjaktarević, 1977: 44-46). The writer goes on to point out that at that time Poreč had grown to be the strongest centre of mass tourism in Europe, whilst the Poreč area had the greatest concentration of accommodation facilities in Yugoslavia and Europe.

In the light of the above, the basic aim of this paper is to present the path of development of the provision of sports and recreational facilities in *Riviera* in Poreč, one of the largest tourist organizations on the Yugoslav Adriatic coast, during the time of socialist Yugoslavia.

## A brief overview of the beginnings of tourism in Poreč from the middle of the 20<sup>th</sup> century

In the early post-war years, in line with the Yugoslav politics of that time, most visitors were from this country. The main body responsible for accommodation services and organizing entertainment and recreational activities was the city hospitality company, known simply as *Poreč*, founded in 1947. It had various forms of accommodation available (4 hotels, 1 villa and 1 castle), three inns, two restaurants, one pastry shop and one swimming pool (HR-DAPA-303). At the end of 1953, it ceased to exist and by a decision (no. 1994) of the People's Committee of the Municipality of Poreč, on 20<sup>th</sup> November of the same year the hospitality enterprise *Riviera* was launched founded upon it, named after the first hotel built in Poreč in 1910 (*Riviera Adria*, 2013). In the middle of the 1950's about 8 000-9 000 guests stayed in Poreč each year, of whom more than 50% were Yugoslav tourists, who accounted for 70 000-80 000 overnight stays (*Barjaktarević*, 1977; *Plava laguna*, 1997). At that time, the Poreč area turned increasingly to tourism as a new branch of industry, pushing agriculture and fishing, which had until then been the mainstays of the economy, into the background. In the early years after their foundation, all the tourist entities in the Poreč area recorded continuous growth, which was primarily the result of the general economic and political circumstances in the country at the end of the 1950's. That is to say, on the level of the whole country, the gradual liberalization of movement by the population and the opening of the state borders to foreign tourists took place, whereby the number of tourist visits increased, especially in terms of foreign arrivals (*Šarić*, 2015). This was the beginning of the tourist boom which took place in Poreč and Istria, and the period when the foundations were laid for the further development of tourism, which meant that Poreč became one of the most important tourism centres on the eastern Adriatic coast (*Vukonić*, 2007).

## The history of sports tourism at *Riviera*, Poreč

The history of sports and recreational services within the work organization *Riviera*, one of the initiators of Yugoslav tourism, began in the middle of the 1960's on the island of Sveti Nikola, south-west of the centre of Poreč. Up until then, it had only had one structure to offer for physical activities (HR-DAPA-103). From 1963 to 1965 investment increased and the entire social community gave precedence to investment in tourism (*Pašiček*, 1983). Apart from restoration of existing structures, new ones were also built, and investments were made in provision of facilities for tourist expenditure outside of their hotel package. The first facilities on the mainland were crazy golf courses, bocca courts and table tennis tables, and in subsequent years the number of beach loungers and facilities for use on the sea itself increased.

At the beginning of 1966 expansion began outside the town, with the construction of accommodation spreading into more distant attractive locations. Within the new apartment complex, *Luna*, and the later construction of a hotel with the same name right next to it, a small sports centre was opened by the beach, providing facilities on the sea and land (*Pašiček*, 1983). The facilities were mainly in the form of canoes, rowing boats, table tennis tables and a crazy golf course (*Relac*, 1979).

One year later, construction began to the north of the town of the future tourist giant, *Lanterna*. In the years that followed hotels, villas, apartments, camp sites and three sporting and recreational centres were built in that tourist settlement (*Lanterna*, *Lanterna Camp*, and *Solaris*). They included a wide range of sporting services and facilities, on the sea and land, of which we should mention in particular: water skiing, boat rides, sailing, windsurfing and universal sporting facilities, horse riding, table tennis tables, an air rifle shooting range, crazy golf courses, tennis courts and many others. There were also schools for water skiing, sailing, tennis and riding (*Relac*, 1979).

The first tennis court was built in *Riviera* in 1970 in the *Brulo* sports centre, in the bay of the same name to the south of the town. Alongside two tennis courts, with clay surfaces, and the other usual facilities on the land, the centre paid particular attention to providing activities on the sea, and later a diving centre. As the *Brulo* hotel resort spread to include new hotels, the centre became increasingly important and supplemented its offer with new, more diverse content (*Relac*, 1979). In 1973 the management concluded that none of the hotels with a large sports centre should be without a tennis court. One year later they hosted the famous international Alpe-Adria cycling race, which started in the *Brulo* tourist resort, and the state chess championships of Yugoslavia for men and women, in the hotels *Neptun* and *Riviera* (*Riviera Adria*, 2013). With the construction of the *Diamant* hotel in 1975, the Riviera Work Organization (hereinafter WO) raised its entire sporting offer to a higher level. That is to say, it was the first hotel in the Poreč area to include a sports hall large enough for handball matches. This also meant that the entire hotel complex was able to extend the tourist season and led to the arrival of many sportsmen and sportswomen, and teams for preparation, especially in indoor sports, from this country and abroad. As well as the halls, there was a large automated bowling alley, spacious changing rooms and auxiliary facilities. In the hotels, staffing and programmes were subject to special requirements for all types of active vacations (A-category: PAO a and b; B-category: AO; C-category: AO and D-category: AO), for holding professional conferences, seminars, courses, events and preparation of sportsmen and sportswomen, as well as holding sporting and recreational competitions (*Relac*, 1979). In the same season it opened, the hotel hosted many Yugoslav Olympic athletes preparing for the 21st Olympic Games in Montreal, Canada. Some of them won medals at that competition (the canoeist Matija Ljubek, the boxing and basketball teams...). Of all the many sportsmen and sportswomen, and the sporting events hosted by this hotel and sports centre over the years, the first World Junior Bowling Championships should be mentioned in particular, held in 1983 (*Bulletin*, 1983).

At the beginning of the 1970's, the work organization was expanding continuously and it took other enterprises under its wing, not only from the municipality of Poreč of that time, but also the whole of Istria. The first important structure included in the growth of the offer for tourists was the hotel spa complex known as *Istarske toplice*, near Buzet (Pašiček, 1983). Two years later the tourist resort *Pical* was merged with the *Riviera* complex, including three structures used for physical activities (HR-DAPA-103). In that same year, 1972, a new sports centre was opened, with a wealth of sporting options. In terms of the facilities on land, table tennis tables accounted for the largest number of items (12), then beach volleyball pitches, crazy golf courses, two tennis courts, and bicycles, and on the sea, canoes, paddle boats, motor boats, sailing boats and others. The centre regularly organized popular table tennis tournaments for its guests, and the especially popular beach volleyball competitions. The first hotels, *Zagreb* and then *Pical*, were built immediately adjacent to the sports centre between 1972 to 1982. The *Pical* was the first A-category hotel in *Riviera*. The building included two semi-Olympic swimming pools, with heated sea water, of which one had a half-covered area for spectators, seating 200 visitors.

Over the three decades of its life, the *Riviera* resort built seven sports and recreation centres. The provision on land comprised: tennis courts (29), table tennis tables (27), crazy golf courses (29), volleyball courts (4), five-a-side football pitches (2) and basketball courts (2), then a bocce court, horses for riding (7), an automatic four-lane bowling alley, a hippodrome, a sports hall, indoor heated swimming pools (2), 104 bicycles etc. For water sports, the following were purchased: speedboats (4), motor boats (54), rowing boats (61), sailing boats (25), canoes (60), windsurfers (12) and sporting equipment for hire for water sports (Prekalj, 1982).

From year to year, *Riviera* recorded increasing success in terms of its business results, and should have allowed its employees to feel the benefits of that success. The union of Poreč tourist workers and the Physical Education Faculty of the University of Zagreb undertook tests of the physical health of the tourism workers in the Poreč area in 1979, and the results they found were not encouraging. After examining all the needs of the employees, work began to organize quality rest and recreation for all the staff (Pašiček, 1983). A programme of sports and recreation was launched in 1980. Physical exercises were organized every week for 2500 employees (Riviera Adria, 2013). Moreover, a Self-managing Agreement on Rest and Recreation for Workers was passed by referendum, along with Regulations on Organization and Implementation of Rest and Recreation of Workers and the use of resources for that purpose. These acts made it possible for employees to make better use of planned rest times, with recuperation in climatic health resorts, organized annual leave, active weekly and daily rest periods, and a wealth of sporting and recreational activities. It should be emphasized that all the rest and recreation activities were run by physical education experts, specialists in recreational sports from the work organization. In order to make good use of rest and for the many sporting activities provided, significant financial resources were needed, which were acquired by provision from the final balance of each Basic Organization of Associated Labour (hereinafter: BOAL), that is, 5% of the revenues earned, whilst employees contributed 30% of their holiday pay (Pašiček, 1983). The quality of the recreation programme soon became well-known, and workers from other areas of Yugoslavia came to Poreč for organized active vacations, especially from the interior (Riviera Adria, 2013).

In construction of facilities for tourists, priority was given from the very beginning to market requirements. All the structures that were initially intended solely for providing accommodation services and food and drink, were supplemented over the years by many attractive additions for additional tourist expenditure. Sporting and entertainment facilities became the top priority. New sports centres were built and old ones extended, especially in the *Turist* camp site in Vrsar and *Istra* in Funtana, and the tourist resorts *Lanterna*, *Brulo* and *Pical*, where significant construction also took place of a large number of tennis courts. The sporting facilities in *Pical* were also enriched and rounded off before the 1984 tourist season by a new tennis centre with ten courts. As luck would have it, the tenth court was the one hundredth tennis court in the Poreč area (Orlić, 1984). The traditional international tennis tournament known as the Istrian Riviera was held in that tennis centre the following year (Kramer, 2007). In those years, the *Pical* sports centre incorporated the sub-centres in the hotels *Pical*, *Zagreb*, *Luna* and the island Sveti Nikola. It became the largest sports centre in *Riviera* in terms of revenue, the number of employees and the content offered, both on sea and land (Orlić, 1984).

One year before the joining together of the enterprises in the Poreč area, the *Rivierasport* Working Unit of Associated Labour had nine sports centres and sub-centres, offering about seventy different sporting activities on land and sea. The most attractive were motor boats, tennis courts and crazy golf, and the total revenues reached 40 million dinars (approximately 131 147 \$, without revenues from hospitality services) (Komin-Perhat, 1985).

With the construction of two (clay) tennis courts in 1990 in the *Lanterna* tourist resort, the enterprise rounded off the number of courts to 60, which was an absolute record in the offer for tourists in the Poreč area (Prodan, 1990), and most probably along the entire length of the Adriatic coast.

As the enterprise continued to develop very rapidly, the organization of its operations changed at different stages, adjusting and improving. However, the individual units (the lowest form of association) of the sports never formed separate BOALs. For the longest period of time they were part of the *Rivieraturist* BOAL, which united work of joint interest for all the hospitality BOALs, including market research, sales of accommodation, tourist propaganda in this country and abroad, and organization of sports and entertainment (Pašiček, 1983).



## Sports tourism as an associated enterprise in the Poreč area

It should be pointed out that sporting services of all three work organizations in the Poreč area, many years before their formal association, worked together as appropriate and showed that it is possible to work in association on specific projects, jointly and therefore rationally. Their cooperation was seen most clearly in the exchange of experience in the procurement of sporting equipment, alignment of the dates of sporting tournaments and regattas, joint procurement of the materials needed, printing of common forms and graphics for the needs of the sports centres, etc. (Tomičić, 1984).

From 1987 to 1989 the tourism enterprises of the Poreč area (*Plava laguna*, *Riviera*, *Turist-biro*, and *Anita*) acted together in the combined conglomerate known as the *Plava laguna* Composite Organization of Associated Labour (hereinafter: the COAL). In this way the sporting activities of all three work organizations were united into the newly formed *Sport i nautika* BOAL, which comprised three work units: *Lagunasport*, *Intersport* and *Nautika* (*Plava laguna*, 1997). The 34 sports centres were divided, in terms of location, into north and south. The area of rest and recreation for workers was regulated jointly for the entire COAL by a self-managing agreement on joint organization and implementation of recreation for workers, and on provision of resources for that purpose. In addition, the *Workers' Rest and Recreation Service* was founded, whose basic tasks were to create plans and programmes, and coordinate, verify and realize them. The most important activities of the Service were to organize and implement sporting competitions for workers of the *Plava laguna* COAL, conferences for hospitality and tourism workers on the Adriatic, sporting and recreational activities, planned active medical vacations (hereinafter: PAMV) and active winter vacations. Every worker, according to the regulations, was permitted to make use of one form of vacation lasting 10 to 14 days, once a year. They paid only 30% of the total costs to use the COAL in specialized recuperation centres not in their place of residence, whilst the remainder was covered by the enterprise, 35% from the material expenditure of the BOAL/WA, and 35% from the rest and recreation fund (Vrus, 1989). In the last year of the work of the Service, it recorded excellent work and record results. "3650 workers were involved in various forms of activities organized by this department, which is about 2000 more than in the previous year" (Baronica, 1990). The most interest was shown in using annual leave in the snow, and in spas, taking part in the *Plava laguna* games, COAL programmes in spas, recreation in their place of permanent residence, tennis schools, swimming lessons, and appearances in the Adriatic meetings in Portorož.

The second half of the decade brought significant economic benefits for Yugoslav tourism. The Poreč enterprises held high positions in the tables of economic achievements in sports tourism even before they formed the association. According to the results of a survey on recreational sports conducted by the Committee for Tourism and Sport of Yugoslavia at the end of the 1970's, the first two places were held by *Plava laguna* and *Riviera* from Poreč, whilst *Anita* from Vrsar was in sixth place (Orlić, 1978). Through their amalgamation they became unbeatable to all their Adriatic competitors, which is clearly shown by the official statistical results. In the first business year, the *Sport i nautika* BOAL had almost 160 permanent employees and 110 seasonal workers, and earned a rough estimate of approximately one billion dinars (approx. 791 765 \$), with income of 680 million dinars (approx. 538 400 \$) and 200 million dinars (approx. 158 353 \$) income remainder. Apart from this direct economic indicator, a significant role in the business was played by indirect economic indicators realized in the form of "sporting overnight stays" for preparation by sportsmen and sportswomen, workers' sporting events, organized active vacations (especially the COAL), use of tennis courts, sports seminars, conferences, courses and the like (Bartoluci, 1999; Relac and Rubeša, 1988). According to an overview of "sporting overnight stays" in the period from 1986 to 1989, Poreč accounted for 500,824 which was a share of 6%. In comparison, its first Yugoslav competitors (Umag and Rovinj) achieved only 191 800 and 89 680 overnight stays, respectively (Bartoluci, 1999). The average number of users per type of recreation in the same period was: 133 000 for tennis, 80 534 for sea sports, 56 000 used a sports hall, 42 596 table tennis, 19 200 ball games, and 168 945 other sports. The sports and recreation centres of the *Plava laguna* COAL achieved an average profit of 892 000 Deutsch marks in their three years' joint operations (Bartoluci, 1998).

Since the association did not achieve the desired results, however, at the beginning of 1990 the procedure was launched to liquidate the composite enterprise, that is, the disassociation of the Poreč industry. Profit centres were formed within the organizational structure of the newly independent *Riviera* work organization, including Sport PC, which continued investment in the provision of sporting facilities (*Riviera Adria*, 2013). The work organization *Riviera* was the forerunner of today's *Valamar Riviera d.d.*, which is based in Poreč.

## Conclusion

During the time of the socialist Yugoslavia, the Poreč area developed into the most successful tourist destination on the eastern Adriatic. The achievement of these results was the result of the concentration of three major tourism organizations in the territory of the municipality and their fitting competition, especially in the realm of sports tourism. One of them was *Riviera* from Poreč, which from its foundation chose to develop mass tourism, in which a significant role was played by sport and recreational sport. Thanks to its well-developed infrastructure, in its sports centres it hosted a large number of international events and competitions, and provided suitable training conditions for national and international sportsmen and sportswomen involved in a large number of team and individual sports. These events significantly contributed to



filling its accommodation facilities, thereby easing the effects of seasonality, which is one of the main indirect economic effects of sports tourism. Workers at *Riviera* took part in various sporting events for workers throughout Yugoslavia, and were given the opportunity to take active vacations in and beyond the place where they were staying, and thereby themselves becoming part of the development of their own organization. Three decades of constant investment in the development of sports tourism in the Poreč area resulted in the fact that in the state of that time there was no other town or municipality of approximately the same size and population that could be compared with Poreč in terms of the number of sporting structures and content related to sport, for which *Riviera*, without doubt, was partially to thank.

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## ENGAGEMENT IN ORGANIZED FORMS OF PHYSICAL ACTIVITY IN THE ISTRIA COUNTY

Iva Blažević<sup>1</sup>, Danijela Lazarić-Zec<sup>2</sup>, Loris Benassi<sup>1</sup>

<sup>1</sup>Juraj Dobrila University of Pula, Faculty of Educational Sciences, Croatia

<sup>2</sup>Public Health Institute of the Istrian Region, Croatia

### Abstract

The aim of the present research is to analyse the existing activities and resources oriented toward the promotion of physical activity, and to establish the number of active participants in organisations which conduct organised forms of physical activities. The questionnaires were filled out by each club/association's representatives. The questionnaire included the participants' demographic data (sex and age), data about the club/association (title, part of sports, recreational, medical or school sports activities, sports branch or discipline), and the city or municipality they are affiliated with. This research results show that with regard to both sexes, most of the participants engaged in organized forms of physical activity are aged 10-19, while from the age of 20 the physically active population gradually diminishes up to an older age. Organised physical activities for which there is great interest in the Istria County are martial arts, football and medical gymnastics.

**Key words:** *physical activity, chronological age, local communities*

### Introduction

Sport is not a novelty when it comes to mankind, but it became a very important phenomenon, a sort of essence of a person's contemporary behaviour and human collective relationships, and as any wider phenomenon, it cannot escape from human attention or philosophical questioning, especially when compared to sport which is considered a general treasure and necessity of mankind (Temkov, 2009). According to Milanović (2013), depending on the level of quality, number of participants and the population it is intended for, in the area of sport there are a few types of sports: top, professional, amateur, school, recreational, sport for everyone and sport for people with disabilities. Physical activity is defined as each bodily movement produced by a skeletal muscle which results in energy expenditure. When it comes to everyday life it can be classified as working, sport, conditional, house or other activities (Caspersen, Powell and Christensen, 1985). In its recent global action plan about physical activity for the period between 2018 and 2030, the World Health Organisation (WHO) names walking, cycling, sport and active forms of recreation, such as dance, yoga and tai chi, as the most frequent physical activities. They are usually conducted in one's free time as organised or unorganised activities at an amateur level and for health, educational or social purposes. Furthermore, it emphasizes that if they are regularly practiced, with sufficient intensity and duration, all forms of physical activity may provide health benefits (WHO, 2018). According to Vuora (2004), physical activity was and remains an unavoidable biological stimulus necessary to maintain the structures and functions of organs and organic systems.

Today the need to propagate a healthy and active life style among adults, and especially among children and young people, is enormous and shows an increasing trend since more and more of them grow up leading a sedentary life. About a third of the world's population (23% of men and 32% of women), and more than 80% of adolescents do not satisfy the minimum recommended criteria for the conduction of physical activity necessary to preserve health (WHO, 2010).

The importance of this problem is vividly represented by the fact that insufficient physical activity has been identified as the fourth factor of risk for mortality in the world (6% of cases of death). Among the first five leading factors of risk responsible for mortality in the world there are also high blood pressure (13%), consumption of tobacco products (9%), high blood glucose level (6%) and overweight or obesity (5%) (WHO, 2009). Approximately 3.2 million cases of death per one year in the world are attributed to insufficient physical activity (WHO, 2004). Adult persons (18 to 64 years old) who are insufficiently active have a 20 to 30% higher risk of exposure to all mortality causes than those who participate in physical activities according to the WHO criteria (WHO, 2018).

In light of everything mentioned so far, the aim of this research is to establish the number of active participants in organisations which conduct organised forms of physical activities.

## Methods

A questionnaire was created for the needs of this research and its aim was to analyse the existing activities and resources oriented toward the promotion of physical activity and to establish the number of active participants – members of associations, clubs and organisations which conduct organised forms of physical activity.

The questionnaire was sent to all local community addresses (10 cities and 31 municipalities) of the Istria County which forwarded it to all sports communities in their cities or directly to the address of each legal entity in their area which deal with organised forms of physical activity. Differently from municipalities, in each city there is a community of sports associations which brings together most sports clubs and associations and which, among other things, collects and updates the necessary data of each of its members on an annual basis. The collected data represent the information necessary for this research. The questionnaires were filled out by each club/association’s representatives. Only 16 local communities, more precisely 9 cities and 7 municipalities with a total of 217 sports subjects, have delivered the questionnaire filled out with the completed data for 2019. The questionnaire included the participants’ demographic data (sex and age), data about the club/association (title, part of sports, recreational, medical or school sports activities, sports branch or discipline), and the city or municipality they are affiliated with. Moreover, each club/association had to present the total number of registered members, as well as the number of active members according to their sex. Each individual who participated in his/her club, association or organisation’s sports and recreational activities at least eight times in the last month was considered an active member. The results are presented in the form of charts and tables. The answers were processed by the frequency method according to variables, and their percentages were calculated.

## Results

The obtained results show that in the area of the Istria County (Bale, Barban, Brtonigla, Buje, Buzet, Funtana, Karojba, Labin, Lanišće, Novigrad, Pazin, Pićan, Poreč, Pula, Rovinj, Vodnjan) the number of active members in organisations which conduct organised forms of physical activities equals to a total of 24,704 members. Of the total number of active members, there are 15,436 male and 9,353 female members.

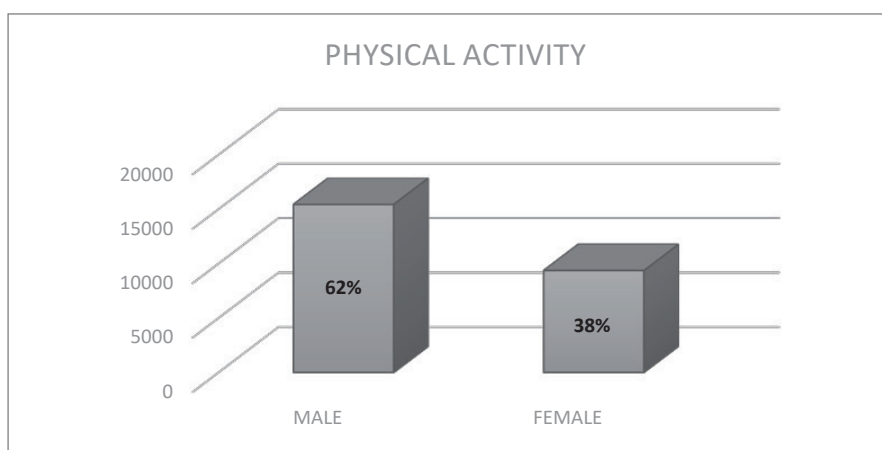


Figure 1. Chart representing active members of the Istria County regarding their sex

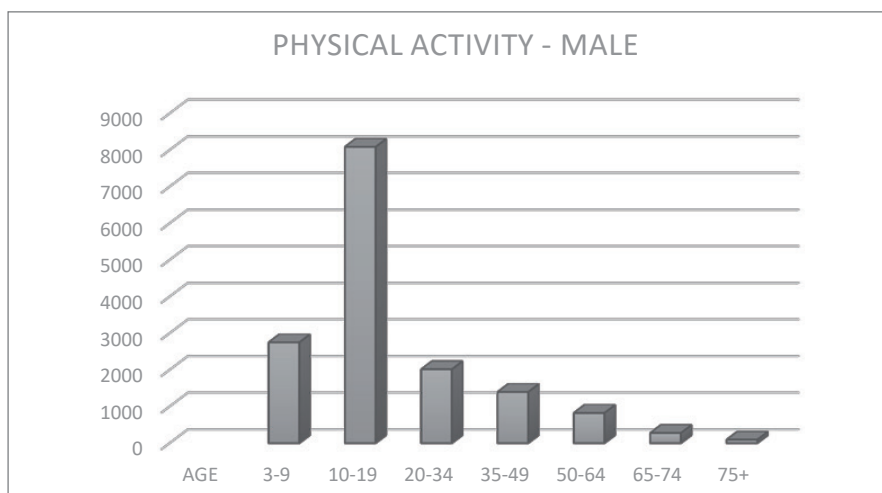


Figure 2. Chart representing active male members in the Istria County regarding chronological age

Of the total number of active male members regarding chronological age, the highest number regards the population of young men between 10 and 19 years old (52.7%), followed by the population of boys aged 3 to 9 (17.8%), the population of men aged 20 to 34 (13.1 %), 35 to 49 (9%), 50 to 64 (5.2%), and 65 to 74 (1.6%), while the lowest percentage was evidenced among men being more than 75 years old (0.6%).

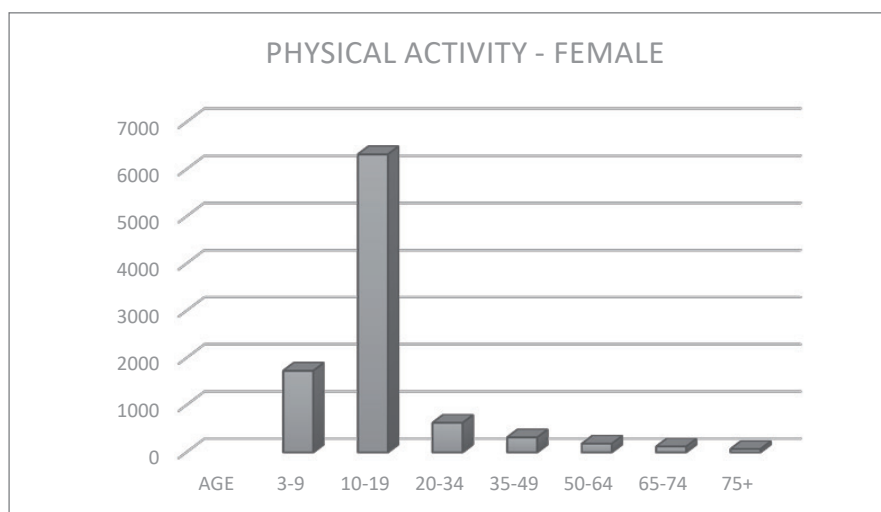


Figure 3. Chart representing active female members in the Istria County regarding chronological age

Regarding the number of active female members in the Istria County according to their chronological age, the highest percentage regards the population of young women aged 10 to 19 (68%), followed by the population of girls between 3 and 9 years old (18.4%). The population of 20 to 34-year-old women is represented by 6.6%, the 35 to 49 year-olds are represented by 3.3%, the 50 to 64 year-olds by 1.8% and the 65 to 74 year-olds by 1.2%, while the lowest percentage among women was evidenced for those older than 75 (0.7%).

Table 1. Preference for physical activities in the Istria County

PHYSICAL ACTIVITIES	PERCENTAGE
MARTIAL ARTS	11.36
FOOTBALL	10.91
MEDICAL GYMNASTICS	10.00
BOULES	7.73
TENNIS	6.36
HANDBALL	4.09
VOLLEYBALL	4.09
RHYTHMIC GYMNASTICS	3.64
BASKETBALL	3.18
ARCHERY	3.18

Organised physical activities stirring up the highest interest in the Istria County are: martial arts (11.36%), football (10.91%) and medical gymnastics (10%). These are forms of physical activities whose goal is primarily to correct and prevent the deformation of the locomotor system.

Results indicate that the female population shows a greater interest in organised participation in rhythmic gymnastics, while the male population's interest is directed toward martial arts and football.

## Discussion

The comparison of obtained results leads to the conclusion that most of the participants engaged in organized forms of physical activity are aged 10-19, namely children attending higher primary school grades up to the completion of secondary school. One of the reasons for that is a higher engagement of children in extracurricular activities which are part of school sport societies. Butt, Weinberg, Breckon and Claytor (2011) and Pharr and Lought (2014) have established in their research that male students participate in sports more than female students and that their participation diminishes

by passing to higher grades of secondary school. The results obtained in this research indicate that the number of people engaged in organized forms of physical activity is higher in younger age groups, i.e. by passing to higher grades of primary school, starting faculty studies and entering the working-life period the percentage of physically active population gradually diminishes up to an older age.

Data show that the percentage of participation in organised forms of physical activity among 3 to 9-year-old boys is 17.8%, and among girls it equals 18.4%. By starting primary school children start to join sport clubs' activities to a greater extent. Former research has shown that, despite the popular opinion that preschool children are physically very active and more active than older children, today's preschool children satisfy the authentic need for movement less and less, which consequently leads to a degradation of their anthropological characteristics and abilities, and thus influences their health (Pinhas and Zeitler, 2000; Vujičić, Petrić and Pejić Papak, 2018; Petrić et al., 2018).

Active men and women, when compared to less active adults, have a lower mortality rate caused by a number of chronic diseases (coronary heart disease, arterial hypertension, stroke, metabolic syndrome, colon and breast cancer, diabetes and depression) and manifest a higher level of functional abilities, muscular fitness, healthier body mass composition and biomarker profiles which are more beneficial for the prevention of cardiovascular diseases, type 2 diabetes and bone health (WHO, 2010).

## Conclusion

The research results indicate that for both sexes most of the participants in the Istria County engaged in organized forms of physical activity are aged 10-19. They are children attending higher primary school grades up to the completion of secondary school. The number of people engaged in organized forms of physical activity is higher in younger age groups, i.e. by entering their working-life period the percentage of physically active population gradually diminishes up to an older age.

Organised physical activities raising the highest interest in the Istria County are: martial arts (11.36%), football (10.91%) and medical gymnastics (10%). These are forms of physical activities whose goal is primarily to correct and prevent the deformation of the locomotor system.

The presented conclusions are based on a low response rate, so for future research it would be necessary to include a larger sample of participants belonging to different age groups.

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## THE TIME SPENT ON COMPUTER GAMES, TV AND THE REDUCED MOTOR FITNESS OF 6-YEAR-OLD CHILDREN

Elżbieta Cieśla, Magdalena Lelonek, Marzena Cieśla, Edyta Suliga

*Collegium Medicum, The Jan Kochanowski University in Kielce, Poland*

### Abstract

The article deals with the relationship between the motor fitness of children aged 6 years and the number of hours they spend playing computer games and watching TV. 15126 children (7465 girls and 7661 boys) aged 6 were tested with the EUROFIT battery test. Additionally, the parents of the children were asked about the time that their children spent in front of computer and TV screens. The results were compared by screen time with the analysis of variance ANOVA. The time spent on computer games significantly affected the level of children's motor fitness components. Children of both sexes using computer and TV more were characterized by lower abdominal strength ( $p=0.000$ ) and running speed ( $p=0.000$ ). In addition, girls more involved in sedentary leisure activities were characterized by weaker explosive strength of the legs ( $p=0.045$ ). A similar direction of changes was noted in body flexibility ( $p=0.000$ ) of boys. The speed of hand movements in girls using computers and TV more often (over an hour/two hours) turned out to be significantly better than in girls using this form of activity less than an hour a day ( $p=0.01$ ). Studies confirm the need to limit sedentary leisure activities when building motor skills in preschool age.

**Key words:** motor fitness, preschool children, sedentary behaviour

### Introduction

According to many European medical societies, children aged 6-10 should not spend more than 1–1,5 hours a day in front of TV, computer or mobile phone screens (Ashton et al., 2019). Limiting the level of daily physical activity results in the increase in the percentage of individuals diagnosed with numerous conditions (Dietz 2004, Craige et al., 2011). The increased screen time causes sleep problems, excessive irritability, limited contacts with peers, snacking between main meals, overweight and obesity. For example: children and adolescents studied by Tabbalis et al. (2018) who spent more than 2 hours a day watching TV, using computer, playing console games, in comparison to their peers who were less involved in screen time, reported insufficient sleep duration. Studies of over 40,000 17- year-old adolescents in the US showed that more than an hour daily screen time was associated with lower psychological well-being, including lower self-control, more distractibility, a bigger difficulty making friends, less emotional stability, being more difficult to care for, and inability to finish tasks (Twenge & Campbell, 2018). Additionally, Iranian research showed that students who were characterized by sitting time (more than 4 hours a day) had a higher probability of daily consumption of sweets, salty snacks, soft drinks and canned fruit juice (Kelishadi et al., 2017). Most of the problems also affect children at the preschool age (Swarzfisher et al., 2020, DeBoer, 2019). According to a study by Williams et al. (2008), children who were less active were characterized by weaker motor skills measured by the CHAMPS Protocol. Studies of Polish children from rural regions showed that time devoted to computer games was negatively correlated with some components of Health-Related physical fitness (Cieśla et al., 2012).

### Purpose

The aim of the research is to assess the relationship between screen time and motor skills of 6-year-old children.

It was assumed that with the increase in the number of hours spent in front of a TV and computer screen, the level of physical fitness decreases.

### Methods

The research program was carried out in Poland. 15126 children (7465 girls and 7661 boys) aged 6 were tested. They ended the annual preparation for school. The collected sample was representative for Polish territories (region and educational institution to which attendants were taken into account). Children's body height, body mass, BMI and physical motor fitness were measured. For this purpose, the Eurofit test was carried out. The following tests were performed: flamingo balance (total balance), plate tapping (speed of arm movement), sit and reach (flexibility), standing broad jump

(explosive strength of lower limb), sit-ups (abdominal strength), shuttle run (running speed and agility) and arms hang test (arms strength). In case of the bent arm hang, a modification was used – overhang on straight arms in time. The research program also provided a survey among parents of the children, in which questions about ways of spending leisure time were also taken into consideration (including screen time and physical activity). For the purposes of the analysis, the screen time was divided into 4 categories: not at all, less than an hour, 1-2 hours, 2 hours and more.

The research findings were grouped according to independent variables and basic characteristic were calculated. Parametric assumptions were established using the Kolmogorov-Smirnov procedure for normality of sampling distribution and Levene's test for homogeneity of variance. The significance of the differences between children from groups separated by screen time was assessed by the analysis of variance (ANOVA) F test. The significance was tested at the level of  $p \leq 0.05$ . Difference between the groups was based on NIR test. The calculations were performed by means of statistical package Statistica 13.3 software.

## Results

Basic characteristics of children's health behaviour, place of residence and motor fitness were shown in table 1-2.

Table 1. Place of living, screen time and physical activity of children

Variables N		Girls		Boys		p
		%	N	%		
Place of living	City	4208	57.19	4538	58.42	0.126
	Village	3150	42.81	3230	41.58	
Screen time	Not at all	297	4.04	293	3.77	0.001
	Less than 1 hr	3251	44.18	3207	41.28	
	1-2 hrs	2175	29.56	2415	31.09	
	2 and more hrs	1635	22.22	1853	23.85	
Physical activity	Less than 1 hr	2409	32.74	2055	26.45	0.001
	1 hr and more	4949	67.26	5713	73.55	
Organized physical activity	Not at all	5713	77.64	6192	79.71	0.004
	1-2 times/week	1562	21.23	1482	19.08	
	More than 2 times/week	83	1.13	94	1.21	

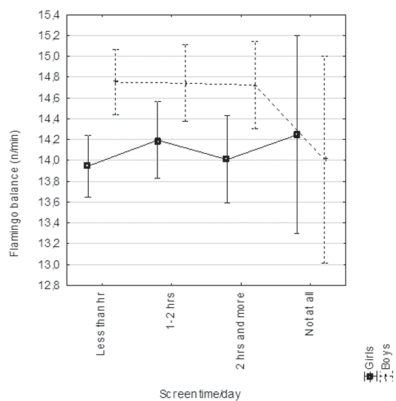
Table 2. Characteristics of motor fitness of children

Motor fitness	Girls		Boys		p
	$\bar{x}$	sd		sd	
Total balance (n/min)	14.04	7.02	14.72	7.00	0.001
Arms movement speed (sec)	26.16	5.98	25.88	6.07	0.004
Flexibility (cm)	2.51	5.15	1.05	5.26	0.001
Strength of lower limb (cm)	90.93	17.29	97.56	18.45	0.001
Abdominal strength (n/30sec)	9.67	3.91	9.97	3.95	0.001
Arms strength (sec)	25.52	18.83	28.32	19.48	0.001
Running speed (sec)	27.98	3.97	27.37	3.84	0.001

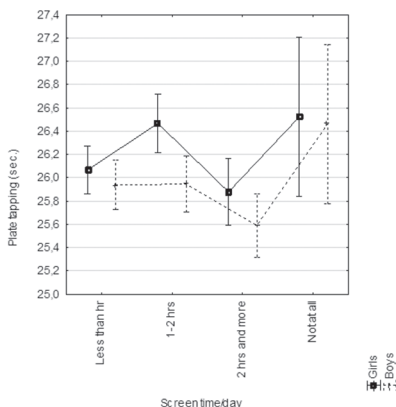
More often girls than boys did not use TV and computer or used them for less than an hour a day. A greater percentage of boys than girls played computer games, watched TV programme and surfed the Internet for two hours or more a day (tab. 1). However, compared to girls, they were more physically active. The girls' parents indicated, that their daughters did extra-curricular activities once or twice a week (Tab.1). The girls compared to the boys obtained significantly better results in two tests: "flamingo balance" (total balance) and "sit and reach" (flexibility). The boys performed strength and speed tests significantly better than girls (Tab. 2.). Graphs 1-7 show motor fitness components according to screen time a day.

In both sexes a significant influence of screen time a day on abdominal strength and running speed was observed ( $p < 0.001$ ). Children using computer and TV more than 1 hour a day were characterized by lower results of two tests: sit-ups, shuttle run. In both sexes and trials significant differences were observed between groups: "2 hours and more" vs. "not at all" ( $p = 0.000$ ), vs. "less than an hour a day" ( $p = 0.000$ ), and vs. "1-2 hour a day" ( $p = 0.000$ ). Differences were also seen

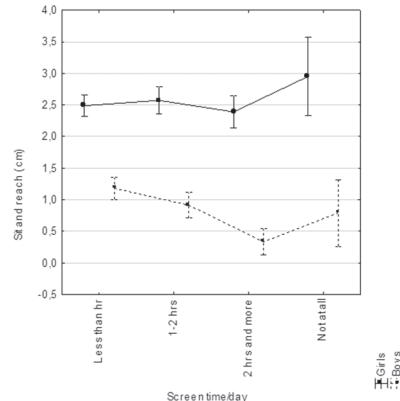
between a pair of groups: “1-2 hours a day” vs. “not at all” ( $p=0.000$ ), „less than an hour a day” ( $p=0.000$ ). Additionally, screen time significantly influenced the explosive strength of the lower limbs in girls ( $p = 0.000$ ). Girls who were more involved in screen time ( $>1$  hr/day) had lower results than their peers who did not use TV and computer. Significant differences were observed between groups: “2 hrs and more a day” vs. “less than an hour a day” ( $p=0.017$ ) and “not at all” ( $p=0.014$ ), and between groups: “1-2 hours a day” vs. “less than an hour a day” ( $p=0.004$ ) and “not at all” ( $p=0.003$ ).



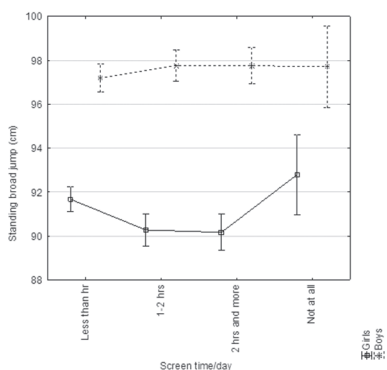
Graph. 1. Total balance according to screen time a day.



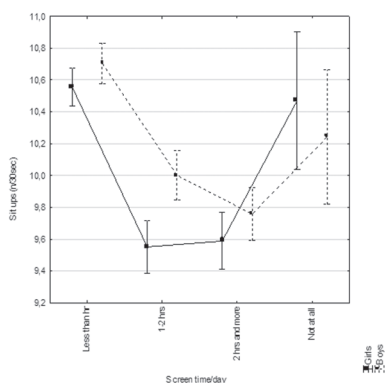
Graph. 2. Speed of hand movement according to screen time a day.



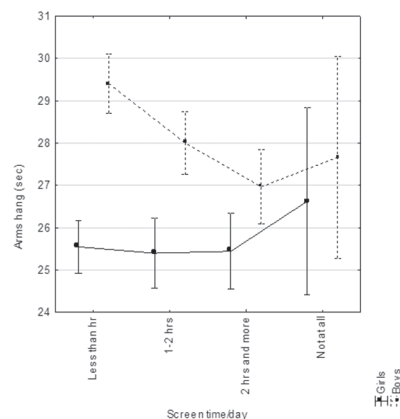
Graph. 3. Flexibility according to screen time a day.



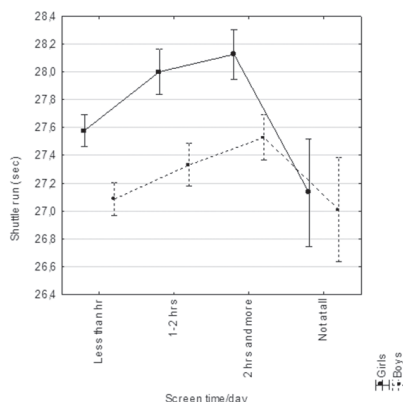
Graph. 4. Explosive strength of lower limb according to screen time a day.



Graph.5. Abdominal strength according to screen time a day.



Graph. 6. Arms' strengths according to screen time a day.



Graph. 7. Running speed according to screen time a day.

A similar direction of changes was noted in body flexibility ( $p=0.000$ ) of boys. Post-hoc tests showed differences between the following pairs of groups: “1-2 hours a day” vs. “less than an hour a day” ( $p=0.041$ ), and “not at all” ( $p=0.001$ ), and for group comparison: “less than an hour a day” vs. “not at all” ( $p=0.000$ ). The speed of hand movements in girls using computers and TV more often (over an hour/two hours) turned out to be significantly better than in girls using this form of activity less than an hour a day ( $p=0.01$ ). The links between screen time and total balance and arms strength in both sexes were not observed.

## Discussion

The article assesses whether the different components of motor fitness measured separately in both sexes depend on the time children spend on sedentary behaviour related to watching TV, playing computer games and using the Internet. It was observed that boys more often than girls spent an hour and more on sedentary behaviour related to watching TV and computer game. Many studies observe a significant influence of gender on sedentary behaviour including screen time (Jago et al., 2012, Schmutz et al., 2018, Xie et al., 2020). For example in the research by Jago et al. (2014) similar to our observation, 15 years-old boys declared greater involvement in computer games. Whereas, in the studies on Chinese and Swiss children, a similar tendency was found even in preschool children. Those observations are alarming. This may be evidence of inadequate control of screen time in the families of the children studied. Therefore, increasing parents' awareness of the recommended limit of screen time, changing parents' attitudes towards their children's involvement in screen time, and increasing parents' effectiveness in overcoming barriers and refusing to allow their children to spend time in front of a screen may be key to developing an appropriate strategy for the future (Carson et al., 2012).

In our research significant influence of screen time was visible in basic strength and speed components, and flexibility. Children who spent  $\geq 1$ hr/day at the front of computer/TV screen were characterized by lower results of strength and running speed, flexibility (boys) and higher level of arms movement speed (girls). So far, a little amount of research was focused on the relationship between screen time and motor fitness. Moreover, their results were based on observation of older children and adolescents. Hence it is difficult to relate the achieved results to other. However, it is possible to conclude that screen time may play a role in the motor fitness development during the pre-puberty and puberty stage. The study on younger children has shown a strong correlation between sedentary behaviour and weaker handgrip strength when PA was not adjusted, but after adjusting vigorous physical activity, the significant association disappeared (Leppänen et al., 2016). A similar relation between screen time and muscle strength was observed by the other authors (Otinawa et al., 2016, Hardy et al., 2018). Moreover, the relationship deepened with age (Hardy et al., 2018).

It is surprising how little research has examined the relationship between screen time and body flexibility, with the results obtained tending to suggest a non-significant role of screen time in shaping this component of fitness (Potter et al., 2017). While, in our study, boys excessively engaged in screen time achieved lower results. It is likely that prolonged sitting in one position may over-tension postural muscles and weaken abdominal muscles, hence the lower levels of body flexibility observed in them (Kett et al., 2008).

The reported low level of speed ability in children engaged in 2 hours and more during a day of TV viewing and computer playing is not supported by previous research. It is likely that a higher level of sedentary behaviour, significantly impair the muscle groups involved in running. The study also observed a high level of hand movement speed in girls who used a computer or watched TV for 2 hours and more a day. It is probably related to the earlier maturity of the nervous system structures, the level of manual skills additionally shaped during the use of the keyboard, remote control or game console (Borecki et al., 2013).

## Conclusion

In children excessively involved in screen time, low levels of abdominal strength and running speed were observed. In addition, girls who spent  $\geq 2$ h/day in front on TV and computer screen were characterized by weaker explosive strength of legs. A similar direction of changes was noted in body flexibility of boys. Studies confirm the need for the limitation of sedentary leisure activities when building motor skills in preschool age and increasing physical activity to reduce negative effect for too long sitting at the front of computer/TV screens. It also seem important making parents aware of negative health effects of sitting time for too long in front of TV and computer screens, and to encourage them to build active models of spending free time together with their children.

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## EFFECTS OF PERSONALIZED RECREATIONAL GROUP EXERCISE PROGRAMME ON HEALTH-RELATED FITNESS: A QUASI-EXPERIMENTAL STUDY

Ana Đerek<sup>1</sup>, Danijel Jurakić<sup>2</sup>

<sup>1</sup>Primary school Jure Kaštelan, Croatia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

Research on effects of personalized group exercise on health-related fitness are scarce. We designed a study with aim to determine the effects of personalized group exercise programme on health-related fitness of apparently healthy people. The sample consisted of 50 adult women (age 20 – 65) assigned into the control (standard) and experimental (personalized) group. The main difference between programmes in control (CG) and experimental (EG) group was in the organization and execution of the conditioning part of the training session. CG participants undergo the same activities and intensity in the conditioning part of the training while participants in EG were divided into groups according to specific intensity and activities adequate to their baseline fitness level. Four components of health-related fitness were assessed at baseline and after the intervention. Morphological fitness was represented by body mass index (BMI) and flexibility of lower back and hamstring muscles (Sit-and-reach test), motor fitness was assessed through balance (One-leg stance test) and transfer skills (Sit-stand test), muscular fitness was evaluated based on upper body endurance (Push-ups) and muscular endurance of the lower body (Squat hold test), and cardio fitness was determined using  $VO_{2max}$  (Queens College step test). Both programmes produced significant improvements in the most of assessed variables i.e., morphological, motor, muscular, and cardio fitness levels ( $p < 0.05$ ). Nevertheless, changes were more favourable in the personalized group programme (EG) for *Sit-and-reach*, *Balance test*, *Sit-stand test*, *Push-ups*, *Squat hold*, and  $VO_{2max}$  ( $p < 0.05$ ). It seems reasonable to advise applying personalized training mode to group exercise which aims to improve morphological, motor, muscular, and cardio fitness.

**Key words:** tailoring, health-related fitness, supervised exercise, customized programme, intervention

### Introduction

World Health Organization ranked physical inactivity as a fourth major risk factor for mortality (World Health Organization, 2010). On the other hand, regular physical activity is a well-established protective factor for the prevention of numerous chronic diseases such as cardiovascular diseases, diabetes, cancer, etc. (World Health Organization, 2018). Although different types of physical activity can contribute to sustaining and improving health, most of the scientific evidence indicates that supervised exercise is more effective in improving health-related fitness compared to unsupervised exercise (Lacroix et al., 2016; Nicolai et al., 2009; Turner et al., 2018). One of the most popular types of supervised exercise are group exercise programmes. According to the American College of Sports Medicine's (ACSM) survey of fitness trends, group exercise was ranked as the third most popular programme in 2020 worldwide (Thompson, 2019). Numerous studies have suggested that group exercise programmes have a positive impact on multiple health outcomes (Christle et al., 2017; Ho et al., 2012; Kraemer et al., 2001). Besides physical health benefits, group exercise can reduce anxiety symptoms (Hale & Raglin, 2002), improve cognitive functioning and wellbeing (Williams & Lord, 1997). However, there are some limitations related to group exercise programmes such as the impossibility to adjust exercise intensity according to the participants' individual abilities and needs. Exercise intensity in group programmes is usually determined based on the average fitness level of all participants. Nevertheless, it is well known that different individuals respond differently to such exercise. Although a variety of factors can influence variability in training responsiveness, scientists and practitioners in the field generally recommend personalized exercise prescription or tailoring of exercise according to individual needs and fitness level. Personalized exercise programmes have been proven superior to non-personalized exercise programmes in the terms of improving health-related fitness in multiple studies. However, most of the above-mentioned studies included solely clinical populations (Armstrong & Vogiatzis, 2019; Beckie & Beckstead, 2010; Saner et al., 2015; Weatherwax et al., 2018) with only a few conducted on non-clinical samples (Byrd et al., 2019). Therefore, we designed a study to determine the effects of personalized and standard (non-personalized) group exercise programme on health-related fitness of apparently healthy people.

## Methods

### Sample

The sample consisted of 50 adult women (age 20 – 65), engaged in a group exercise programme in a recreational centre. Participants were selected into the control (standard) and experimental (personalized) group based on the preferred timing of the group exercise program. All participants signed the written consent and filled out the Physical Activity Readiness Questionnaire (PAR-Q). The exercise program did not include dietary recommendations and participants were advised to continue with their usual daily physical activity.

### Intervention

Control group (CG) programme was a standard 12-week group exercise programme. Each session was 60 minutes long consisted of warm-up, conditioning, cool down, and stretching. The experimental group (EG) programme was a 12-week group exercise programme personalized according to the baseline fitness level of participants. Each session was 60 minutes long and encompassed warm-up, conditioning, cool down, and stretching as in the control group. The main difference between CG and EG was in the organization and execution of the conditioning part of the session. Namely, while all CG participants had the same activities and same intensity in those part of the training, participants in EG were divided into two groups according to their baseline fitness levels. Activities and exercise intensity in conditioning part of the session were adjusted to the baseline fitness level of each group. Additionally, due to low baseline motor fitness level of majority of participants in EG, warm-up part of the session highlighted mobility and stability exercises.

### Variables

Four components of health-related fitness were assessed. To be more specific, morphological fitness was represented by body mass index (BMI) and flexibility of lower back and hamstring muscles (Sit-and-reach test), motor fitness was assessed through balance (One-leg stance test) and transfer skills (Sit-stand test), muscular fitness was evaluated based on upper body endurance (Push-ups) and muscular endurance of the lower body (Squat hold test), and cardio fitness was determined using  $VO_{2max}$  (Queens College step test).

### Data analysis

Descriptive statistics included means and standard deviations of pre- and post-intervention conditions. The dependent sample T-test was used to determine differences between before and after intervention conditions in both CG and EG. The one-way ANCOVA (analysis of covariance) was used to determine the difference between CG and EG in all post-intervention variables (adjusted for covariate i.e., baseline condition). The significance of all tests was set to  $p < 0.05$ .

### Results

A total of 50 participants successfully completed pre- and post-intervention assessment (CG:  $n = 25$ ; EG:  $n = 25$ ). Nine participants were unable to finish the study due to illness, reallocation, and inability to attend exercise sessions 3 times per week. The differences between baseline and after intervention characteristics as well as comparison of post-intervention conditions between CG and EG are presented in Table 1. After 12 weeks, significant improvements were observed in both CG and EG for *Sit-and-reach*, *Balance test*, *Sit-stand test*, *Squat hold*, and  $VO_{2max}$  ( $p < 0.05$ ). Additionally, significant improvements in EG were observed for *BMI* and *Push-ups* ( $p < 0.05$ ). Regarding the comparison of CG and EG in post-intervention conditions, mean changes were significantly more favourable in EG for *Sit-and-reach*, *Balance test*, *Sit-stand test*, *Push-ups*, *Squat hold*, and  $VO_{2max}$  ( $p < 0.05$ ).

Table 1

Variable	Control group		p (1)*	Experimental group		p (2)**	F	p (3)***
	Pre M ± SD	Post M ± SD		Pre M ± SD	Post M ± SD			
<b>Morphological fitness</b>								
BMI	22.83 ± 3.08	22.97 ± 3.66	0.709	22.35 ± 3.12	22.03 ± 2,87	0.006	1.499	0.227
Sit-and-reach	34.80 ± 8.11	37.16 ± 7.23	<0.001	34.36 ± 6.97	40.24 ± 5.86	<0.001	23.299	<0.001
<b>Motor fitness</b>								
Balance test	4.62 ± 3.63	5.39 ± 3.13	0.049	3.97 ± 2.72	10.71 ± 9.47	<0.001	5.806	0.020
Sit-stand	8.40 ± 1.45	8.84 ± 1.02	0.009	8.90 ± 1.03	9.56 ± 0.65	<0.001	8.991	0.004
<b>Muscular fitness</b>								
Push-ups	7.88 ± 7.42	8.92 ± 5.93	0.309	9.00 ± 9.58	25.64 ± 10.57	<0.001	71.004	<0.001
Squat hold	73.16 ± 39.79	108.64 ± 52.97	<0.001	83.76 ± 38.82	157.36 ± 52.78	<0.001	14.713	<0.001
<b>Cardiorespiratory fitness</b>								
VO <sub>2max</sub>	37.50 ± 3.08	38.57 ± 2.71	0.010	36.44 ± 3.62	40.11 ± 2.30	<0.001	18.903	<0.001

\* The significance level of within group change in CG

\*\* The significance level of within group change in EG

\*\*\* The significance level of post-intervention conditions between CG and EG (adjusted for baseline)

## Discussion

The purpose of this research was to determine the effectiveness of personalized versus standard (non-personalized) group exercise programme on health-related fitness level of apparently healthy women. Our results demonstrated that both, 12-week personalized and standard programmes, produced significant improvements in the most of assessed variables i.e., morphological, motor, muscular, and cardio fitness levels. Nevertheless, changes were more favourable in the personalized group programme (EG). To the best of our knowledge, this was the first study that comprehensively compared the effects of personalized versus standard (non-personalized) group exercise intervention on the health-related fitness of apparently healthy women.

Our finding regarding greater improvements of personalized exercise programme versus non-personalized programme are in accordance with similar previous research (Byrd et al., 2019; Weatherwax et al., 2018). For instance, in study of Byrd et al. (2019) it was determined that personalized exercise prescription cause a greater increase in VO<sub>2max</sub>, compared to moderate-intensity continuous exercise training. Positive effects of personalized exercise programmes were also proven in clinical settings. For example, Beckie et al. (2011) determined that the tailored cardiac rehabilitation programme is more effective than a traditional programme in reducing depressive symptoms and programme adherence in women with coronary heart disease. It seems that exercising in smaller i.e. personalized groups is associated with improved motivation, greater satisfaction, increase in exercise self-efficacy, and greater self-reported health (Wayment & McDonald, 2017).

There are several limitations to our study that could be addressed in future research. First, due to organizational issues, the sample was not randomized. Instead, participants were assigned to either CG or EG based on their availability to attend group exercise sessions at a specific time. Second, although participants were advised to maintain their usual dietary habits and physical activity, those behaviours were not strictly controlled. Changes in either of those above-mentioned behaviours could potentially bias the results of the study.

## Conclusion

Both, personalized and standard (non-personalized), 12-week group exercise programmes significantly improved the health-related fitness level of apparently healthy women. However, greater improvement was determined in the group that attended the personalized exercise. It seems reasonable to advise applying personalized training mode to group exercise which aims to improve morphological, motor, muscular, and cardio fitness.

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## ATTITUDE TOWARDS DANCE OF ZAGREB FITNESS CENTER USERS

Maja Horvatin, Alen Plevnik, Jadranka Vlašić

University of Zagreb Faculty of Kinesiology

### Abstract

Assuming that a person with a negative attitude towards an activity will not opt to engage in such an activity, the aim of this research is to determine the attitude towards dance of individual and group program users of a fitness center in Zagreb in order to determine whether the attitude towards dance is the reason for choosing an individual or a group program, and the difference in the attitudes towards dance of individual and group programs users. The study was conducted on a suitable sample of 84 users of a fitness center in Zagreb who exercise in various recreational individual or group programs, with an average age of  $32 \pm 1$  year. Fitness center users' attitude towards dance was assessed by means of a questionnaire, using SPP dance attitude scale (Vlašić, Bosnar, 2007). The scale consists of 20 items in both directions (positive and negative) with 5-degree responses. A total score above 60 indicates a positive attitude, while a score below 60 marks a negative attitude. Based on the results obtained, descriptive statistical parameters were calculated for each variable, and the independent sample T-test showed significant differences between individual and group program users in their attitudes towards dance. According to the results obtained, users of all fitness center programs generally have a positive attitude towards dance; however, group program users have a better attitude towards dance than individual program users. Therefore, it can be concluded that fitness centers should pay more attention to the promotion of group fitness programs in order for a larger number of users of both genders to get involved in them.

**Key words:** *individual programs, group programs, SPP (ATD - attitude towards dance)*

### Introduction

The two most common motives for exercise are relaxation and fitness improvement (Jurakić et al., 2014.). Individual programmes are predominantly related to resistance exercise in the gym with an emphasis on competitiveness. Group fitness programs include programs: aerobics, dance, pilates and therapeutic exercise in which it is dominated by motives social incentives and health improvement (Flood & Hellsted, 1991; Caglar, Canlan & Demir, 2009 according to Đerek et al., 2014)

Recreational programs in fitness centers in the city of Zagreb offer a variety of group and individual programs. Recreational dance programs are predominantly offered by dance centers, and some fitness centers also offered them.

Group fitness programs usually consist of programs that combine basic elements of step technique into choreographic units (hi / low, step, funk aerobics, zumba, ..., etc.), as well as programs in which individual motor tasks are alternated and repeated (cycling, fit boxing, corrective gymnastics, etc.) and music with its rhythm and tempo defines the intensity of exercise and is an important factor in the success of performance (Zagorc, Furjan-Mandić, Vjerna & Željковиć, 1997). Individual programs often use music only as incidental or background music that contributes to a comfortable atmosphere during workout (exercise using training equipment, etc.). When comparing the characteristics of dance programs with the offer and basic training settings of choreographically set group fitness programs in which the exercisers' attention is focused on remembering and picking up the choreography, a remarkable similarity is noticed. In both types of programs, in addition to physical exertion, exceptional mental engagement and concentration of exercisers to carry out the elements of the technique in a given order is necessary, which is one of the basic preconditions for choosing the type of program – group or individual.

In addition, such group programs place an additional intellectual burden on users.

Attitude is defined as an acquired, relatively permanent and stable organization of emotions, evaluations and reactions to an object (Petz, 1992) or as a permanent evaluation of people, objects and ideas (Aranson, Wilson, Akart, 2005). It is considered necessary for the interpretation and prediction of behavior (Ajzen, 1988 according to Benassi, Bosnar, 2008). All attitudes have an emotional, cognitive, and behavioral component and may be based on one component more than the other. Cognitively-based attitudes are largely based on beliefs about the characteristics of an object. An affectively-based attitude is based on emotions and values towards the attitude object, and behaviorally-based attitude is based on actions towards the attitude object. Attitudes determine behavior, that is, people behave in accordance with their attitudes, but they also change their attitudes by changing their behavior. A positive attitude towards an activity does not necessarily mean that the person will engage in that activity. When it comes to activities such as playing a sport, it can be assumed that a



person with a negative attitude to an activity is not very likely to practice it. The question is whether fitness center users opt for individual programs precisely because of the similarity of certain group programs (those in which choreography is performed as part of the training) with dance activities, i.e. because of their negative attitude towards dance and, therefore, towards the activities that nurture dance forms.

Pursuant to the foregoing, the aim of this research is to determine the attitude towards dance of individual and group program users of one fitness center in Zagreb in order to determine whether the attitude towards dance is the reason for choosing an individual or a group program and the difference in the attitudes towards dance of individual and group programs users.

## Methods

The research was conducted on a suitable sample of 84 users of a fitness center in Zagreb who exercise in various recreational individual or group programs. The average age of the respondents was  $32 \pm 1$  year. Fitness center users' attitude towards dance was assessed using SPP dance attitude scale (Vlašić, Bosnar, 2007). The scale consists of 20 items in both directions (positive and negative) with 5-degree responses: "strongly agree", "mostly agree", "not sure", "mostly disagree" and "strongly disagree". The answers are scored using points from 1 to 5 in such a way that a higher score indicates a positive attitude. The overall, summarized score ranges from 20 to 100 points, with the mean value of 60 points indicating a neutral attitude. A total score above 60 indicates a positive attitude, while a score below 60 marks a negative attitude.

The results obtained by measurement were analyzed using *Statistica 7* programs. Descriptive statistical parameters were calculated for each variable: arithmetic mean (AM), minimum value (Min), maximum value (Max) and standard deviation (SD), and normality of result distribution was checked by the Kolmogorov-Smirnov test.

The significance of differences between individual and group program users in their attitudes toward dance was determined by using the T-test for independent samples, whereby the following values were calculated: arithmetic mean (AM), standard deviation (SD), T-test values (t) and alpha level, i.e. significance level (p).

## Results and discussion

The results of descriptive indicators shown in Table 1 show the average attitude towards dance values of the respondents who are physically active in individual programs (67.93), group programs (75.98) and all respondents (73.39). Based on this, it can be concluded that respondents involved in group programs have a generally positive attitude towards dance, while clients who use exclusively individual recreational exercise programs have a slightly neutral attitude towards dance. It can also be noticed that individual program respondents are only 7.93 points away from the neutral attitude, while group program respondents are 15.98 points away from the neutral attitude in the positive direction. The results obtained indicate that group program clients contributed more in the overall positive attitude than individual training clients which is in line with the research in which the respondents changed their attitude from neutral to positive after the dance program (Vlašić, 2010).

Table 1. Descriptive parameters of the overall SPP (ATD) test score of group program and individual training clients (N=number of respondents; AM=arithmetic mean; MIN=minimum; MAX=maximum; SD=standard deviation)

VARIABLE	N	AM	MIN	MAX	SD
SPPUK individual training	27	67.93	38	100	18.55
SPPUK group programs	57	75.98	30	97	13.54
SPPUK all	84	73.39	30	100	15.68

Dance is a powerful form of expression which uses exclusively non-verbal signals to convey the desired message (Petyo, 2019). Due to the lack of non-verbal communication skills, clients may be reserved and may feel uncomfortable when performing motor tasks integrated into a unified whole, a choreography, with an inevitable aesthetic component that has to be presented within the group following a set rhythm and pace. Due to all of the above, the respondents that showed a better attitude towards dance opted for group workout programs more easily.

When observing the attitude of the respondents who are individual training users (relatively close to the neutral attitude), it is necessary to emphasize that attitudes determine behavior, that is, people behave in accordance with their attitudes, but they also change their attitudes by changing their behavior. This may depend, inter alia, on the situation in which a person finds himself or herself, that is, behavior influenced by situational factors, which is not in accordance with a person's attitudes, may have an effect on the change of their previous attitude. The aforementioned means that if the individual training users were subjected to participating in the described group programs and experienced the pleasant emotions they provide, a change in attitude would probably occur (Vlašić, 2010). This might make it easier for them to opt for group programs.

The results of the attitude towards dance test show that 59% of the respondents who are individual training clients and 88% of the respondents who are group program users have a positive attitude towards dance, while 41% of individual program clients and 10% of group program clients have a negative attitude towards dance.

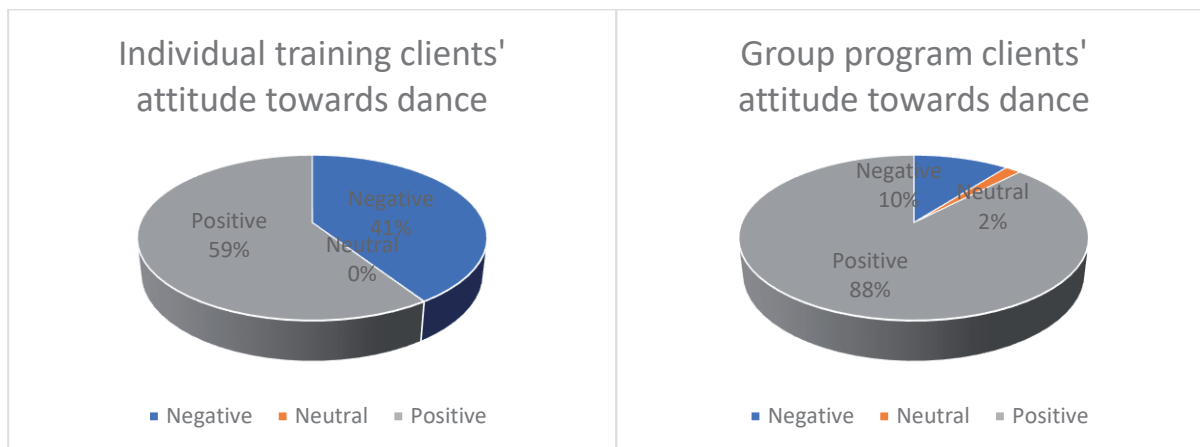


Table 2. T-test results of the attitudes towards dance of group program and individual training clients (AM = arithmetic mean; t-value = T-test value; p = alpha level / T-test significance level)

T-test	AM group	AM individual	t-value	p
ATTall	75.98	67.93	-2.25	0.03

T-test (with alpha level of 0.03) showed statistically significant differences in attitudes towards dance between the individual training and group program respondents in favor of group programs. It should also be pointed out that, when it comes to group program respondents, 84% of the respondents are women and only 16% are men, while the ratio for individual program respondents is 63% women and 37% men. If we know that dance is stereotypically characterized as a “women’s” sport (Oglesby and Hill, 1993, according to Bosnar, Sertić and Prot, 1999), and according to the characteristics of women’s sports (they are in balance with other aspects of life; diffuse energy is invested; they are natural, spontaneous and fun, safe and good for health, friendly, cooperative; coaches and staff are predominantly female; and they can be described with the words “for every girl”) group fitness programs can also predominantly be classified in this group of sports, the results obtained are fully justified.

In the last decade, many authors have addressed the issue of preferences for sport and attitudes towards different kinesiological activities in their research (Markuš, Andrijašević, Prskalo, 2008; Andrijašević et al., 2005). They pointed out that there are significant differences in the attitudes of the male and female population, which can be equated with the research conducted at the mentioned fitness center.

### Conclusion

Zagreb Fitness centers offer their users various group and individual exercise programs. Despite the fact that users can take up physical activity in various group programs, some users of the fitness center where the research was conducted prefer individual training. Since a large number of group programs is based on the integration of motor tasks into a unified whole that is repeated in the rhythm and tempo of musical accompaniment during training, which is the basis of training of various dance techniques, and considering that dance is stereotypically characterized as a “women’s sport, the attitude towards dance of individual and group program users was checked. The question was whether the respondents choose individual programs precisely because of the similarity of certain group programs with dance activities, i.e. because of their negative attitude towards dance. Given the results obtained, although in both groups the attitude towards dance ranges from neutral (individual programs) to positive (group programs), it is possible to conclude that the attitude still affects the choice of fitness program because those who have a positive attitude opt for group programs.

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## DIFFERENCES IN MAIN MOTIVES OF PARTICIPATING IN NAUTICAL TOURISM AND SPORT ACTIVITIES DURING THE WATERTOUR PROJECT ACCORDING TO THE GENDER

Sara Jovanović<sup>1</sup>, Zsolt Katona<sup>2</sup>, Tijana Šćepanović<sup>1</sup>, Aleksandra Dragin<sup>3</sup>, Maja Mijatov<sup>3</sup>, Bojan Rašković<sup>1</sup>, Darinka Korovljev<sup>1</sup>

<sup>1</sup>*Faculty of Sport and Physical Education, University of Novi Sad, Serbia*

<sup>2</sup>*Juhasz Gyula Faculty of Education, Institute of Physical Education and Sports Science, University of Szeged, Hungary*

<sup>3</sup>*Faculty of Science, Department of Geography, Tourism and Hotel Management, University of Novi Sad, Serbia*

According to the available literature, it could be said that there is a lack of the previous research conducted within the recreation campus, with students, in order to identify their main motives of participating in different sport activities, especially in terms of the gender preferences. In respect to that, it stayed unclear whether the gender differences might be reflected in the students' motivation for participation and in which manner.

Therefore, the aim of this paper was to determine the gender differences in the main motives for participating in nautical tourism and sports activities of the Tisza River. Respondents who participated in this research were students of the Faculty of Sports and Physical Education from the University of Novi Sad and from the University of Szeged, with the sample of 179 students (112 males and 63 females). This research is a part of the WATERTOUR IPA Project.

Completely new questionnaire was designed with the purpose of analyzing the main motives for participating in the camp with issues related to rest and relaxation, physical and mental recovery, desire for new experience and adventure, need for physical activity, as well as to the completion of a mandatory college course. Respondents were also asked about their companion de voyage: family members, friends from college, athletes from the club.

The research results pointed to a recorded difference in percentages when it comes to individual motives between males and females. It could be noted that males usually go to the camp for rest and relaxation to a much greater extent (31.3% comparing to females 11.8%), then for physical and mental recovery (17.2% comparing to females 0%), while females' visits of the camp are usually pushed by their desire for new experiences and adventures to a greater extent, comparing to males (35.3% of females vs. 25% of males), as well as by their need for physical activity (11.8% comparing to males 0%). These differences in responses were statistically significant:  $\chi^2(5)=20.43$ ,  $p<0.01$

In terms of their companion de voyage, significant differences were not found between the different genders, which was tested by using the Chi squares:  $\chi^2(7)=677.$ ,  $p=0.08$ .

The research results showed that there are significant differences in the main motives for participating in preferring activities in the camp, according to participants' gender, which might be considered as the basis for designing a different programs of sports activities in nautical tourism.

**Key words:** *sports activities, motives, camp, nautical tourism, water sports, Tisza river, WATERTOUR Project*

## PREDICTIVE MODEL OF FALL PREVENTION IN OLDER ADULTS - PILOT STUDY

**Andrea Martincová, Lenka Svobodová, Martin Sebera**

*Masaryk University - Faculty of Sports Studies, Czech Republic*

**Background:** Falling is one of the problems that threatens the health of elderly patients. The frequency of falls increases with age and frailty level. Falls mainly caused during activities of daily living are the third common cause of death in seniors. The aim of this pilot study is preparation for developing predictive model prevention for falls in older adults to prevent injuries leading to mortality and morbidity. Based on study of validated studies on this topic we have defined fitness parameters that are closely related to activities of daily living (ADL) and instrumental activities of daily living (IADL).

**Methods:** The piloting group (n=59, age>65) of pilot study was recruited through snowball method. Proband were evaluated for basic anamnesis, fear of falling by questionnaire FES-I and by a fall risk assessment using the Downtown fall risk index, cognitive test by The Montreal Cognitive Assessment, basic anthropometric data were measured using an Inbody 270 and their strength, balance and functional fitness were evaluated by means of the Chair stand test, Hand grip strength test, Functional Reach Test (FRT), Timed Up and Go Test (TUG), Kistler stabilometric platform and 2 minutes walking test.

**Results:** Due to limitations caused by COVID 19, the last measurement took place in the first week of May. For this reason, we have not processed all the data yet. Measured data will be processed by a statistical method of regression analysis during June 2021. Based on the analysis will be created test form predictive model of fall prevention for older adults.

**Conclusion:** We found very important to develop predictive model prevention for falls in older adults to prevent injuries leading to mortality and morbidity. This pilot study is a first step to success creating predictive model. Based on predictive model, we will be able to design a targeted intervention program for elderly adults to prevent risk of falling, promoting well-being and increase quality of their life.

**Key words:** *predictive model, fall, prevention, older adults*



## THE INFLUENCE OF YOGA ON THE SUBJECTIVE PERCEPTION OF STRESS, ANXIETY AND DEPRESSION IN INDIVIDUALS WITH AND WITHOUT PREVIOUS YOGA EXPERIENCE

**Tena Matolić**

*University of Zagreb Faculty of Kinesiology, Zagreb, Croatia*

### Abstract

The beneficial influences yoga can have on the average person have been known to us for thousands of years, but have only recently become a common subject of scientific research. The main goal of this study is to determine the immediate impact, a usual yoga session might have on the subjective perception of stress, depression and anxiety, in women with or without the prior experience. The study was conducted on 18 healthy women of different ages. Of those, nine women formed the “yoga women” group (YW = 9), while the other nine women, without previous yoga experience were set to form the “non-yoga women” group (NYW = 9). Both groups have been given a single, identical yoga program. The results showed statistically significant differences in the final measurements, relative to the initial measurements in both groups. The results did not show significant intergroup differences in any of the observed variables. The two-factor variance analysis in repeated measurements showed that the impact, which yoga session has on individuals, isn't affected by their previous yoga experience. This study highlights the possibility of an acute and immediate influence upon the mentioned variables, through yoga practice.

*Key words: mind-body exercise, breathing, pranayama, meditation, calmness, stress-relieving, relaxation, women*

### Introduction

The philosophy of yoga (supported increasingly by science), among other things, teaches that the whole body pulses (that every cell in the body “is breathing”). Nowadays, due to constant tensions, worries, fears and frustrations of everyday life, a state of stress and unbalanced work of ANS (Autonomic Nervous System) often occurs. This can result in the so-called „frozen“ reaction (withdrawal, passivity), where the imbalance of ANS is manifested as the intensified work of parasympathicus, which corresponds with the so-called hypotonic organism, and can lead to depression in the long run (Colombo, Arora, DePace, Vinik, 2015). It can also lead to over-activation of sympathicus, or the so-called “fight or flight” reaction (defense, attack, rebellion), which puts the body in a hypertonic state - a stressful condition which represents a good basis for development of anxiety. The constant dis-balance affects the muscles, the organs, and also obstructs the flow of ‘nerve energy’ throughout the body. Therefore, the yogic training system tries to ‘liven up’, relax and consciously activate the muscles, to stimulate the reaction of tension relief, to harmonize the functioning of organic systems, and to stimulate the formation of homeostasis within the human organism. Many papers support this statement, pointing to the positive physiological and mental changes, encouraged by the practice of yoga. (Chu et al. 2016; Huang, Chien, Chung 2013; West et al. 2004; Friis and Iii, 2012).

The large number of different existing yoga traditions and systems has led to difficulties in the interpretation of the former studies, and to inability of drawing more concrete conclusions about the impact yoga has on the human organism. Therefore, this paper does not emphasize any particular yoga program, considering that the breath meditations, asanas and pranayama performed here, are an integral part of a thorough yoga session, at almost every yoga center. It could be said that a certain form of traditional Hatha yoga was used in this study.

Also, the effects of yoga on a ‘healthy’ population were very rarely monitored, and there is hardly any research taking into account the level of yoga experience between attendants, which could have affected their relaxing ability and consequently influenced the variables observed.

## Methods

### Subjects

There were 18 women participating in the study. With respect to the subject of the study, a suitable sample of women was compiled, with and without the yoga experience. The first group of „yoga women“ YW (women=9; age=46.22 ± 4.47 years; height=1,66 ± 0,07 m; weight=62,83 ± 8,88 kg) was formed by nine women, randomly selected - depending on the experience in yogic practice (minimum 3 years). The other nine women were also randomly selected, provided they had never encountered yoga before. They formed the second group of „non-yoga women“ NYW (women=9; age=39.11 ± 8.33 years; height=1,72 ± 0,04 m; weight=67.78 ± 7,07 kg). Only female subjects were involved, in order to exclude the impact of hormonal sex differences on the results, so it would not preclude the valid conclusions. In order to participate in the study, the subjects could not be diagnosed with central and peripheral nervous system diseases – stress, anxiety.

### Protocol

The study was conducted during the time of three weeks. Within these three weeks, each subject only came to the measurements once, with the complete protocol lasting about 120 minutes. On all the subjects, the measurements were taken in the morning. The study consisted of the initial measurements with filling out the general questionnaire, of practicing the yoga program, and followed by the final measurements. The same person carried out the measurements (initial and final), as well as the yoga program.

The “Depression, Anxiety and Stress Scale - 21 Items” (DASS-21) consists of 21 questions, divided into three categories (stress, anxiety and depression. Respondents were asked to complete the questionnaire, depending on their perception about each query within the past week. The questionnaire suggested five values for each category: „normal“, „mild“, „moderate“, „severe“ and „extremely severe“. (Henry & Crawford, 2005; Antony, Bieling, Cox, Enns & Swinson, 1998; Lovibond & Lovibond, 1995).

The yoga program, which was attended by all the subjects, lasted for one hour and fifteen minutes altogether, in the beginning consisting of a relaxation (8 min.), with a breath calming meditation (7 min.). This was followed by asanas or postures (43 minutes), and at the end by pranayama (breath control) which is called Chandra-bhedana (8 min.), followed by the relaxation in Shavasana (the final asana - 7 min.)

## Results

The descriptive indicators of initial and final measurements of the follow-up variables, and the changes between the initial and final measurements for each separate group (t-test for dependent samples) are presented in table 1. In the variables of both stress and depression, the results of both groups of subjects showed statistically significant decline in values, namely: The stress variable - with YW ( $p = 0.033$ ), and with NYW ( $p = 0.004$ ); The depression variable - with YW ( $p = 0.035$ ), and with NYW ( $p = 0.002$ ). There was also an obvious decrease in the value of the anxiety variable, but not statistically significant.

Table 1. Descriptive indicators of initial and final measurements (arithmetic mean ± standard deviation) and the results of T-test for dependent samples of DASS-21 questionnaire

VARIABLE	GROUP	INITIAL (AM±SD)	FINAL	pre/post T-TEST (p-value)
STRESS	Yoga women	12.0±11.27	4.4±5.36	0,033
	Non-yoga women	16.2±7.45	5.6±5.08	0,004
DEPRESSION	Yoga women	7.3±9.43	1.1±2.03	0,035
	Non-yoga women	6.7±3.74	1.3±1.73	0,002
ANXIETY	Yoga women	6.0±10.68	2.9±3.02	0,197
	Non-yoga women	4.7±4.24	1.8±1.86	0,051

The results of the two-factor variance analysis through repeated measurements (group x time) indicate that there have been no statistically significant differences between the two groups of subjects (YW and NYW), in neither of the variables (table 2).

Table 2. Changes in DASS-21 questionnaire variables, analyzed with the two-factor variance analysis through repeated measurements

VARIABLE	RANOVA	F	p	GROUP	INITIAL (AM±SD)	FINAL (AM±SD)
STRESS	Group	0,93	0,348	Yoga women	12.0 ± 11.27	4.4 ± 5.36
	Time	14,96	0.001*	Non-yoga women	16.2 ± 7.45	5.6 ± 5.08
	Time*Group	0,44	<b>0,518</b>			
DEPRESSION	Group	0,01	0,906	Yoga women	7.3 ± 9.43	1.1 ± 2.03
	Time	12,59	0.003*	Non-yoga women	6.7 ± 3.74	1.3 ± 1.73
	Time*Group	0,07	<b>0,788</b>			
ANXIETY	Group	0,336	0,570	Yoga women	6.0 ± 10.68	2.9 ± 3.02
	Time	2,507	0,133	Non-yoga women	4.7 ± 4.24	1.8 ± 1.86
	Time*Group	0,003	<b>0,954</b>			

## Discussion

The most important finding of this study is the confirmed impact potential of a conventional yoga session to the aforementioned indicators of the psychophysiological state of the human organism, regardless of previous yogic experience. The anxiety variable shows a decreasing, but not statistically significant trend. A higher trend change occurred in the NYW group, although the NYW group showed higher initial values only in the stress variable. The initial values of depression and anxiety variables were higher in the YW group, but also the standard deviation was much higher in that group – suggesting the possible problem of a small sample of subjects. The conducted research did not prove statistically significant intergroup differences in any of the variables, due to the carried-out yoga session.

The past studies also showed the significant impact of a yoga session on the perception of stress, depression and the quality of living. For example, the work of West et al. (2004), in addition to the questionnaire about the perceived stress scale, also examined the level of cortisol in the body, before and after the yoga session, concluding that the yoga session had an acute impact on statistically significantly lower perception of stress, as well as the levels of cortisol (the so-called „stress hormone“) in the blood. Furthermore Chu et al. (2016) examined the impact of a 12-week yoga program on 23 sedentary women with mild depression, which led to conclusions about statistically significant difference in perceived stress levels according to the PSS questionnaire, as well as the BDI-II questionnaire values (referring to the depression variable). However, this paper demonstrates a similar effect, but applied on a ‘healthy’ population.

The possible limits of this study primarily address the small number of subjects, that is - only nine of them in each group. The same difficulty is closely related to the problem of significantly older YW group, but considering just two subjects from the NYW group were significantly less than 37 years old (they were 25 and 26), the above assumption needs to be further examined by future studies and with more subjects.

Furthermore, it is important to emphasize that YW group is still a group of women who practice yoga recreationally. The results of the variance analysis through repeated measurements, which indicate the similar yoga impact on stress, depression and anxiety, regardless of previous yoga experience, could be due to the degree of adopting the relaxation ability. However, the women involved in this research practiced yoga for 3-15 years at a recreational level, and did not delve deeper into particular aspects of yoga (relaxation techniques, pranayama, meditations, kriyas etc.). Therefore, in the future studies it is necessary to investigate the theory of a different impact a yoga session has on the psychophysiological indicators in persons with no experience in yoga, compared to ‘professional’ yogis (men) and yoginis (women) - or those who have dedicated their lives to living yoga. Most of these individuals use physical, as well as the mental practice of yoga on a daily basis. Of course, in this case it would be interesting to see the following: Will yogis/yoginis have better results because they know how to be more efficient and relax, or will the yoga more acutely impact the people without prior experience, because they start from a ‘weaker’ point, which could acutely improve more easily.

Also, the DASS-21 questionnaire only evaluated the mentioned variables and cannot be used for more serious conclusions about potential pathologies, but is a sufficient indicator of an acute impact of yoga. Of course, the big influence on the variables depended on the individual problems and events that preceded the examination, as well as the very understanding of the certain queries. Therefore, for a more detailed analysis it is advisable to engage a professional, and conduct an in-depth oral examination, as well as to study the biological markers of stress.

From a scientific point of view these insights are significant, because they provide a good foundation and further guidelines for a deeper study of a more thorough yoga session on the physiological responses of the human organism, primarily the acute ones, as well as the chronic ones. It is also significant that most of the aforementioned studies did not include asanas, meditation, pranayama and the relaxation in shavasana, but preferred only two or three of the above segments, along with the fact that these studies focused mainly on persons with already diagnosed psychophysiological pathologies. Therefore, if one wishes to address the impact yoga does on a ‘healthy’ person’s organism, the most frequent

forms of the practical session should be represented, which was the case in this study. The practical significance of this study recognizes the fact that this yoga session could be recommended as an example of an acute calming, amidst difficult and stressful situations.

## Conclusion

This study has scientifically confirmed the significance of yoga philosophy and its practical impact on persons of different life habits and ages. It has scientifically established the fact, that was known to older generations for thousands of years, and was back then realized through the findings of long-term practice and through one's own experience in this practice. Given the ever more frequently diagnosed problems of depression, anxiety and stress in today's population, it is clear to us that something should be changed, considering the one's lifestyle; and the one thing that is really necessary for everyone, is a certain amount of time reserved for oneself during the day. Yoga is just that, being mostly with oneself, getting to know oneself, dealing with one's emotions, thoughts, sensations and also observing them, staying in your own area of silence. As shown in this study, there is also a scientifically established background behind these processes, with a certainty that here presented form of activity positively impacts the individuals (even of different ages, sexes and health statuses, which was also confirmed by past similar studies) in various aspects.

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## CAN HIGH SCHOOL TEACHERS REDUCE STRESS (AT THEIR WORKPLACE) WITH PHYSICAL ACTIVITY?

Mislav Papec<sup>1</sup>, Mirna Andrijašević<sup>2</sup>, Andrea Vrbik<sup>2</sup>

<sup>1</sup>Graphics School in Zagreb, Croatia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

An outrageous technological advancement, informatization of the curricular process, modernization of education and society in general, put some new demands in front of the *occupation teacher*. Stated trends demand from the teachers the need to perfect and adapt on daily basis, which because of the complexity of the work itself may induce stress. Frequent stress exposure induce consequences which manifest on health status of the teachers in different manner. The main goal of this paper was to establish the correlation between levels and domains of physical activity (work, travel, household, free time) with stress occurrence at work. The subject sample consisted of 945 high school teachers of Zagreb, stratified by school types and their representation at city level. For the assessment of the physical activity level an International Physical Activity Questionnaire IPAQ-LF, (International Consensus Group, Craig et al., 2003) was used. For the assessment of the levels of stress at workplace a Job Affective Well-Being Scale (JAWS) (Van Katwyk, Fox, Spector and Kelloway, 2000) and Physical Symptoms Inventory Questionnaire, PSI, (Spector & Jex, 1998) were used. For data analysis program packages Statistica 12 and IBM SPSS Statistics were used. Correlation analysis confirmed negative connection of general level of physical activity and levels of leisure time physical activity with indicators of stress at work, and a positive connection of physical activity in household with physical symptoms of stress related to work. The scientific contribution of this research manifests in obtained understanding about correlation between levels and domains of physical activity (work place, transfer to work place, household and leisure time) with the stress occurrence at work place of the high school teachers in town of Zagreb. The results may be a good base for planning a strategy of work conditions enhancement in teachers by administering suitable and adequate kinesiological programs.

**Key words:** *Croatian high school teachers, domains of physical activity, correlation*

### Introduction

Current trends in teaching which imply introduction of new learning methods and evaluation, as well as continuous need for expert improvement and use of information technologies, are being estimated as stressors which may result with stress occurrence. Technological advancement, social changes and globalization contribute to an increase of professional demands in teachers, regarding focus on students and teaching as well as regular need for increasing level of expertise and adapting (Abenavoli et al., 2013). Because of the stated reasons, stress and burnout sindrom have become more and more present in teaching profession (Ministry of science and education, 2019). Teacher's coping with current stressors at work are an important and valuable cognition from the kinesiological perspective as well, in order to offer certain preventive programs. The most accepted and used definition of stress is that it is a state or a feeling in which a certain person feels that the life's demands are exceeding personal and social means at disposal (Foro, 2015). Stress at work may be defined as the physiological, psychological and biochemical reactions of a working person in situations in which the work demands do not correspond to possibilities, abilities and needs of workers (World Health Organization, 2016). Stress triggers, i.e. stressors, cannot be unambiguously defined, but, research show that stress at work is most frequently related to human relations with work colleagues, inability of decision making, time pressure, excessive workload and difficult or impossible adjustment of work obligations with private life (Cooper & Marshal, 2013). Prolonged stress exposure at workplace may lead to health disturbance and so called burnout syndrome (Betoret, 2009, Foro, 2015). Frequent presence of stress lowers immune system, negatively affects sleeping rhythm, diminishes mental health and increases the risk of cardiovascular diseases (Holton, Barry and Chaney, 2015). Modern life trends, which usually imply sedentary behaviour, implicate additional need for physical activity in private but also in work environment, and the people affected may be divided into ones who understand the importance and adapt to current issue, and those who don't (Andrijašević, Čurković, and Papec, 2017). Concerning the global economic crisis and unemployment increase caused by Covid 19 pandemic, teachers with online schooling system have been exposed to everyday stress on workplace even more (Deloitte, 2020). Kortisol and tightly connected activation of



stress gene bring up to the state of elevated blood pressure, internal restlessness, anxiety, decreased appetite and suppressed effectiveness of immune system (Bauer, 2008). Problems caused by stress are manifested by increased sensitivity, internal discomfort, fear of the future, constant mental circle, extreme emotional behavior, catastrophic thinking, self-alienation, weakening of motivation, apatheticness and emotional exhaustion (Hillert & Schmitz, 2004). Stress situations at work most often represent negative emotional experience, although the consequences of perceived stress will depend on stress coping mechanism (Nezirević, Tonković Grabovac and Lauri Korajlija, 2017). Unpleasant emotions signal the presence of difficulties that need to be prevailed (Ashkanasy & Dorris, 2017). Recomendable content, intensity, frequency and duration of physical activity are considered to be an important factor of stress prevention (Williams & French, 2011), while inadequate level of physical activity may bring up to the disturbance of health and psychophysical abilities (Andrijašević et al., 2018). A group of Belgian authors were investigating an influence of teacher's work on physical and mental health on a representative sample of 1606 Belgian high school teachers (Bogaert et al., 2014). Positive correlation was found between physically active teachers during their free time and resistance on occurrence of physical and mental health problems. In an investigation in Finland, on a sample of 16275 subjects, higher levels of physical activity were linked to lower levels of stress at work place (Föhr et al., 2016). The same author in previous research concluded that stress occurrence equally affects men and women (Föhr et al., 2015). Negative correlation of stress occurrence and work ability have been proved in a study conducted in Germany, where perceived work stress of employees and its impact on work ability have been assessed (Yong et al., 2013). In Croatia, positive correlation between perceived health levels and levels of physical activity, and negative correlation between stress occurrence and levels of physical activity, have been confirmed in a study on a sample of 554 subjects of different occupations (Ćurković, Andrijašević and Papec, 2017).

The main goal of this paper was to establish the correlation between levels and domains of physical activity (work, travel, household, free time) with stress occurrence at work, and to confirm the hypothesis which stated that general level and four levels of physical activity domains (workplace, travel, household and free time) will be negatively correlated with the indicators of stress levels at workplace in high school teachers.

## Methods

The subject sample consisted of 945 high school teachers of Zagreb, out of which 645 (68, 25%) women, and 300 (31, 75) men. The subjects were divided in three categories: ( $\leq 35$  years, 36 – 55 years, and 56+ years). The first category consisted of 222 subjects (23, 49%), the second category of 603 subjects (63,81%), and the third category of 120 subjects (12,80%). For the assessment of the physical activity level an International Physical Activity Questionnaire IPAQ-LF, (International Consensus Group, Craig et al., 2003) was used. For the assessment of the levels of stress at workplace a Job Affective Well-Being Scale (JAWS) (Van Katwyk et al., 2000), a Questionnaire version translated to Croatian language with reliability 0,91 – 0,95 was used (Nezirević, Tonković Grabovac and Lauri Korajlija, 2017), and the reliability in this research was 0,77 – 0,92, along with Physical Symptoms Inventory Questionnaire, PSI, Cronbach's alpha = 0,74 – 0,85) (Spector & Jex, 1998), and the reliability in this research was 0,81. For data analysis program packages Statistica 12 and IBM SPSS Statistics were used.

## Results

Table 1. Levels of physical activities in highschool teachers according to physical activity domains and in total, shown in MET hours/weekly

PA DOMAIN	MED	MEAN	MIN	MAX	SD	QUART. RANGE	SKEW	KURT	MAX D	K-S p
WORK	7,70	30,42	0,00	369,00	54,86	39,10	3,19	12,62	0,29	p<,01
TRAVEL	6,60	12,39	0,00	166,50	17,59	16,50	2,68	10,57	0,24	p<,01
HOUSEHOLD	21,00	36,22	0,00	240,00	41,92	43,00	2,09	5,02	0,19	p<,01
FREE TIME	18,00	26,16	0,00	232,40	30,67	30,00	2,35	7,47	0,20	p<,01
<b>PA TOTAL</b>	<b>79,70</b>	<b>96,36</b>	<b>0,00</b>	<b>635,65</b>	<b>96,36</b>	<b>100,60</b>	<b>2,18</b>	<b>6,59</b>	<b>0,15</b>	<b>p&lt;,01</b>

MET – the ratio of the work metabolic rate to the resting metabolic rate. PA – physical activity, MED – median, MEAN – mean value, MIN – minimal result, MAX – maximal result, SD – standard deviation, Quartile range - dispersion measure, SKEW – Skewness, KURT – Kurtosis, MAX D – largest deviation of empirical and theoretical relative cumulative frequency, K-S p – level of significance of Kolmogorov-Smirnovljevi's test.

As presented in Table 1, total level of physical activity of the high school teachers amounted 79,70 MET hours/week. Distributed by domains, the teachers reached the highest levels of physical activity in the domain of household (21 MET hours/week), and in the domain of free time (18 MET hours/week), while being less active in the domain of work (7,7 MET hours/week), and the domain of travel (6,6 MET hours/week). The asymmetry measures of Skewness and Kurtosis, point out positive asymmetry and tailedness, i.e. leptokurtic distribution. Positive asymmetry (2,18 in comparison to

1,03), and also tailedness of the distribution (6,59 in comparison to 0,34) are somewhat bigger than in a similar research done by Jurakić (2009), which was in a way expected due to the sample difference, and also the heterogeneous sample of high school teachers. That would mean that the high school teachers (considering the stated sample) were more physically inactive, since the majority of the results were grouping on the left side of the distribution.

Table 2. Descriptive parameters of the assessment of the levels of stress at workplace - Job Affective Well-Being Scale (JAWS)

JAWS	MEAN	MIN	MAX	SD	SKEW	KURT	MAXD	K-S p
<b>JAWS TOTAL</b>	<b>71,87</b>	<b>20,00</b>	<b>100,00</b>	<b>11,99</b>	<b>-0,58</b>	<b>0,93</b>	<b>0,05</b>	<b>p&lt;,01</b>

MEAN – mean value, MIN – minimal result, MAX – maximal result, SD – standard deviation, SKEW – Skewness, KURT – Kurtosis, MAX D – largest deviation of empirical and theoretical relative cumulative frequency, K-S p – level of significance of Kolmogorov-Smirnovljevi's test.

Table 3. Descriptive parameters for Physical Symptoms Inventory Questionnaire (PSI)

PSI	MEAN	MIN	MAX	SD	SKEW	KURT	MAX D	K-S p
<b>PSI TOTAL</b>	<b>4,34</b>	<b>0,00</b>	<b>17,00</b>	<b>3,30</b>	<b>0,78</b>	<b>0,31</b>	<b>0,12</b>	<b>p&lt;,01</b>

MEAN – mean value, MIN – minimal result, MAX – maximal result, SD – standard deviation, SKEW – Skewness, KURT – Kurtosis, MAX D – largest deviation of empirical and theoretical relative cumulative frequency, K-S p – level of significance of Kolmogorov-Smirnovljevi's test.

Table 4. The correlation coefficient between the variables of physical activity domains and in total in relation to the JAWS Questionnaire of the high school teachers ( $p<0,05$ .)

JAWS ( $p<,05$ )	PA WORK	PA TRAVEL	PA HOUSEHOLD	PA FREE TIME	PA TOTAL
JAWS TOTAL	,06	,05	,01	,13*	,07*

PA – physical activity

Table 5. The correlation coefficient between the variables of physical activity domains and in total in relation to the Physical Symptoms Inventory Questionnaire (PSI) ( $p<0,05$ .)

PSI ( $p<,05$ )	PA WORK	PA TRAVEL	PA HOUSEHOLD	PA FREE TIME	PA TOTAL
PSI TOTAL	,04	-,02	,07*	-,11*	,01

PA – physical activity

The obtained data (Table 2 – 5), in accordance to stated hypothesis, indicate negative correlation of general level, and the level of physical activity in the domain of free time with the indicators of stress levels at work. On the other hand, adversely to stated hypothesis, the relations between physical activity in the domains of work, travel and household with the variables for assessing stress indicators did not show statistical significance, except for the variable of household domain, where positive and statistically significant correlation in respect to physical stress symptoms was found. Stated claims indicate the existence of the physical symptoms related to stress, in accordance to an increase of physical activity in the domain of household. The obtained increase of the physical symptoms of stress in the high school teachers in the domain of household may be attributed to the adverse body positions during conduction of the household work, but also with the necessity of the work, since the activities performed weren't chosen in order to recreate, as it is frequently in the domain of free time. Considering the above, the hypothesis is partially accepted.

## Discussion

The total physical activity amount in this research was 71,87, which represents a better result, that is a higher level of work benefit in relation to the research made on 210 teachers from Pakistan (Malik & Noreen, 2015), which amounted 57,73. Physical Symptoms Inventory Questionnaire, PSI, (Spector & Jex, 1998) was used in order to assess the existence of physical symptoms related to stress at work. The total level of physical symptoms of stress in this research indicated 4,34, which was lower when compared to a survey made on university professors in the USA, where the values were 6,50 (Mazzola, Walker, Shockley and Spector, 2011), and higher when compared to a research made in Argentina on managers where the given level indicated the value of 3,78 (Pujol-Cols & Foutel, 2019), while the research using this questionnaire in Croatia were not found. Comparison of the obtained results with the results of the arithmetic means of the measure instrument by authors (Spector & Jex, 1998), showed the lesser presence of the physical symptoms of stress in the observed sample of the high school teachers in relation to the arithmetic mean of the author (3,93 – the obtained results in this research, 4,8 – arithmetic mean). It is important to point out the possibility of stating the socially desirable answers as a factor of limitation during the results interpretation (Tonković Grabovac, 2013). In accordance to the aim of

this research and the stated hypothesis, the obtained results show negative correlation of the general level, and the level of the physical activity in the free time with the indicators of the stress levels at work. Contrary to the hypothesis, only the physical activity in the domain of household, showed a positive and statistically significant correlation, concerning physical symptoms of stress.

## Conclusion

Many research confirm that physical activity represents an important preventive factor in stress occurrence at work place. The obtained knowledge is useful when conducting adequate kinesiological programs through quality of work enhancement programs in high school teachers. The programs should be directed to physical activity which lower mental load and stress accumulation, as well as enhancement of motor and functional abilities. An adequate physical activity with that goal, mainly imply cyclic activities in aerobic conditions of exercising such as walking, running, swimming, mountaineering, bike riding and roller-skating, which besides decreasing symptoms of stress, have an important role also in enhancement of cardio-vascular and breathing system (Bond et al., 2002). In physical activity in the domain of household, statistically significant positive correlation was obtained in relation to physical symptoms of stress. Along with the making of kinesiological strategy, a challenge put in front of kinesiologists relates to motivational strategies of enticing teachers to tune their habits in the direction of objective needs for physical activity. Besides importance of rising awareness and education of the teachers about an effect of physical activity with the goal of stress prevention which represents risk for numerous health disorders, it is an imperative to create a strategy of program application which will be supported by Ministry of science and education, and to encourage it's realization. The key factor for this are experts, kinesiologists with kinesiological recreation specialization, who are educated for the named problems and should be the key people in this strategies.

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## SPORTS CLUB FOR HEALTH (SCFORH): 12 YEARS OF A SUCCESSFUL EUROPEAN INITIATIVE

Željko Pedišić<sup>1</sup>, Tena Matolić<sup>2</sup>, Hrvoje Podnar<sup>2</sup>, Ivan Radman<sup>2</sup>, Marija Rakovac<sup>2</sup>, Pavel Háp<sup>3</sup>, Jorma Savola<sup>4</sup>, Heidi Pekkola<sup>5</sup>, Matleena Livson<sup>6</sup>, Stjepan Heimer<sup>2</sup>, Danijel Jurakić<sup>2</sup>, Pekka Oja<sup>7</sup>

<sup>1</sup>*Institute for Health and Sport, Victoria University, Melbourne, Australia*

<sup>2</sup>*University of Zagreb Faculty of Kinesiology, Zagreb, Croatia*

<sup>3</sup>*Faculty of Physical Culture, Palacký University Olomouc, Olomouc, Czech Republic*

<sup>4</sup>*Lappajärven Veikot ry, Lappajärvi, Finland*

<sup>5</sup>*EU Office of European Olympic Committee*

<sup>6</sup>*Finnish Olympic Committee, Helsinki, Finland*

<sup>7</sup>*UKK Institute for Health Promotion Research, Tampere, Finland*

**Background:** The Sports Club for Health (SCforH) initiative started in 2008, to assist sports clubs in promoting health-enhancing physical activity. In support of this endeavour, SCforH guidelines were issued in 2011 and updated in 2017. The SCforH initiative has been supported by three large European Union grants and included partner organisations from 18 countries. In 2013, the Council of the European Union proposed the national implementation of SCforH guidelines as one of the 23 indicators for evaluation of HEPA levels and policies in the European Union member states. Recently, the European Commission recognised the SCforH initiative as a “success story” and an example of good practice. The aim of this study was to summarise the outcomes of the SCforH movement in Europe over the past 12 years and provide recommendations for its further development.

**Methods:** We conducted a range of online surveys in 36 European countries (including all 28 EU member states, 5 EU candidate countries, Iceland, Norway, and Switzerland). The survey sample included 549 sport associations, 22 SCforH project partners, and 42 representatives of HEPA Europe member organisations.

**Results:** The awareness of SCforH guidelines was the highest among national sport-for-all organizations (54%) followed by national umbrella sport organizations (50%), national Olympic committees (25%), national sport associations (20%), and European-level sports federations (8%). We also found that more than 40% of HEPA Europe member organizations were aware of the SCforH guidelines. The estimates suggested that in most European countries SCforH initiatives were implemented in less than 10% of sports clubs.

**Conclusions:** Given there are more than 2.5 thousand sport associations, almost a million sports clubs, and more than 60 million individual sport club members in Europe, our findings indicate a great potential and importance of future dissemination of SCforH guidelines among European sports clubs and associations.

**Key words:** *SCforH, Sport Club for health, guidelines, health-enhancing physical activity, EU, European project, sport, initiative, European countries*



## ASSESSMENT OF PHYSICAL FITNESS IN THE ELDERLY: CROSS-SECTIONAL STUDY

**Marijana Ranisavljev, Nikola Todorović, Sara Jovanović, Sergej M. Ostojić**

*Faculty of Sport and Physical Education, University of Novi Sad, Serbia*

### Introduction

Prolonged inactivity combined with genetic factors, disease, injuries, or aging (or some combination) causes muscular atrophy, fatigue, and decreased strength and flexibility. These cause several limitations in movement, physical fitness, and quality of life in the elderly population. In this open-label cross-sectional study, we aim to assess the physical fitness of the elderly population and determine the differences between males and females in a mission to determine their specific needs.

### Methods

The sample consisted of 20 males (75±9.5 yrs, 1.76±0.1 m height, 87.4±25.6 kg weight) and 20 females (74±8.3 yrs, 1.58±0.1 m height, 68.9±18.1 kg weight) with inclusion criteria were the age  $\geq 65$ , and exclusion criteria the presence of any major musculoskeletal injuries. They all gave their written informed consent to participate in the study after receiving a thorough explanation of the study's protocol. The study was approved by the Ethical Committee of the Faculty of Sport and Physical Education, University of Novi Sad, and conducted following the principles of the Helsinki Declaration. To evaluate physical fitness, we conducted a senior fitness test adopted from Rikli & Jones (2013). Participants had one visit to the lab at 8 a.m. T-test for independent samples was used to determine the differences between participants with the significance level set at 0.05. Statistical analysis was performed using the SPSS statistical package (version 20 for Windows, Chicago, IL, USA).

### Results

Results indicate that females have a higher level of flexibility ( $p \leq 0.01$ ) and lower levels of strength ( $p \leq 0.01$ ) and agility ( $p \leq 0.03$ ) than male subjects with no significant difference in cardiorespiratory fitness. In comparison with norms from their age, both sexes mostly fit into the average values. Female participants achieved above-average results for the chair sit and reach test, while males had above-average results for the 8 feet test and below-average results for the back-scratch test.

### Conclusion

There are certain differences in physical fitness between the sexes in the elderly population, which implies that future training programs should be individualized to their needs.

*Key words: elderly, physical fitness, strength, flexibility, agility, senior fitness test, aging*

### Reference

Rikli, R. E., & Jones, C. J. (2013). *Senior fitness test manual*. Human kinetics.

## GENDER DIFFERENCES IN RELATION TO SPORTS ACTIVITIES APPLIED IN CAMPS ALONG THE TISZA RIVER

Bojan Raskovic<sup>1</sup>, Ferenc Gyori<sup>2</sup>, Borislav Obradovic<sup>1</sup>, Milan Cvetkovic<sup>1</sup>,  
Zita Hajdune Petrovsky<sup>2</sup>

<sup>1</sup>Faculty of Sport and Physical education, University of Novi Sad, Serbia

<sup>2</sup>Gyula Juhasz Faculty of Education, Institute of PE and Sport Science, University of Szeged, Hungary

**Purpose:** The aim of this paper was to determine the differences between men and women in relation to the types of sports activities offered at camps along the Tisza River. We based our study on the increased need for active tourism delineated in previous studies.

**Methods:** The total number of respondents in this research was 179 students (112 males and 63 females), from the Faculty of Sports and Physical Education, University of Novi Sad and from the University of Szeged. The survey itself used a questionnaire designed to analyse supply and demand in the nautical tourism segment of Tisza, as part of the WATERTORUR IPA CBC project. "We observed the participants" preference regarding sports activities in the summer camp such as: horse riding, cycling, hiking, sailing, water skiing, fishing and dragon boat sailing.

**Results:** The results of this study showed that there are statistically significant gender differences related to the types of sporting activities that are implemented in the Tisza River camps. It can be seen that men prefer riding, (24.8% compared to women 18%), cycling (50.5% compared to women 37.7%), and walking (7.3% compared to women 4.9%) as additional activities at the camp. On the other side, women prefer sailing (14.8% compared to man 8%), and water skiing (9.8% compared to man 6.4%). These differences were statistically significant ( $p < 0.05$ ).

**Conclusion:** Modern living conditions characterized by increased levels of stress, noise and sedentary lifestyle encourage tourists to take active holidays, comprising of sports, primarily to maintain and promote health. Therefore, this research was of great importance for new findings on the interest in sports activities in camps along the Tisza River. We concluded that men were more interested in sports activities on land, while women were more interested in water sports.

**Key words:** sports activities, recreation, nautical tourism, water sports, gender

## SPECIAL PERFORMANCE IN AIKIDO TRAINING: THE RATE OF FALLING TECHNIQUES

Zdenko Reguli, Michal Suchánek

Masaryk University, Czech Republic

### Abstract

**Introduction:** Aikido is a non-competitive martial art. There is no evidence on the training load. The purpose of this study is to find if there is any difference in the load in experienced and non-experienced aikidokas practising together in aikido training.

**Methods:** 10 training sessions were video recorded for the next analysis of the number of falling techniques in experienced and non-experienced aikido practitioners.

**Results:** In evaluated aikido training lessons, non-experienced aikido students perform more falling techniques (average=106.97 per session and one practitioner; min=44.77; max=139.57; SD=26.26) than experienced aikidokas (average=102.88 per session and one practitioner; min=62.00; max=138.43; SD=25.73). This difference was not significant. In this study, we did not evaluate the intensity and difficulty of performed techniques.

**Discussion:** The mission of experienced aikidokas is not just training for themselves, but also to teach and help their less experienced counterparts. The proportion of forward falls to backward falls was higher in experienced aikidokas than in non-experienced. This was due to the fact that experienced aikidokas are falling forward roll instead backward fall from different throwings.

**Conclusion:** There is no difference in the number of falling techniques in non-experienced and experienced aikido practitioners at the same training session.

**Key words:** *combat sport, martial arts, injury prevention, sport performance*

### Introduction

Falling techniques are a highly visible part of aikido training. Falling techniques are related mainly to avoiding injuries (Reguli et al., 2015). Aikido is a modern non-competitive combat sport and martial arts currently lead by Aikikai Foundation, created by Morihei Ueshiba in the first half of the 20th century (Ueshiba, 2012). Research on physical performance in aikido is scarce as well as research in the physiological influence of aikido training on its practitioners (Szabolcs et al., 2018). Aikido training consists of different throws and pinning techniques. Frequency of falling techniques is a way how to indirectly assess physical performance in aikido. There is no evidence about the ratio of falling during aikido training. In aikido, the only way how to differentiate the level of experience is according to their technical degree. There are white belts, kyu holders, from the beginners and black belts, dan holders, as advanced practitioners. Experienced aikido students also wear hakama on their practice suit dogi as a symbol of experience. It was from the rank of 2. kyu in the observed group. The structure of aikido training consists of short meditation at the beginning of the session, followed by warming up. The central part is learning motor skills represented by different aikido techniques. In aikido, the technique aims to deflect an attack of the opponent, to unbalance him, which cause a fall and to control the opponent on the ground. Training session ends with cooling down, followed by a short meditation. Training in aikido is not divided according to the level of students. In one session, beginners, intermediate and advanced train together. This follows the general Japanese martial arts idea of mutual benefit, when experienced helps non-experienced to grow (Green & Svinth, 2010). For each other exercise, partners are changing. This method of training is against the elementary rule of increased load in theory of sports performance (McGill et al., 2019). The increased load is necessary for the adaptation of the sportsman body to that load. Reguli, Bernacikova and Kumstat (2016) stated that aikido practitioner's body composition, even in the subgroup of dan holders, is not much different to the reference average non-athlete man counterparts. This demonstrates the fact that body composition is not as crucial as might be seen in other martial arts disciplines.

The purpose of this study is to find if there is any difference in the load in experienced and non-experienced aikidokas practising together in aikido training.

## Methods

Indirect observation and performance analysis of 10 training sessions in the duration of 90 minutes of each were analysed from video recording (Suchánek, 2019). Record sheet was prepared according to Reguli & Vit (2017)2013. Research protocol consisted of recording falls and falling techniques (Reguli et al., 2015) during the training sessions for experienced and non-experienced aikido practitioners. Falls and falling techniques were coded according to the a) direction (forward, backward, sideward), b) using rolling, and c) using slapping down. For analysis, only fallings caused by training partner during aikido techniques were recorded. All video records were coded by one examiner. Three (30%) of training sessions were coded also by another examiner for the control. In total 10720 fallings were observed.

## Results

As there was a different number of participants for each training session (Table 1), frequency of fall techniques were calculated per person. Although irregularly one experienced female athlete participated, only male aikidoka were examined. The same experienced teacher was leading all training sessions, but participants attended practice irregularly. The total number of non-experienced participants was 15, in average age 33.26 years (min=20.00; max=52.00; SD=9.45). The average age of 7 experienced aikidokas was higher (41.29 years; min=28.00; max=52.00; SD=8.50) that naturally comes from years of their experience.

The sample was small, and there was not calculated normal distribution. To test the null hypothesis that there is no difference in the number of falling techniques in non-experienced and experienced, the Mann-Whitney U test was used. Although the number of falling techniques in non-experienced was higher, the difference was not significant.

Table 1. Number of non-experienced and experienced participants for each of 10 training sessions (avg=average number; min=minimal number; max=maximal number; SD=standard deviation)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Avg	min	max	SD
<b>Non-experienced</b>	8	7	7	5	8	7	5	3	13	5	6.80	3	13	2.56
<b>Experienced</b>	2	7	3	4	4	2	1	3	7	3	3.60	1	7	1.91

Table 2 shows the frequency of falling techniques for each of 10 consecutive (2 times per week) training sessions calculated per person in non-experienced aikidokas. In average there were 55.67 of all forward falls (min=11.15; max=90.00; SD=20.80), 46.25 of all backward falls (min=15.71; max=80.00; SD=19.12), and 5.05 off all others (sidewards and combined) falls (min=0.00; max=26.00; SD=8.16) observed. In Table 2, the number of falls higher than average for each training session is highlighted.

The average number of all falling techniques per non-experienced person for each training session was 106.97 (min=44.77; max=139.57; SD=26.26). As it is seen in Table 3., extremely low number of falling techniques in the ninth session caused that higher number than average was observed in 7 other sessions.

Table 2. Frequency of falling techniques for each of 10 sessions calculated per person in non-experienced aikidokas (avg=average number; min=minimal number; max=maximal number; SD=standard deviation)

	Front					Back			Side	Comb.
	roll slap	roll	direct slap	Direct	direct barrel	roll	direct slap	direct		
<b>1.</b>	<b>10.25</b>	<b>40.13</b>	0.00	<b>5.25</b>	0.00	<b>13.50</b>	21.00	<b>17.88</b>	0.00	0.13
<b>2.</b>	<b>10.71</b>	<b>62.14</b>	<b>17.14</b>	0.00	0.00	0.71	9.86	<b>27.14</b>	0.00	0.00
<b>3.</b>	5.86	<b>43.43</b>	11.43	0.43	0.00	0.43	9.57	5.71	0.14	0.00
<b>4.</b>	6.00	28.20	5.40	0.00	0.00	<b>14.00</b>	14.40	5.80	<b>10.00</b>	<b>16.00</b>
<b>5.</b>	4.00	14.25	<b>14.00</b>	<b>5.25</b>	0.00	<b>7.50</b>	<b>48.88</b>	<b>21.63</b>	0.00	0.00
<b>6.</b>	<b>9.71</b>	21.86	<b>27.43</b>	0.14	0.00	<b>8.43</b>	<b>55.71</b>	<b>15.86</b>	0.29	0.14
<b>7.</b>	<b>35.00</b>	28.40	<b>12.80</b>	0.00	0.00	0.00	26.60	7.40	0.40	2.80
<b>8.</b>	0.00	10.33	<b>29.00</b>	<b>24.67</b>	0.00	<b>10.00</b>	27.33	10.33	0.00	<b>7.00</b>
<b>9.</b>	0.62	10.54	0.00	0.00	0.00	0.62	27.62	5.38	0.00	0.00
<b>10.</b>	3.20	<b>59.20</b>	0.00	0.00	0.00	1.60	<b>36.00</b>	11.60	<b>11.80</b>	1.80
<b>avg</b>	<b>8.54</b>	<b>31.85</b>	<b>11.72</b>	<b>3.57</b>	<b>0.00</b>	<b>5.68</b>	<b>27.70</b>	<b>12.87</b>	<b>2.26</b>	<b>2.79</b>
<b>min</b>	0.00	10.33	0.00	0.00	0.00	0.00	9.57	5.38	0.00	0.00
<b>max</b>	35.00	62.14	29.00	24.67	0.00	14.00	55.71	27.14	11.80	16.00
<b>SD</b>	9.53	17.94	10.16	7.32	0.00	5.35	14.74	7.14	4.34	4.88

Table 3. The average number of all falling techniques for each of 10 sessions per person in non-experienced (non-exp.) and experienced (exp.)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
<b>Non-exp.</b>	<b>108.13</b>	<b>127.71</b>	77.00	99.80	<b>115.50</b>	<b>139.57</b>	<b>113.40</b>	<b>118.67</b>	44.77	<b>125.20</b>
<b>Exp.</b>	91.00	<b>138.43</b>	89.33	<b>124.00</b>	<b>115.25</b>	67.50	62.00	<b>114.67</b>	89.29	<b>137.33</b>

The frequency of falling techniques for each of 10 consecutive (2 times per week) training sessions calculated per person in experienced aikidokas were also calculated (Table 4). In average there were 57.98 of all forward falls (min=26.14; max=102.86; SD=20.59), 40.83 of all backward falls (min=20.00; max=73.25; SD=16.87), and 4.08 of all others (sideways and combined) falls (min=0.00; max=20.67; SD=7.13) observed., The number of falls higher than average for each training session is highlighted In Table 4.

The average number of all falling techniques per experienced aikido practitioner for each training session was 102.88 (min=62.00; max=138.43; SD=25.73). As it is seen in Table 3., a deficient number of falling techniques in the 6. and 7. training session, when the ratio between the number of non-experienced and experienced was the highest.

Table 4. Frequency of falling techniques for each of 10 sessions calculated per person in experienced aikidokas (avg=average number; min=minimal number; max=maximal number; SD=standard deviation)

	Front					Back			Side	Comb.
	roll slap	roll	direct slap	direct	direct barrel	roll	direct slap	direct		
<b>1.</b>	<b>18.00</b>	<b>40.50</b>	0.00	<b>4.00</b>	0.00	<b>13.00</b>	7.50	8.00	0.00	0.00
<b>2.</b>	<b>15.00</b>	<b>66.86</b>	<b>20.86</b>	0.14	0.00	0.71	8.86	<b>26.00</b>	0.00	0.00
<b>3.</b>	2.00	<b>47.67</b>	<b>19.67</b>	0.00	0.00	0.00	14.67	5.33	0.00	0.00
<b>4.</b>	<b>13.00</b>	<b>47.75</b>	6.25	0.25	0.50	<b>10.00</b>	20.75	10.50	13.50	1.50
<b>5.</b>	5.50	15.25	<b>17.25</b>	<b>4.00</b>	0.00	<b>6.00</b>	<b>40.50</b>	<b>26.75</b>	0.00	0.00
<b>6.</b>	8.00	22.00	9.50	0.00	0.00	0.00	<b>19.00</b>	9.00	0.00	0.00
<b>7.</b>	<b>15.00</b>	18.00	8.00	0.00	0.00	0.00	8.00	13.00	0.00	0.00
<b>8.</b>	0.00	6.33	<b>51.00</b>	<b>6.00</b>	0.00	<b>5.00</b>	<b>29.67</b>	12.00	0.00	<b>4.67</b>
<b>9.</b>	4.86	21.00	0.29	0.00	0.00	2.86	<b>49.14</b>	10.71	0.00	0.43
<b>10.</b>	1.33	<b>64.00</b>	0.00	0.00	0.00	2.00	<b>38.67</b>	10.67	10.33	<b>10.33</b>
<b>Avg</b>	<b>8.27</b>	<b>34.94</b>	<b>13.28</b>	<b>1.44</b>	<b>0.05</b>	<b>3.96</b>	<b>23.68</b>	<b>13.20</b>	<b>2.38</b>	<b>1.69</b>
<b>Min</b>	0.00	6.33	0.00	0.00	0.00	0.00	7.50	5.33	0.00	0.00
<b>Max</b>	18.00	66.86	51.00	6.00	0.50	13.00	49.14	26.75	13.50	10.33
<b>SD</b>	6.19	20.19	14.66	2.18	0.15	4.31	14.25	6.89	4.82	3.20

## Discussion

When experienced aikidokas are teaching and helping their less experienced counterparts, they show them the right way of the execution of the technique. That means they are throwing them down. That fact could be the reason, why non-experienced aikidokas performed more fallings than experienced ones. That could be seen in training session 6 and 7 when the difference between non-experienced and experienced aikidokas was highest (Table 3) and the number of experienced aikidokas was the lowest (Table 1). In opposite, the number of falling techniques in experiences doubled the number of non-experienced fallings in 9. session (Table 3), when the number of experienced aikidokas was the highest (Table 1).

The proportion of backward falls to forward falls was higher in non-experienced aikidokas than in experienced. This was due to the fact that experienced aikidokas are falling forward roll instead of backward fall from basic throwings like irimi nage, shiho nage and especially kote gaeshi. Experienced practitioners are able to lower impact forces when falling (Soltoggio et al., 2016) a consequence of which is believed to be a minimisation of impacts. This study measures the effectiveness of aikido-specific movements to minimise impact forces, and arguably the risk of injuries, in person-to-floor contact. In one experiment, we measured a significant reduction of impact forces with the ground for aikido experts during a forward roll in comparison to untrained participants. This first initial result encourages further studies of aikido techniques in areas such as safety and efficacy in sport exercise, safety during full body motion involving falls and impacts, transfer to human-robot interaction and training of elderly people. “;“container-title“:“Proceedings of the 10th International Symposium on Computer Science in Sports (iscss.



The intensity in falling techniques is given by velocity of fall, dependent on the initial force and the height of fall. Secondary, intensity is given also by the difficulty of coordination in advanced falling techniques (Ueshiba & Stevens, 2003).

Simple training sessions differ from each other. The number and proportion of different falling techniques vary on each training session according to its goal and specificity of given exercises. The methodology of aikido teaching is still in development and it should be inspired more by current sport methodology or even competitive branches of aikido (Shishida & Nariyama, 2001).

## Conclusion

In ordinary aikido training lesson, although non-significantly, non-experienced aikido students perform more falling techniques than experienced aikidhighokas. Thus the total load is higher in non-experienced. In this study, we did not evaluate the intensity and difficulty of performed techniques.

For further research, a quasi-experiment is recommended to divide a group of non-experienced and experienced aikido students. Also, the intensity and difficulty of aikido techniques and falling techniques should be evaluated.

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## EFFECTIVE PHYSICAL ACTIVITY INTERVENTIONS AT WORKPLACE: SPORT4HEALTH NETWORK

Valdemar Stajer<sup>1</sup>, Darinka Korovljević<sup>1</sup>, Igor Jukić<sup>2</sup>, Nebojsa Maksimović<sup>1</sup>, Sergej Ostojic<sup>1</sup>

<sup>1</sup>University of Novi Sad, Serbia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

**Introduction:** There is a large and well-developed body of evidence concerning the effectiveness of traditional physical activity interventions at workplace (e.g. walking initiatives, active travel) yet it appears that sparse data are available on the effects of specific types of exercise interventions (including stretching and muscle strengthening) on various groups of employees, including inactive individuals.

**Methods:** An extensive literature search in four bibliographical databases (PubMed, Web of Science, Scopus, and JSTORE) was conducted from outset up to February 2020. Randomized-controlled trials (RCTs) were included if participants were operative workers, the outcome measures included health-related physical fitness outcomes at baseline and follow-up to exercise interventions, and physical activity programs included strength and/or stretching exercise.

**Results:** Only three RCTs ( $n = 3$ ) of modest methodological quality were found, concluding that workplace-related specific physical activity interventions were superior to control or no intervention in terms of health-related physical fitness. One study of high methodological quality (Hunter et al., 2018) concluded that 8-week moderate- to vigorous-intensity resistance exercise program is sufficient to improve health-related physical fitness in fifty mid-age university employees. No RCT evaluated the effects of individual stretching program completed at the workplace.

**Conclusions:** A limited evidence is available concerning the effects of specific types of exercise interventions (stretching in particular) on health-related physical fitness outcomes at workplace (Prieske et al., 2019) while no information has been provided whether such interventions yield an additional benefit for health profiles of employees. Further high-quality RCTs comparing programs that encompass stretching and strengthening are needed to draw high-quality conclusions on the optimal program to upgrade health-related physical fitness in various work environments.

**Key words:** *physical activity, workplace, SPORT4HEALTH*

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## DIFFERENCES IN MOTIVATION FOR PHYSICAL EXERCISE AMONG PEOPLE WITH DIFFERENT EDUCATIONAL LEVELS

Nebojša Trajković<sup>1</sup>, Miroslav Zečić<sup>2</sup>, Mario Baić<sup>2</sup>, Damir Pekas<sup>2</sup>, Špela Bogataj<sup>3,4</sup>

<sup>1</sup>*Faculty of Sport and Physical Education, University of Novi Sad, Serbia*

<sup>2</sup>*University of Zagreb Faculty of Kinesiology, Croatia*

<sup>3</sup>*Faculty of Sport, University of Ljubljana, Slovenia*

<sup>4</sup>*University Medical Centre Ljubljana, Slovenia*

### Abstract

**Purpose:** A lack of physical exercise has been noticeable from an early age. Such behavioral patterns lead to obesity and other health problems. This study aimed to determine differences in exercise motivations regarding participants' educational levels. We assumed that there would be significant differences in exercise motivation between groups with different levels of education.

**Methods:** The study was conducted on a sample of 138 men and 80 women. One hundred eight of them had higher education (HE) and 110 had lower education (LE). The measuring instrument for this research was the Questionnaire for motivation factors for physical activity. The questionnaire consists of thirteen factors for exercise motivation. We calculated the correlation among factors with Person's correlation coefficient and between-group differences with the Mann-Whitney test.

**Results:** Both groups stated that the motivation factor „To feel in good shape physically“ has the highest rating and the factor „To get together and meet new people“ the lowest for their engagement in physical activity. When we look at statistically significant differences between the HE and LE, seven factors were rated with a higher score in the HE population compared to the LE population.

**Conclusions:** Information about differences in exercise motives is essential for finding ways and motives to engage as many people as possible in some form of physical exercise. Our study demonstrated that the population with higher education has stronger motives for exercise participation.

**Key words:** *motivation, exercise, man, woman, level of education, physical activity*

### Introduction

Although the benefits of regular PA have been strongly documented (Warburton & Bredin, 2017), motivating people to start or to maintain a program of regular organised or non-organized PA remains a challenge in most countries across the world.

By understanding what motivate people to be physically active, institutions, health and exercise professionals could create and apply programs that can motivate people to be more physically active (Lauderdale et al., 2015).

According to available informations, prevalence of overweight and obesity is increasing worldwide (Roberto et al., 2015). In some countries increased body weight has reached epidemic levels (Di Cesare et al., n.d.). Increase of body fat reduces the quality of life due to an increased risk of cardiometabolic, neurological and concomitant mental illness (Heymsfield & Wadden, 2017). In the same time some authors emphasize the importance of physical activity in improvement of the quality of life associated with health (Gómez-Bruton et al., 2021). Regular physical activity prevents or delays various chronic diseases, promotes mental health, reduces symptoms of depression and anxiety and improves quality of life (Duggal et al., 2019; M. C. Sun & Kawthur, 2013). Diversity in motives for physical exercise between men and women has been studied by several authors (Gutiérrez et al., 2018; Lauderdale et al., 2015; Walter et al., 2021). Walter et al., (2021) noted that the motivation for physical exercise for women was more related to Figure / Appearance and Activation / Enjoyment whereas for men the motivation for physical exercise was related to Competition / Performance in sports. The same authors studied the impact of BMI on motivation for physical activity. They also showed a decline in motivation for physical exercise with ageing which coincides with some previous research (Sun et al., 2013; Takagi et al., 2015). Furthermore, some studies tried to understand the reasons for decreased physical activity after transferring

from high school to college and what were the motives of the students which continued physical activity (Arzu et al., 2006; Valenzuela et al., 2021).

Previous research shows that men and women differ in exercise habits (Lustyk, Widman, Paschane, & Olson, 2004; Tiggemann & Williamson, 2000) and exercise motives (Crawford & Eklund, 1994; Davis & Cowles, 1991; Hsiao & Thayer, 1998; Markland & Hardy, 1993). However, studies that investigated the difference in motives according to educational level are missing.

Because of all of the above and the need to motivate the global population for physical activity, the aim of this manuscript is to investigate differences in motivation between the population that have higher education ( bachelor diploma or higher ) and the population that have high school or lower education.

## Methods

### Sample of respondents

The total population of the respondents is 218, of which 138 are men and 80 are women. 108 of them have higher education (HE) and 110 have lower education (LE). All respondents have been engaged in recreational sports for more than one year 2 to 3 times a week. The total number of enrolled trainees at the center by the day of the survey and the survey is 3211 trainees. There is a noticeable difference in the number of those who already exercise on a regular basis and there is a significant fluctuation in those who exercise but from time to time. The population of respondents is involved in various group programs offered by this center (military drill, body toning, total body workout, cardio pilates, pro ski up, etc.) and in the work on machines in the gym that are conducted individually with the supervision of a trainer. The group programs listed above are organized and implemented in groups of 10 to 15 trainees.

We divided the sample of respondents into two groups.

1. LE - a group consisting of trainees who exercise regularly with high school education and below. This group includes men and women with no completed primary school, completed primary school, completed three-year high school and completed four-year high school.
2. HE- a group consisting of trainees who exercise on a regular basis with post-high school education. This group includes men and women with a bachelor's diploma (180 ECTS credits), a university degree (300 ECTS credits), a Master of Science and a Doctorate.

### Measuring instrument and variables

The measuring instrument for this research is the Questionnaire for motivation factors for physical activity (Campbell, MacAuley, & McCrum, 2001). The questionnaire consists of 13 motives for exercising representing thirteen factors for exercise motivation. The examinees were asked with the question „How important it is to you during physical activity “ representing the variables.

The answers to the questions are graded on a five-point scale ranging from 1 to 5, depending on the importance of each factor to each respondent (1 - not at all important; 2 - mostly unimportant; 3 - moderately important; 4 – important; 5 - very important).

In addition, information about each respondent was included in the survey.

In determining the level of education, the answers offered were: **NSS** (Lower education– which means completed elementary school and below), **SSS** (High school education – which implies a three-year or four-year high school graduation), **VŠS** (College education – which implies the completion of additional education from 2 to 3 years after high school - the equivalent of 180 ECTS credits), **VSS** (Higher Education - which means university degree - equivalent of 300 ECTS credits - Master's Degree), **Magisterium** (Master of Science - which means additional education for 2 years after graduation), **Doctorate** (which implies a Doctorate level of education). When forming groups NSS and SSS drop into group LE, while VSS, VSS, Master's degree, Doctorate are drop into group HE.

### Data processing method

Statistical analysis was performed with statistical program Statistica for Windows 9.0. The mean value and the standard deviation were obtained for all parameters. Normality of distribution was tested with the Kolmogorov-Smirnov test.

Descriptive statistics is presented as mean value (mean) and standard deviation (SD), range (MIN-MAX), variance (S<sup>2</sup>), and distribution parameters (skewness, kurtosis). Correlation between the variables was tested with the Pearson correlation coefficient (r). Between-group differences were performed with the Mann Whitney test. Statistical significance was set at  $p < 0.05$ .

## Results

Table 1 shows the descriptive parameters of the first group (higher education- HE) and the second group (lower education - LE). Results generally presents relatively high scores in population HE (3,38±1,01 for motivation factor „*To get together and meet new people*“ and 4,55±0,69 for motivation factor „*To feel in good shape physically*“) and in population LE (2,95±1,18 for motivation factor „*To get together and meet new people*“ and 4,56±0,64 for motivation factor „*To feel in good shape physically*“).

Both groups stated that the motivation factor „*To feel in good shape physically*“ has the highest meaning and the factor „*To get together and meet new people*“ the lowest for their engagement in physical activity.

Table 1. Descriptive parameters of the first group (higher education- HE) and the second group (lower education - LE)

Variables	Mean±SD LE	Mean±SD HE
To improve or maintain your health	4,33±0,74	4,48±0,67
To get together and meet new people	3,38±1,01	2,95±1,18
To look good	3,99±0,98	3,77±0,94
To relax, forget about your cares	4,10±0,89	4,05±0,97
To learn new things	3,88±1,01	3,54±1,07
To seek adventure and excitement	3,56±1,17	3,07±1,13
To go outdoors	3,65±1,27	3,17±1,28
To have fun	4,00±1,03	3,66±1,13
To control or lose weight	3,88±1,26	4,02±1,00
To feel mentally alert	4,12±0,93	4,11±1,00
To feel in good shape physically	4,55±0,69	4,56±0,64
To feel independent	3,90±1,09	3,59±1,24
To feel a sense of achievement	4,29±1,01	4,10±0,99

Abbreviations: SD, standard deviation; HE, higher education group; LE, lower education group.

When we look at statistically significant differences between the HE and LE group, we notice differences in motivational factors “To get together and meet new people”, “To look good”, “To learn new things”, “To seek adventure and excitement”, “To go outdoors”, “To have fun”, and “To feel a sense of achievement.” All of these seven factors were rated with a higher score in the HE population compared to the LE population (Table 2). Leading to the conclusion that the HE group considered these factors statistically significantly more important to start exercising and remain physically active than the LE group.

Table 2. Differences between the first and second groups (HE and LE) determined by Mann-Whitney's U test.

Variables	Rank Sum HE	Rank Sum LE	U	Z	p-value	Z	p-value
To improve or maintain your health	11158,50	12712,50	5272,50	-1,43	0,15	-1,61	0,11
To get together and meet new people*	13087,50	10783,50	4678,50	2,71*	0,01*	2,80*	0,01*
To look good*	12688,50	11182,50	5077,50	1,85	0,06	1,98*	0,05*
To relax, forget about your cares	11928,50	11942,50	5837,50	0,22	0,83	0,23	0,81
To learn new things*	12921,00	10950,00	4845,00	2,35*	0,02*	2,46*	0,01*
To seek adventure and excitement*	13294,00	10577,00	4472,00	3,15*	0,00*	3,25*	0,00*
To go outdoors*	13127,50	10743,50	4638,50	2,79*	0,01*	2,87*	0,00*
To have fun*	12860,50	11010,50	4905,50	2,22*	0,03*	2,34*	0,02*
To control or lose weight	11732,00	12139,00	5846,00	-0,20	0,84	-0,21	0,83
To feel mentally alert	11773,50	12097,50	5887,50	-0,11	0,91	-0,12	0,90
To feel in good shape physically	11769,50	12101,50	5883,50	-0,12	0,90	-0,14	0,89
To feel independent	12655,50	11215,50	5110,50	1,78	0,08	1,85	0,06
To feel a sense of achievement*	12710,50	11160,50	5055,50	1,90	0,06	2,06*	0,04*

Abbreviations: HE, higher education group; LE, lower education group.



## Discussion

The main goal of numerous health organizations is to increase exercise participation because of the problems caused by sedentary life and obesity. Therefore, it is necessary to understand the reasons and motives for participation in order to encourage exercise and minimize possible dropouts. The present study aimed to identify the motives for exercise participation and how are they related to educational characteristics in a Croatian population. These findings enable the identification of the type of motivation in people with different education and might find the solutions for the increase of exercise participation and adherence. In our study, we obtained statistically significant differences in the seven motivational factors. All of these factors were rated higher by the HE group. This results support the fact that different populations have different motivations to exercise. There are different mediators related to motivation to exercise. Most researchers have addressed differences in motivation between men and women (Davis & Cowles, 1991; Craft, Carroll, & Lustyk, 2014; Pekas, Baić, Zečić, & Trajković, 2019). Moreover, Brunet and Sabiston (2011), found that middle-aged people had lower intrinsic motives compared to younger adults. Regarding educational level, studies showed that the greater the education, there is a greater chance that a person will participate in sufficient physical activity (Crespo, Ainsworth, Keteyian, Heath, & Smit, 1999; Mullineaux, Barnes, & Barnes, 2001). It is possible that better educated people have better understanding of benefits of exercise which may lead to greater participation in physical activity. This was confirmed in the current study showing that some factors were rated higher by the HE group.

## Conclusion

It is evident that the motives for physical exercise differ in people, and the fact is that regular physical exercise has a tremendous impact on the health and quality of life of the individual and the population as a whole. Being overweight due to a sedentary lifestyle decreases quality and life satisfaction. This further causes various psychological problems. In this paper, we tried to find differences in motivation depending on the level of education and found that education is important factor in differentiating between motivations to exercise.

Information on the differences in exercise motives is essential in terms of finding ways and motives to engage as many people as possible in some form of physical exercise, thus increasing quality and life satisfaction. In the future, more detail should be explored on how to activate as many people as possible for physical exercise, as this will improve people's health and quality of life in general.

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# Top-level Sport

## 9<sup>th</sup> INTERNATIONAL SCIENTIFIC CONFERENCE ON KINESIOLOGY

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## COMPARISON OF TWO DIFFERENT GROUPS OF TOP LEVEL WRESTLERS

Mario Baić<sup>1</sup>, Włodzimierz Starosta<sup>2</sup>, Damir Pekas<sup>1</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>State Research Institute of Sport in Warsaw, Poland

### Abstract

**Purpose:** The aim of this research was to identify the differences in the physical fitness between two top-level groups of wrestlers. **Methods:** The sample was composed of two groups of top-level Greco-Roman wrestlers (Polish and Croatian). The group of Polish wrestlers was 2.4 years older, and it had more international level medalists. First we calculated significant differences between different groups with univariate analysis of variance. The discriminant analysis was used to test if there was any discriminant function that statistically significantly differentiated Polish top level junior and Croatian top-level cadet Greco-Roman wrestlers. To better interpret the acquired data we used 100 point T-Scale. **Results:** With univariate analysis of variance a statistically significant difference between means 10 of 14 variables for physical fitness assessment was found. Using “T” scale we got a linear graph in which established statistically significant differences in physical fitness between two groups of wrestlers was shown. In accordance with its goal, the research results confirmed that there was one discriminant function that statistically significantly differentiated Polish junior from Croatian cadet top-level wrestlers. This discriminant function we named “endurance in power”. **Conclusion:** The practical value of this research is that it provided a scientific basis for solving a problem of how to increase the quality of Croatian Greco-Roman wrestling in the international arena. This was an important factor when we consider the significant increase in the quality of Croatian Greco-Roman wrestling in the international arena over the last 15 years.

*Key words:* Greco-Roman wrestling, junior, cadet, physical fitness, conditional preparation

### Introduction

Science and wrestling practice are still interested in the question what are the differences among different groups of top level wrestlers in the area of physical fitness. This issue is especially important because of frequent changes in wrestling rules during history. Consequently, many scientific studies have been made on this topic.

Starosta and Tracewski (1981) have tried to establish a standard set of tests (Set of tests assessing basic and specific preparedness of advanced wrestlers) to test the fitness preparation of advanced wrestlers. The specificity of this test set among other things is the particular emphasis on measuring general and specific coordination.

Furthermore, in 1984, Starosta also gave norms for successful wrestlers. The standards were determined on the basis of studies conducted from 1981 to 1984 using the battery of tests mentioned above. Standards use a T-score scale in which each score in a particular test is assigned a certain number of points (1-100 points).

Horswill et. al. (1989) found that different quality of wrestlers lies in anaerobic strength. For better wrestlers, anaerobic strength and capacity are at least 13% higher than at lower quality wrestlers. According to the authors, the reason for such results may be due to the relative amount of muscle mass or due to neuromuscular coordination. Faff et.al. (1999) studied the difference in space of aerobic and anaerobic capacity in higher and lower quality wrestlers. Furthermore, according to the authors, even maximum aerobic capacity should not be neglected as one of the important factors that determine the success of top wrestlers. Marić et.al. (2003) presented the hypothetical equation of wrestling specification in the classic style in which, according to the authors, power (maximum, explosive, repetitive, and static) takes the first place. Motor speed is in second place, followed by coordination, balance and flexibility. The authors found the importance of each of these abilities difficult to accurately calculate because this importance changes depending on the weight category and the age of the wrestler. Baić (2006) studied differences in physical fitness of differently successful wrestlers. The research was done on the group of cadets who competed in Greco-Roman wrestling. According to this study, more successful than less successful wrestlers are different in: hands strong endurance, specific speed and specific endurance. The authors of this paper tried to find out what significant differences were between different quality Polish and Croatian wrestlers in the area of physical fitness.

## Methods

### Sample of respondents

The sample consisted of top level Polish junior wrestlers (17-20 years old) and top level Croatian cadet wrestlers (15-17 years old) of Greco-Roman. The first group consisted of 63 Polish wrestlers who were members of the national junior team, (years of age  $18.31 \pm 0.90$  years; body weight  $74.74 \pm 14.80$ ; body height  $174.90 \pm 9.02$ ) while the second group consisted of 58 wrestlers of the Croatian cadet national team (years of age  $15.90 \pm 0.77$  years; body weight  $65.14 \pm 13.84$ ; body height  $172.19 \pm 9.59$ ). Tests were conducted between 1998 and 2004. The first group has more medals of international rank.

### Sample of measuring instruments

Starosta and Tracewski (1981 and 1998) describe a sample of measuring instruments that make up a set of tests assessing basic and specific preparedness of advanced wrestlers. The proposed set of tests fully meets the high requirements, and because of its value, this test suite becomes one of the most widely used set of tests worldwide. Metric characteristics have been reported in numerous papers (Starosta 1984, Sertić et al., 2005, Starosta et al., 2005, Marić et al., 2005) and it can be concluded that the tests used have very good metric characteristics. The specificity of this test set among other things is the particular emphasis on measuring general and specific coordination.

### Data processing methods

First, descriptive statistics for each group were calculated. Univariate analysis of variance established the statistical significance of differences between groups of Polish junior wrestlers and Croatian cadets. To see the differences between the best Polish junior wrestler and the best Croatian cadet wrestlers, a discriminant analysis was used. By discriminant analysis, we tried to determine whether there is a discriminatory function in the area of conditional preparation that significantly discriminates against a group of top Polish junior Greco-Roman wrestlers from top Croatian cadet Greco-Roman wrestlers. The criterion for the discriminatory power of functions is determined by the so-called Wilks lambda. As help in interpretation of the results we used 100-point T-Scale (Starosta 1984).

## Results

Univariate analysis of variance (Table 1) revealed a statistically significant difference ( $p < 0.05$ ) between means of 10 of the 14 variables used to assess physical fitness. Evaluation means using the 100 point "T" scale was used as an assistant method for easier interpretation of the results obtained. Croatian wrestling cadets of the Greco-Roman wrestling style only achieve numerically better results in the variable for evaluation explosive strength – Vertical jump test. Polish wrestlers juniors of the Greco-Roman wrestling style scored numerically better in the variables for evaluation specific coordination – Maximal turn in the jump, agility – Run with turnover, repetitive strength – Parallel bars dips, absolute maximum strength – Bench-press, Back squat, endurance - 1500-m running, flexibility – Backward trunk bending, specific coordination – The catch (snatch) from the neck and specific speed – Pirouettes. Based on these values, we are likely to draw the following conclusions:

1. Croatian wrestling cadets of the Greco-Roman wrestling style have significantly better explosive power of the jump type;
2. Polish wrestlers juniors Greco-Roman wrestling style have a more pronounced coordination - type of agility in the air around longitudinal axis; agility - change of the direction of movement; repetitive strength of the arms; absolute maximum power of arms and legs extensor; the flexibility of the lumbar spine; general endurance - running type and specific coordination - the catch (snatch) from the neck and specific speed – Pirouettes.

In accordance with the aim of this paper, discriminant analysis has established differences between top Croatian wrestlers cadets and top Polish wrestlers juniors in Greco-Roman wrestling style.

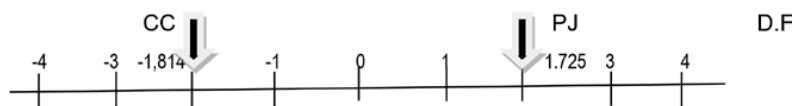


Table 1. Univariate analysis of variance for the variables assessing the physical fitness level of Polish and Croatian wrestlers in greco-roman style (n = 119)

Variables	SS Effect	df Effect	MS Effect	SS error	Df error	MS Error	F	p-level
Maximal turn in the jump (degrees)	171046.58	1	171046.58	1621141.93	114	14220.54	12.03	0.00
Zig-zag running, so-called envelope; (s)	0.81	1	0.81	99.13	114	0.87	0.93	0.34
Run with turnover (s)	18.58	1	18.58	53.47	111	0.48	38.57	0.00
Parallel bars dips (rep)	4303.39	1	4303.39	8490.22	114	74.48	57.78	0.00
Bench-press(kg)	16077.38	1	16077.38	46624.90	111	329.95	48.73	0.00
Back squat (kg)	7444.02	1	7444.02	60192.66	104	578.78	12.86	0.00
Vertical jump test (cm)	438.05	1	438.05	6865.66	114	60.23	7.27	0.01
20-m run from the flying start (s)	0.03	1	0.025	2.07	84	0.03	1.01	0.32
1500-m running (s)	96735.42	1	96735.42	114435.97	83	1378.75	70.16	0.00
Backward trunk bending (cm)	303.98	1	303.98	7482.81	114	65.64	4.63	0.03
flips backward (rep)	0.84	1	0.84	49.57	97	0.51	1.64	0.20
Bridge from above the upper stance (s)	0.19	1	0.19	9.34	109	0.09	2.24	0.14
The catch (snatch) from the neck (s)	42.99	1	42.99	129.99	82	1.59	27.12	0.00
Pirouettes(s)	19.93	1	19.93	132.44	109	1.22	16.40	0.00

Legend: SS Effect – the sum of square between groups; Df Effect – degrees of freedom between groups; MS Effect – mean squares between groups; SS Error – sum of squares within groups; Df Error – degrees of freedom within groups; MS Error – mean squares within groups; F – F approximation; p-level – probability of error; red – statistically significant.

Higher results of top Polish junior wrestlers found in most tests are caused primarily by biological maturation and the synergistic impact of better training technology for top wrestlers in Poland. A discriminant function was defined as endurance in strength that statistically significantly discriminated between these two quality groups of wrestlers. It was found that a group of top Polish wrestling juniors of the Greco-Roman style had significantly more endurance in strength than a group of top Croatian wrestling cadets of the Greco-Roman style.



Legend: D.F. – I. discriminant function („endurance in strength“); CC – croatian cadets Greco-Roman style wrestlers; PJ – Polish juniors Greco-Roman style wrestlers

Figure 1. Position of the centroids of the groups of Polish junior Greco-Roman style wrestlers and Croatian cadet Greco-Roman style wrestlers in the space of significant discriminant function (DF)

Special emphasis was put on numerically better results in the variable for estimating repetitive strength of arms and shoulders, which can be explained by the increasing use of technical and tactical elements, but also in the physical exercises for the development of strong endurance of the arms and shoulders in training.

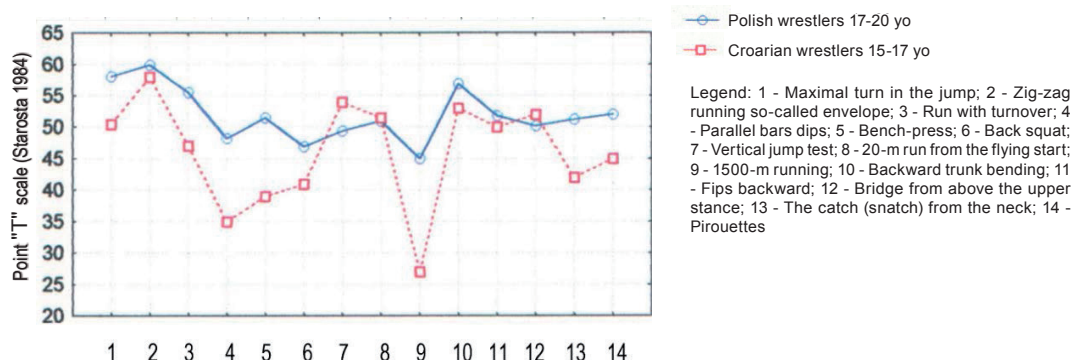


Figure 2. Differences between top-level Polish (17-20 yo) and Croatian Greco-Roman style wrestlers (15-17 yo) in variables for assessment of the physical fitness level (modified by Baić 2006)

## Discussion

The obtained results confirm the opinion of expert wrestling coaches from long ago that the basic problem of Croatian wrestlers is their lack of specific endurance. Previous research has produced the same or similar results (Nagle et.al. 1975; Silva et.al. 1981; Horswill et.al. 1989; Faff et.al. 1999; Baić et.al. 2003) which found that dynamic endurance ability is most likely a critical physiological factor for the distinguishing between successful and less successful wrestlers. The value of this research is great because it was and it still is a scientific way to address the problem of once inferior quality of Croatian wrestlers (cadets and juniors) in international arena and guidance to the quality of repair in the future.

## Conclusion

In accordance with the aim of this research, results confirmed that there was one discriminant function that statistically significantly differentiated two different quality groups of wrestlers. This discriminant function we named “endurance in power“. The practical value of this research is that it provided a scientific basis for solving a problem of how to increase the quality of less quality Croatian wrestlers Greco-Roman wrestling in the international arena. This was an important factor when we consider the significant increase in the quality of Croatian Greco-Roman wrestling in the international arena over the last 15 years. The above is consistent with the previous studies of many authors who found that the dynamic endurance is likely a critical factor distinguishing more than less successful wrestlers.

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## DETERMINATION OF STABILITY OF PERFORMANCE INDICATORS IN FOOTBALL

Valentin Barišić, Ivan Mikulić, Tihana Nemčić, Goran Sporiš, Stipo Dajaković

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The aim of this study was to determine minimal number of matches needed for obtaining a stable performance profiles of technical-tactical elements of players and teams in defined indicators. Based on the 88 matches of the Croatian First Football League in season 2014/2015, the cumulative arithmetic mean was used to determine stable performance profiles. Results showed that evaluation of the level of competitive performance through situational efficiency indicators requires different minimal number of analysed matches: 7 to 8 matches for the lost balls, 9 to 10 matches for ball possession, 12 to 13 matches for shots on goal, crosses, clearances and throw-ins, 13 to 14 matches for clearances after crosses, 14 to 15 matches for corner kicks, 15 to 16 matches for assists, key passes, blocked shots and crosses, 16 to 17 matches for yellow cards and at least 17 to 18 games for red cards and infringements resulting in penalty kick. Based on the results it can be concluded that a relatively large number of matches needs to be analysed for obtaining objective feedback and drawing conclusions on players' and teams' performance profiles, as well as different number of matches considering ranking of the team is needed to stabilize certain performance indicators.

**Key words:** notational analysis, situational efficiency, performance stability, football, soccer

### Introduction

Football match can be considered as a complex dynamic system in which two mutually opposing entities are trying to outperform each other and win. The performance of these entities and its successfulness is determined by the level of players'/ competitors' abilities, traits, skills and knowledge. Systematic observation of the football match reveals many match characteristic events that are repeated, recognizable and can be recorded. These events and their outcomes show players' and teams' level of situational efficiency (performance). Analyses of these events enable determination of reasons why certain teams have competitive advantage, i.e. how the final score of the match has been reached. Game analysis is often based on the subjective evaluation, but these methods are incomplete because it is not possible to record all events that occur. Some research (Laird and Waters, 2008; Franks and Miller, 1986) showed that experienced football coaches remember about 50% of critical events during the match, they remember mostly events that include player with the ball and their subjective assessment can occur under influence of emotions, previous experience and/or partiality towards particular action (Hughes and Bartlett, 2008). Relevant events leakage potentially limits further development of the entire system. To base their decisions on objectively determined players' and teams' performance indicators, coaches need as much information possible regarding the important events on football matches. Notational analysis is used to determine this relevant indicators regarding players and/or teams during the match. Notational analysis is a method for notating/recording events during the competition (football match in this case) and includes video analysis and use of statistical methods. Many different events can be tracked during the match, but selection of variables tracked depends on the assessment of the importance of performance indicators by the coaching staff. According to Hughes (2004), for the successful use of data collected by the notational analysis, several basic problems need to be solved: a selection of relevant performance indicators that allow sensible interpretation and effective use; acquirement of the reliable data and collection of enough data for creation of stable performance profiles. Stable performance profile is the one whose arithmetic mean and standard deviation would not significantly change with the addition of data from the new matches. The point of interest is how many matches need to be analysed for determining stable performance profiles. Thus, this research will try to determine the stable performance profiles of relevant situational efficiency indicators in football.

## Methods

### Analysis material

Material consists of 88 football matches of Max TV Croatian First Football League. For the purposes of this research, only a half-season consisting of 90 matches was analysed. Due to technical issues one match was not tapped, and one was scored 3:0 with no playoff.

### Subjects

Subjects were 10 football clubs from Croatian First Football League.

### Variables

Football matches are described by notarized performance indicators (variables) for the attacking phase, defensive phase, and indicators of play stops, fouls, warnings and sent-offs (Bašić et al., 2015).

### Data collection

Matches were recorded on HDD/DVD. Five notators used specifically designed computer tool “Courteye” for analysis and data processing.

### Data processing

Measurement of *intra-observer variability* was used to determine reliability of collected data for differences in data collected by the same notator in two occasions (Hughes et al., 2002; 2003; 2004).

Cumulative arithmetic mean was used to determine stable performance profile of technical-tactical components and deducing the minimum number of matches needed to be analysed to get a stable estimation of competitive performance in certain performance indicator.

$$\text{cum } \bar{x}_i = \frac{\sum_{j=1}^i f_j}{i} \cdot 100 ; \text{ for } i = 1, \dots, n$$

in which:

- $\text{cum } \bar{x}_i$  – cumulative arithmetic mean of observed indicator calculated for “i” played matches
- $f_j$  – frequency of observed performance indicator during a match
- $i$  – number of matches in a cumulative sequence
- $n$  – total number of matches

and;

$$\text{margin of error } 1\% = \bar{x}_n \pm \bar{x}_n \cdot 0,01$$

$$\text{margin of error } 5\% = \bar{x}_n \pm \bar{x}_n \cdot 0,05$$

Number of matches taken into analysis after which cumulative arithmetic mean does not exceed margins of error (5%) is considered sufficient for stable estimation of competitive performance, i.e. stable performance profile.

## Results

Table 1. Intra-observer reliability of notators for differences in indicators collected by the same notator in two occasions

Performance indicator	Reliability		
	Low	Moderate	High
Ball possession			97%
Shots on goal			93%
Crosses			92%
Assists			100%
Key passes	63%		
Lost balls		79%	
Clearances			95%
Blocked shots and clearances			91%
Clearance after crosses			93%
Corner kicks			94%
Throw-ins			92%
Yellow cards			100%
Red cards			100%
Infringement resulting in penalty kick			100%

Legend – low reliability (< 70%); moderate reliability (70 – 90%); high reliability (> 90%)

Parameters of reliability were somewhat lower only for variable *key passes* (63 %) and moderate for variable *lost balls* (79%), while for all the other performance indicators high reliability has been shown.

Table 2. Number of matches needed for estimation of stable profiles of performance indicators for individual technical-tactical elements in football

Performance indicator	Low degree of stability	Moderate degree of stability	High degree of stability
Ball possession			9 to 10
Shots on goal		12 to 13	
Crosses		12 to 13	
Assists	15 to 16		
Key passes	15 to 16		
Lost balls			7 to 8
Clearances		12 to 13	
Blocked shots and clearances	15 to 16		
Clearance after crosses	13 to 14		
Corner kicks	14 to 15		
Throw-ins		11 to 12	
Yellow cards	16 to 17		
Red cards	17 to 18		
Infringement resulting in penalty kick	17 to 18		

Legend – low degree (> 13); moderate degree (10 to 13); high degree (>10 matches) of stability.



Table 3. Stable profile indicators of individual situational efficiency parameters, coefficient of correlation (*r*), arithmetic mean (*AM*) of stable profiles for all analyzed teams and arithmetic mean (*AM*), standard deviation (*SD*), minimal (*MIN*) and maximal value (*MAX*) for three teams of which one ranked first (GNK Dinamo), one fifth (NK Zagreb) and one ninth (NK Osijek) in Croatian First Football League.

Performance indicator	R	Team (1 <sup>st</sup> place)					Team (5 <sup>th</sup> place)				Team (9 <sup>th</sup> place)			
		AM	AM	SD	MIN	MAX	AM	SD	MIN	MAX	AM	SD	MIN	MAX
Ball possession	0,82	<b>9,34</b>	<b>8,03</b>	2,77	2	13	<b>8,80</b>	2,73	3	14	<b>11,20</b>	2,94	3	16
Shots on goal	0,85	<b>12,83</b>	<b>12,27</b>	2,86	6	17	<b>12,33</b>	2,68	6	17	<b>13,90</b>	1,88	8	17
Crosses	0,63	<b>12,48</b>	<b>12,23</b>	3,07	6	17	<b>12,37</b>	2,54	7	16	<b>12,83</b>	2,63	9	17
Assists	0,84	<b>15,87</b>	<b>15,97</b>	1,27	13	18	<b>15,67</b>	1,30	11	18	<b>15,97</b>	1,97	13	18
Key passes	0,33	<b>15,82</b>	<b>15,33</b>	1,69	11	17	<b>15,63</b>	1,63	10	17	<b>16,50</b>	1,46	12	18
Lost balls	0,17	<b>8,13</b>	<b>9,87</b>	2,89	4	15	<b>7,50</b>	3,41	1	14	<b>7,03</b>	3,16	2	13
Clearances	-0,58	<b>13,70</b>	<b>14,70</b>	2,61	6	18	<b>12,97</b>	2,40	8	17	<b>13,43</b>	2,71	8	17
Blocked shots and clearances	-0,66	<b>15,26</b>	<b>16,27</b>	1,53	10	17	<b>14,23</b>	2,03	8	17	<b>15,27</b>	1,78	11	17
Clearance after crosses	-0,70	<b>13,62</b>	<b>14,27</b>	2,42	8	17	<b>12,20</b>	3,08	6	17	<b>14,40</b>	2,19	9	17
Corner kicks	0,79	<b>14,06</b>	<b>13,57</b>	1,89	10	17	<b>13,93</b>	2,21	9	17	<b>14,67</b>	1,81	10	17
Throw-ins	0,38	<b>11,27</b>	<b>10,13</b>	3,32	3	15	<b>11,83</b>	3,03	6	16	<b>11,83</b>	2,74	7	17
Yellow cards	-0,25	<b>15,56</b>	<b>15,90</b>	1,21	12	17	<b>15,43</b>	1,91	10	17	<b>15,33</b>	1,81	9	17
Red cards	-0,54	<b>17,76</b>	<b>18,00</b>	0,00	18	18	<b>18,00</b>	0,00	18	18	<b>17,27</b>	3,10	1	18
Infringement resulting in penalty kick	-0,54	<b>17,93</b>	<b>17,93</b>	0,25	17	18	<b>17,93</b>	0,25	17	18	<b>17,93</b>	0,25	17	18

Stable performance profile of technical-tactical elements is the one whose arithmetic mean will not be significantly changed with the addition of the data obtained from the new matches. Results in the table 3 showed that there are differences in stability of individual situational efficiency parameters with respect to needed minimal number of matches, as well as the stability of the same parameter in different teams.

## Discussion

High measure of internal overlap of the notators for situational efficiency indicators collected by the same notator in two time points has been found, which fulfills the preconditions for quality analysis of football matches. This method of analysis shows a high degree of notational reliability for all matches. Low reliability of variable *key passes* is associated with more complex process of defining opportunities for scoring because it is not possible to fully and uniquely define what a scoring opportunity is, and key passes precede the scoring opportunities. *Lost balls* moderate reliability can be explained with reduced capacity to differ, or interference of this event (lost ball) with other defensive actions such as clearances, blocks and infringements. According to Bašić et al. (2015) stable profiles of performance are very important for quality estimation of certain situational efficiency parameter, i.e. for obtaining true feedback on minimal number of matches needed for objective estimation. Some situational parameters show higher stability, i.e. smaller number of matches is needed for determining their stable performance profile. Due to its technical structure and frequency of occurrence during the matches, parameters like *shots on goal*, *crosses*, *clearances* and *throw-ins* have moderate stability, i.e. their true estimation requires 12 to 13 matches. Parameters like *assists*, *key passes*, *blocked shots and crosses*, *clearances of balls and crosses*, *corner kicks*, *yellow cards*, *red cards* and *infringements resulting in penalty kick* require relatively big number of matches for their stabilization (Bašić et al., 2015). Further on, when it comes to minimal average number of matches needed for stabilization of individual efficiency indicators of all first league teams, as well as the average number of matches needed for getting stable profiles of teams with different final football league rank: *ball possession*, *shots on goal*, *crosses*, *key passes*, *corner kicks* and *throw-ins* are stabilized earlier in higher ranked teams comparing to lower ranked teams. This means that smaller number of matches are needed to be analyzed in order to reach stable results in these variables. Higher ranked teams' superior application of attacking tactical knowledge enables them to have longer ball possession, more ball touches, more scoring opportunities preceded by key passes, and more crosses. Moreover, number of corner kicks is higher for better ranked teams due to more frequent entry into final attacking sub-phase and more throw-ins, while lower ranked teams who possess lower quality of tackling the ball have lower ball possession and tend to kick

the ball out of play more often. *Assists* as a situational efficiency indicator show stability, on average, after equal number of matches for all teams regardless of their rank, even though it would be expected that commonly winning teams score and assist more often. The fact that higher quality teams score more from players' individual actions explains it, which confirms the individual quality of players in that match segment. *Lost balls, clearances, blocked shots and crosses, and clearances after crosses*, as indicators of lower quality of handling the ball and frequent loss of the possession, achieve stability faster in lower ranked teams than in higher ranked. *Yellow cards, red cards and infringements resulting in penalty kick*, as indicators rarely awarded during matches, have similar stability in all teams, i.e. there is no significant difference with respect to the final team's league rank.

## Conclusion

Different number of matches in football needs to be analyzed for different performance indicators to get objective feedback and be able to make conclusions on players' and teams' performance profiles. Minimal number of matches needed for stabilization of certain performance indicators in football have been determined. Furthermore, some technical-tactical elements, i.e. performance indicators, do not have the same stability in higher ranked teams comparing to lower ranked teams. These results indicate that there is still need for prolonged and more detailed analysis of certain performance indicators to objectively value their situational efficiency.

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## FITNESS LEVEL AND QUALITY OF HANDBALL REFEREES IN REGARD TO THEIR AGE

Ivan Belčić<sup>1</sup>, Lana Ružić<sup>1</sup>, Slaven Krtalić<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Croatian Institute of Public Health, Croatia

### Abstract

The aim was to determine whether there was any difference in conditioning level between young and experienced handball referees which officiate at the highest rank of national competition. The total sample of subject consisted of all 16 pairs of referees (32 total) representing the highest rank in national competition. They were divided to referees under (young) and over (experienced) 35 years. The results show the statistically significant differences in five abilities: 10-meter sprint ( $p=0.05$ ), relative maximal oxygen uptake ( $p=0.01$ ), relative maximal oxygen uptake at anaerobic threshold ( $p=0.01$ ), maximal heart rate ( $p=0.01$ ) and maximal heart rate at anaerobic threshold ( $p=0.01$ ). Motor and functional abilities did not differ between experienced and young referees in highest rank of national competition, at least not in those abilities that might influence the quality of refereeing. The differences found in functional abilities were related to ageing process and it seemingly did not affect referee performance, as referees who are experienced had significantly better grades at the end of the season, which means that they had better refereeing performance (quality of refereeing) during matches.

**Key words:** referee performance, conditioning level, age difference, elite-level referee

### Introduction

The referees need to be as close as possible to the game action to notice and sanction violations of the rules. The referee performance in contact sports is closely linked to the ability of monitoring physical and physiological requirements during a match (Caballero et al., 2011; Rebelo et al., 2011; Weston et al., 2010). The referees officiate and manage the game with their decisions related to the rules of the game and apply disciplinary measures to ensure fair implementation of the rules and their application to keep players safe and protected throughout the game (Mallo et al., 2012). A significant role in the selection of players in handball are anthropometric characteristics, functional abilities (aerobic and anaerobic capacity), social personality characteristics, motor abilities, cognitive and conative characteristics, as well for referees to officiate at a constant high-quality level during a match or competition. During the season handball referees need to keep their physical level high, but they also have to cope with mental pressure (Mirjamali et al., 2012) in the form of several types of stress, as the work of sport referees is recognized as a very stressful activity. Considering this fact, the referees might suffer from various stressors which might negatively affect cognitive and psychosocial processes such as concentration, focus, effort, attention and lead to decreased motor performance (Anshel & Sutarso, 2007). And it is precisely the motor abilities that affect the quality of refereeing (Belcic et al., 2018), and it might be expected that with a better level of motor abilities the referees come to a better position during the match and consequently a better position on the field can make the right decision. Also, physiological loads of referees are very high during matches and referees need to have high level of functional abilities to be able to cope with all the requirements of handball match (Roux et al., 2021). In previous times, a success was mostly based on the technical readiness of players, unlike today's modern handball which requires a higher physical preparation from players (Belcic & Sporis, 2012). Several factors contributed to development of modern fast handball and one of the most important is the change in the rules of the game such as a quick restart of the game and passive play (Krüger et al., 2014). After these changes the time between the defence phase and the attack phase was significantly reduced, so the game became more dynamic and demanding (Póvoas et al., 2014) for both referees and the players.

The aim of this study was to determine whether there was any difference in conditioning level between young and experienced handball referees which officiate at the highest rank of national competition. The hypothesis set for this study was that the young referees would be condition-wise on higher level and would perform better than the experienced referees in individual tests used determining conditioning level.

## Methods

### Subjects sample

The total sample consisted of all 16 pairs of referees, which means 32 handball referees (age  $34.80 \pm 5.63$  years, height  $184.57 \pm 5.67$  centimetres, body mass  $92.08 \pm 10.76$  kilograms, body fat  $19.98 \pm 4.14\%$  and Body mass index  $26.78 \pm 2.49$  kg/m<sup>2</sup>) representing the list of the Premier Croatian Handball League referees (the highest league in rank in Croatia). The referees were divided into two groups according to chronological age, with one group up to 35 years (young referees) and the other above 35 years of age (experienced referees). One subject had had a hamstring injury during the maximal speed test and his results before injury were excluded from final results (so the total sample for data analysis comprised of 31 subjects). Ten of the subjects were also officiating in multinational competitions and European competitions, whether on club levels or international level.

### Procedure

The study design had two phases and was conducted at the premises of Sports-Diagnostic Centre of Faculty of Kinesiology, University of Zagreb. The first phase consisted of measuring anthropometric measurements: body weight, body height and body fat percentage (which was calculated according to Brožek equation (Brožek et al., 1963):

- Body density =  $1,11200000 - 0,00043499 \times (\text{sum of 7 skin folds}) + 0,00000055 \times (\text{sum of 7 skin folds})^2 - 0,00028826 \times \text{age}$

$$\text{Body fat percent} = \left( \frac{457}{\text{Body density}} \right) - 414$$

After the measurements, the subjects performed a warm-up protocol which lasted for 20 minutes after which their motor abilities were determined through five tests: sidestep test, frontal agility test with a turn (9-3-6-3-9 with 180-degree turn), eights with bending, agility T-test and 20 meters sprint with split times on 5 meters and 10 meters). The second phase was testing of functional abilities with ergospirometry test (all-out VO<sub>2</sub>max treadmill test) in standard laboratory microclimatic conditions (closed and ventilated room with 18-21°C) on treadmill (HP Pulsar 3P, Cosmos, Nußdorf, Germany). The test was supervised by an MD and sports science experts who led protocol and instructed subjects during the test. The standard test protocol was used with subject standing still and breathing through the respiratory mask in the beginning of the test. Subjects started to walk at 3 km/h and then speed increases every minute for 1 km/h at incline of 1.5%. Most of the subjects start to run at an app. speed of 8 km/h (running speed is individual) and they continued to run until the voluntary exhaustion.

### Data analysis

Data were analysed in software Statistica for Windows version 13.5 (StatSoft, Inc., Tulsa, OK, USA). Central tendency parameter (mean) and measure of variability (standard deviation) were calculated for both groups of referees, along with the maximum and minimum result (range). Differences in tested variables of experienced and young referees were tested by Student t-test for independent samples while the level of significance was set at  $p < 0.05$ .

### Results

Basic anthropometric measures and conditioning parameters of referees presented in Table 1 shows statistically significant differences in 10-meter sprint test, maximal heart rate and heart rate at anaerobic threshold as well as in relative maximal oxygen uptake and the VO<sub>2</sub> at anaerobic threshold. Also, referees differ in grades from supervisors which represent the quality of refereeing. The difference in age was expected and confirmed that the referees age was an important factor influencing the fitness level.

Table 1. Basic anthropometric measures and conditioning parameters with significant differences according to T-test for independent samples

Variables	Experienced referees x ± SD Range	Young referees x ± SD Range	T-test				
			t-value	df	p	F-ratio variances	p variances
Age (years)	41.07 ± 3.00 37 – 46	29.67 ± 2.93 24 – 34	<b>-10,81</b>	<b>31</b>	<b>0,00*</b>	<b>1,05</b>	<b>0,91</b>
Body weight (kg)	94.13 ± 8.20 76.0 – 108.7	88.68 ± 11.39 71.70 – 109.8	0,00	31	1,00	1,26	0,68
Body height (cm)	183.90 ± 5.32 176.0 – 196.4	183.91 ± 5.98 174.3 – 195.0	-1,5	31	0,14	1,93	0,23
Body fat (%)	20.21 ± 3.58 14.50 – 29.07	18.48 ± 4.02 11.80 – 24.48	-1,3	31	0,21	1,26	0,68
Sidestep test (s)	8.86 ± 0.91 7.53 – 11.14	8.83 ± 0.64 7.84 – 10.00	-0,10	30	0,92	2,02	0,19
9-3-6-3-9 with turn 180° (s)	9.12 ± 1.13 7.49 – 11.33	8.81 ± 0.56 8.11 – 10.11	-1,0	30	0,32	4,18	0,01
Eights with bending (s)	19.9 ± 2.1 16.96 – 23.59	19.00 ± 0.98 16.73 – 20.56	-1,6	30	0,13	4,58	0,01
Agility T-test (s)	9.47 ± 1.15 7.71 – 11.87	9.13 ± 0.38 8.47 – 9.88	-1,2	30	0,26	9,16	0,00
5m sprint (s)	1.65 ± 0.18 1.37 – 1.86	1.57 ± 0.12 1.31 – 1.78	-1,5	30	0,16	2,02	0,19
10m sprint (s)	2.51 ± 0.23 2.16 – 2.81	2.35 ± 0.18 1.98 – 2.62	<b>-2,08</b>	<b>30</b>	<b>0,05*</b>	<b>1,58</b>	<b>0,39</b>
20m sprint (s)	3.96 ± 0.35 3.52 – 4.79	3.78 ± 0.2 3.40 – 4.13	-1,8	30	0,09	3,19	0,03
Heart rate maximum (bpm)	181.18 ± 6.69 171 – 190	189.33 ± 8.58 175 – 203	<b>2,68</b>	<b>30</b>	<b>0,01*</b>	<b>1,65</b>	<b>0,43</b>
Heart rate at anaerobic threshold (bpm)	170.82 ± 7.28 161 – 179	178.56 ± 7.25 166 – 190	<b>2,79</b>	<b>30</b>	<b>0,01*</b>	<b>1,01</b>	<b>0,95</b>
Maximal running speed (km/h)	13.82 ± 1.75 11.50 – 15.50	14.25 ± 1.36 12.50 – 18.00	0,74	30	0,46	1,65	0,35
Running speed at anaerobic threshold (km/h)	11.95 ± 1.44 9.0 – 14.0	12.31 ± 0.91 10.50 – 15.0	0,81	30	0,43	2,50	0,09
Maximal oxygen uptake (l/min)	4.03 ± 0.36 3.52 – 4.59	4.15 ± 0.47 3.12 – 4.74	0,72	30	0,48	1,67	0,41
Relative max oxygen uptake (ml/min/kg)	41.91 ± 3.31 38.06 – 47.51	47.70 ± 6.44 38.50 – 61.02	<b>2,75</b>	<b>30</b>	<b>0,01*</b>	<b>3,79</b>	<b>0,04</b>
Relative max oxygen uptake at anaerobic threshold (ml/min/kg)	38.26 ± 3.30 32.62 – 42.60	43.23 ± 4.74 34.74 – 52.74	<b>3,04</b>	<b>30</b>	<b>0,01*</b>	<b>2,07</b>	<b>0,24</b>
Quality of refereeing grade	72.63 ± 5.04 67.38 – 81.96	69.82 ± 2.31 66.00 – 73.79	<b>-2,05</b>	<b>30</b>	<b>0,05*</b>	<b>4,79</b>	<b>0,00</b>

Legend: \* - statistically significant difference according to T-test for independent samples

## Discussion

The most important finding of this study was only one statistically significant difference in motor abilities determined between experienced and young referees and this finding was exactly opposite from similar study on basketball referees (Rupčić et al., 2011), where comparing two age groups of referees the significant differences were found in all motor tests. The only motor ability that differed in this study was a 10-meter sprint. It is a very interesting finding as this test is part of full 20-meter sprint with measuring intermediate times as 5, 10 and 20 meters. It might be explained with much better explosive power abilities, or even reaction times, in younger group. Still it seems that the older group was able to catch up in the second part of the test as the difference in final result of the total 20m test was not significant. The difference in maximal heart rate and consequently in heart rate at anaerobic threshold was expected due to the age difference between groups as maximal heart rate decreases with age (Betik & Hepple, 2008; Hawkins & Wiswell, 2003; Rogers et al., 1990). Widely used method for estimation of decline of maximum oxygen uptake is 1% per year after 30 years of age (Astrand, 1960), and it explains the obtained difference very precisely, as the most experienced referee had 46 years and the youngest only 24 of age. As an anaerobic threshold is usually expressed as maximal heart rate at threshold (Sales et al., 2019), logically that values also differed as were dependant on HRmax. In case the values were expressed as relative (percentage of HRmax at anaerobic threshold) the differences would probably not be that big. As the relative maximum oxygen uptake decreases with age because of the decrease of maximal cardiac output the results of the VO<sub>2</sub>max after all-out treadmill test confirmed a somewhat lower aerobic capacity in older group, but surprisingly not too large (only around 6 ml/kg/min but significant). Also, consequently, the difference in relative oxygen uptake at anaerobic threshold



was found due to difference in previously mentioned variable. Nevertheless, the referee performance during the match, called quality of refereeing grade, was statistically significantly better for experienced referees. This confirms conclusions of previous studies (Karacam & Pular, 2017; Nurcahya et al., 2019) which proved the experience to be a vital factor for quality of refereeing meaning referees might compensate the lack in fitness level with their experience.

## Conclusion

The motor and functional abilities did differ to a certain extent level between experienced and young referees in highest rank of national competition which have an influence on quality of refereeing. The differences found in functional abilities were probably due to the normal ageing process and did not affect the referee performance as referees which were experienced had the statistically significant better grades at the end of the season. It could be concluded that despite the fitness level the quality of refereeing largely depends on experience. The findings might be important for various handball federations in future, as the age and the fitness level should maybe be reconsidered, and tests interpreted cautiously in top level referee selection process.

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## DIFFERENCES IN SITUATIONAL EFFICIENCY PARAMETERS OF SERVE AND SERVE RETURN BETWEEN MATCH WINNERS AND LOSERS IN 2019 AUSTRALIAN OPEN

Danijel Bertović<sup>1</sup>, Tomislav Hublin<sup>2</sup>, Zlatan Bilić<sup>1</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Polytechnic of Međimurje in Čakovec, Croatia

### Abstract

The aim of this research was to determine the differences in situational efficiency parameters of serve and serve return between match winners and losers at the 2019 Australian Open. For the purpose of this research, official data was used from all played men's singles matches in the main part of the 2019 Australian Open draw. Serve and serve return variables were compared from the first three sets in all played matches for each male player who won and lost in the men's singles category. The examined sample consisted out of statistical data from matches played between 128 tennis players in the main part of the draw. The sample of variables in this research was composed of 11 serve parameters and 11 serve return parameters. All the parameters were derived by using the Infosys system, which was the official system for tracking statistical data at the 2019 Australian Open tournament. Descriptive parameters were calculated for each variable, as follows: arithmetic mean (AM), standard deviation (SD), minimum and maximum values (MIN and MAX). The differences in situational efficiency parameters of serve and serve return between match winners and losers at the 2019 Australian Open were determined by using the independent samples t-test. In this research, the results for serve situational efficiency parameters showed that match winners won statistically significantly more points after the first serve in all sets, as well as that they had more total points won on serve in the first two sets. The results for situational efficiency parameters of serve return showed that match winners statistically significantly differ in several components, among which the total number of return points won after first and second serve and the total number of return points won should be highlighted.

*Key words: tennis statistics, serve, serve return, situational efficiency*

### Introduction

In terms of structural complexity, semi-open and open movement structures prevail in tennis, which are performed in changing conditions. The mentioned changing conditions refer to a large number of factors, among which the most relevant ones are the following: type of playing surface, type of tennis ball, surroundings, match interruption due to weather conditions, playing the match in any given time of the day, match tactics of the contestants, etc. As a complex game, tennis requires linking and having an effect on a significant number of factors, all aimed at efficiently mastering and improving one's tennis game. A quality technical-tactical, physical conditioning and psychological preparation are all interconnected links that depend on one another and lead to success (Neljak, Dugandžić & Barbaros Tudor, 2010). In view of various parameters that characterize the game of tennis and that can determine the winner of a match, this scientific paper shall demonstrate efficiency parameters of serve and serve return in the 2019 Australian Open tournament. The research shall include differences between 11 serve variables and 11 serve return variables that can affect the outcome of a tennis match. Return of serve or serve return is a technical-tactical element of the game and the second most important one after serve in terms of its effect on the match outcome. The forehand and backhand during serve return are not considerably different in the technical method of performance from the forehand and backhand during play for a tennis point. The difference lies in the fact that the return is a reaction to the serve, so that the flight, speed and spin of the tennis ball are different than when performing the forehand and backhand within a tennis point (Friščić, 2004).

### Methods

For the purpose of this research, official data was used from all played men's singles matches in the main part of the 2019 Australian Open draw. Serve and serve return variables were compared from the first three sets in all played matches for each male player who won and lost in the men's singles category.

## Sample of examinees

The examined sample consisted out of statistical data from matches played between 128 tennis players in the main part of the draw. For each tennis match, statistical data was processed for the first three played sets. Data was statistically treated for match winners and losers in the first, second, third and fourth round, as well as in the quarterfinals, semi-finals and the final match.

## Sample of variables

The sample of variables in this research was composed of 11 serve parameters and 11 serve return parameters. All the parameters at the 2019 Australian Open tournament were tracked by using the Infosys statistics recording system. The statistical variables by means of which the serve was tracked were as follows: number of aces (AS), number of double faults (DF), number of points played after the first serve (1SP), number of points won after the first serve (1SW), points played after the second serve (2SP), points won after the second serve (2SW), total number of points played on serve (TP), total number of points won on serve (TPW), fastest serve (FS), average speed of first serve (1SA), average speed of second serve (2SA).

The serve return was tracked through the following statistical variables: number of return points played after the first serve (1RT), number of return points in play after the first serve (1RP), number of return points won after the first serve (1RW), number of return points played after the second serve (2RT), number of return points in play after the second serve (2RP), number of return points won after the second serve (2RW), total number of return points played (RT), total number of return points in play (RTP), total number of return points won (RTW), number of return winners (RW), number of return unforced errors (RUE).

## Methods of data processing

In this research, the following descriptive statistical parameters were calculated for all variables: arithmetic mean (AM), standard deviation (SD), minimum and maximum values (MIN and MAX). The differences in situational efficiency parameters of serve and serve return between match winners and losers at the 2019 Australian Open were determined by using the independent samples t-test with a statistical significance of 0.05.

## Results

On the basis of the collected data, the obtained results were then analysed by determining the differences between the players who won and lost in a match in relation to serve parameters from the first, second and third set, as well as by the differences in serve return parameters during the first three sets. The final results in this research represent statistical variables by means of which one can determine the differences in situational efficiency parameters of serve and serve return between match winners and losers at the 2019 Australian Open.

The results presented in Table 1 show arithmetic means and standard deviations ( $AM \pm SD$ ), as well as the significance of differences ( $p$ ) during the first three sets for the winners (N1) and for the losers (N2) in serve efficiency parameters. It is demonstrated that the players who won the match statistically significantly differ in two serve variables during the first set. The afore-mentioned refers to the number of points won after the first serve (1SW), which was on average 15,05 for winners and 13,72 for losers, as well as to the total number of points won on serve (TPW), 21,21 for players who won and 19,38 for players who lost the match.

In other serve variables, there were also differences between average results of players who won and lost the match, however, statistically significant differences were not determined. In all variables, the match winners achieved higher average results.

In terms of determining statistical significance, the differences in situational efficiency parameters of the serve during the second set did not differ from the ones in the first set. The results indicate statistically significant differences in the number of points won after the first serve (1SW) and in the total number of points won on serve (TPW). With regard to the first set, the number of aces and double faults increases in the second set, both for match winners and losers. Likewise, when compared to the first set, the number of points played after the first and second serve is also higher in the second set, both for players who won and lost the match.

In the third set, there are two serve parameters that statistically significantly stand out. Once again, there is a larger difference in the number of points won after the first serve when comparing match winners (14,92) to match losers (13,65), identically as in the first two sets, while for the first time there is also a statistically significant difference in the number of points played after the second serve, which is higher among match losers (11,90) when compared to the winners (10,58). Unlike in the first two sets, there is no statistically significant difference in the total number of points won. The average values for points won after the first serve are the lowest in the third set – third set (14,92/13,65), second set (15,67/14,35), first set (15,05/13,72). Identically as in the first two sets, players who lost the match had more points played after the

second serve, however, it was only in this set that the mentioned difference between match winners (10,58) and losers (11,90) was a statistically significant one.

Table 1. Descriptive statistics and indicators of statistical significance for differences of situational efficiency parameters of serve in the first three sets

VAR	1 <sup>st</sup> set			2 <sup>nd</sup> set			3 <sup>rd</sup> set		
	AM±SD	AM±SD	p	AM±SD	AM±SD	p	AM±SD	AM±SD	p
	N1	N2		N1	N2		N1	N2	
AS	3,39±2,16	2,73±2,8	0,06	3,75±2,64	3,21±2,92	0,13	3,45±2,57	2,86±2,44	0,07
DF	0,79±1,08	1,02±1,02	0,08	0,94±1,03	1,22±1,26	0,06	0,96±0,97	1,04±1,17	0,55
1SP	19,3±6,19	19,65±6,23	0,65	20,44±6,25	20,61±7,34	0,84	19,2±6,50	19,85±6,50	0,44
1SW	15,05±4,96	13,72±5,6	<b>0,05</b>	15,67±4,71	14,35±5,59	<b>0,05</b>	14,92±4,68	13,65±5,2	<b>0,05</b>
2SP	10,64±4,27	11,57±4,04	0,07	11,00±4,83	12,1±4,4	0,06	10,58±4,44	11,90±4,00	<b>0,01</b>
2SW	6,09±2,75	5,65±2,89	0,22	6,05±3,03	5,62±2,88	0,26	5,75±2,71	5,66±2,89	0,80
TP	29,94±8,74	31,22±8,33	0,23	31,4±9,11	32,62±9,31	0,30	29,67±9,25	31,70±8,40	0,07
TPW	21,21±5,8	19,38±7,18	<b>0,03</b>	21,72±5,98	19,88±6,6	<b>0,02</b>	20,61±5,87	19,31±6,76	0,11
FS	204,56±8,94	203,42±10,59	0,45	203,87±9,05	201,95±10,88	0,22	202,78±9,83	201,42±9,05	0,36
1SA	189,34±9,04	187,26±11,56	0,19	188,54±9,33	185,7±10,73	0,07	188,11±9,70	185,65±9,29	0,10
2SA	156,35±9,00	153,48±12,3	0,08	155,55±9,9	154,47±11,34	0,51	155,07±9,21	153,49±10,80	0,32

N1-winners, N2-losers, AM-arithmetic mean, SD-standard deviation, p-significance level, AS- number of aces, DF-number of double faults, 1SP-points played after the first serve, 1SW-points won after the first serve, 2SP-points played after the second serve, 2SW-points won after the second serve, TP-total number of points played on serve, TPW-total number of points won on serve, FS-fastest serve, 1SA-average speed of first serve, 2SA-average speed of first serve

The parameters of serve return presented in Table 2 demonstrate that there was a statistically significant difference in seven parameters. The difference between match winners and losers in the first set, in terms of serve return parameters, consisted in the number of return points won after the first serve (1RW), number of return points played after the second serve (2RT), number of return points in play after the second serve (2RP), number of return points won after the second serve (2RW), total number of return points in play (RTP), total number of return points won (RTW) and the number of return winners (RW).

In terms of serve return in the second set, statistically significant differences can be determined in three parameters - number of return points won after the first (1RW) (6,27/4,75) and second serve (2RW) (5,29/4,02), as well as in the total number of return points won (RTW) (11,56/8,77). As opposed to the first set, there are no statistically significant differences in the number of return points played after the second serve and in the number of return points in play after the second serve. Players who lost the match on average played more points after the second serve (11,13/10,57), as well as they had more return points in play after the second serve (8,08/7,55) with regard to the first set. In addition, match losers also increased the total number of return points played in the second set (31,39/29,88), whereas the players who won reduced their values (32,59/31,29) in this parameter. By comparison with the first two sets, serve return parameters in the third set show the highest number of parameters with statistically significant differences between match winners and losers. Statistical significance can be recognized in the number of return points in play after the first serve (1RP), number of return points won after the first serve (1RW), number of return points played after the second serve (2RT), number of return points in play after the second serve (2RP), number of return points won after the second serve (2RW), total number of return points played (RT), total number of return points in play (RTP) and in the total number of return points won (RTW).

Table 2. Descriptive statistics and indicators of statistical significance for differences of situational efficiency parameters of serve return in the first three sets

VAR	1 <sup>st</sup> set			2 <sup>nd</sup> set			3 <sup>rd</sup> set		
	AM±SD	AM±SD	p	AM±SD	AM±SD	p	AM±SD	AM±SD	p
	N1	N2		N1	N2		N1	N2	
1RT	19,56±6,14	19,3±6,23	0,75	20,65±7,42	20,26±6,1	0,65	19,70±6,42	19,09±6,53	0,46
1RP	12,09±4,42	10,94±5,1	0,06	12,63±5,54	11,6±4,73	0,12	12,30 ±4,89	10,80±5,46	<b>0,03</b>
1RW	5,9±2,58	4,22±2,66	<b>0,00</b>	6,27±3,18	4,75±2,9	<b>0,00</b>	6,12±2,95	4,24±3,10	<b>0,00</b>
2RT	11,73±4,13	10,57±4,2	<b>0,04</b>	11,96±4,33	11,13±4,85	0,16	12,00±4,02	10,38±4,42	<b>0,00</b>
2RP	8,5±3,57	7,55±3,43	<b>0,03</b>	8,77±3,6	8,08±4,12	0,12	8,89±3,89	7,47±3,89	<b>0,03</b>
2RW	4,94±2,41	3,7±2,46	<b>0,00</b>	5,29±2,5	4,024±2,64	<b>0,00</b>	5,28±2,30	3,76±2,49	<b>0,00</b>
RT	31,29±8,46	29,88±8,64	0,19	32,59±9,34	31,39±9,14	0,31	31,71±8,28	29,47±9,30	<b>0,05</b>
RTP	20,58±6,4	18,5±6,83	<b>0,01</b>	21,4±7,38	19,61±7,4	0,06	21,19±6,56	18,27±7,98	<b>0,00</b>
RTW	10,85±3,7	7,93±3,97	<b>0,00</b>	11,56±4,5	8,77±4,54	<b>0,00</b>	11,40±3,80	8,00±4,73	<b>0,00</b>
RW	0,65±0,84	0,39±0,68	<b>0,01</b>	0,55±0,76	0,52±0,82	0,81	0,67±0,91	0,55±0,81	0,27
RUE	1,05±1,14	1,15±1,43	0,56	0,95±1,22	1,024±1,33	0,66	1,02±1,26	0,93±1,14	0,56

N1-winners, N2-losers, AM-arithmetic mean, SD-standard deviation, p-significance level, 1RT-number of return points played after the first serve, 1RP-number of return points in play after the first serve, 1RW- number of return points won after the first serve, 2RT- number of return points played after the second serve, 2RP-number of return points in play after the second serve, 2RW-number of return points won after the second serve, RT-total number of return points played, RTP-total number of return points in play, RTW- total number of return points won, RW-number of return winners, RUE-number of return unforced errors

The results indicate that there are three statistically significant parameters of serve return in all three sets, as follows: the number of return points won after the first and second serve, as well as the total number of return points won.

## Discussion

This research resulted in determining the differences in situational efficiency parameters of serve and serve return between match winners and losers at the 2019 Australian Open. The serve variable that showed as the most relevant for distinguishing between match winners and losers was points won after the first serve, as it was statistically significant in all sets. The identical conclusion was also determined by Fernández-García et al. (2019), as they found that the crucial serve parameter that differs the winners from the losers was the number of points won after the first serve, though they conducted their research on a grass court, where the serve has a more dominant role. The fact that the first serve is an exceptionally relevant factor in tennis, which makes the difference between a winner and a loser, as well as that a proficient first stroke produces an advantage during the entire match has also been established by O'Donoghue & Brown (2017). They demonstrated that a quality first serve could enable an advantage in the initial part of the point, where the opponent thus displays a less quality return of serve, which then allows the server to gain better control of the point. Their analysis showed that in men's tennis the first serve does not only result in an advantage in the number of points that the player wins as aces or serve winners, but also that players uphold the advantage of the serve until their fourth stroke in the point, up until when they win 62,4 percent of points. The variables number of aces and number of double faults, which are generally accepted as relevant, did not show to be statistically significant in the mentioned research. Upon comparing these results with past research, the conclusion is made that the mentioned research variables did not obtain consistent results. Zlatoper (2002) concludes that match winners at Wimbledon and Roland Garros had more aces than the players who lost the match, while at US Open the situation was reversed. Filipic et al. (2008) found that, as a rule, match winners score more aces, however with some exceptions. In comparison to previous research, the conclusion can be made that, as a general rule, match winner do have more aces, as this was also confirmed in our research, nevertheless, without a statistical significance in this difference. A similar conclusion can also be made regarding the number of double faults, which, as a rule, are more common in players who lost the match, as this was also demonstrated in our research. Although the statistical significance of the differences in the number of aces and double faults was not determined, a conclusion can be made that the established differences contribute to the significance of the variables that were statistically significant, such as points won after the first serve and total number of points won.

With regard to serve return, there was a statistically significant difference in all three sets for the three following parameters: return points won after first and second serve and the total number of return points won. The statistical significance of the first two mentioned variables consequently also affects the significance for the variable of total number of return points won. Other serve return variables do not indicate a statistically significant difference during all three sets, however, this does not mean that they should be overlooked, but goes to show that in modern tennis the differences between



players are very subtle and difficult to identify within certain parameters. The return winner and return unforced error variables did not show to be statistically significant, however, match winners regularly achieve better results. Despite the fact of not being statistically significant, the mentioned game segments can prove to be extremely important as a result of an aggressive serve return that pressures the opponent to serve with more strength and precision, which in turn also results with an increased number of serve errors. Fernández-García et al. (2019) established that there are two significant serve return parameters that differentiate winners from losers – the number of return points won after the first serve and the percentage of used break points. Our research confirms that return points won after the first serve are a considerable factor for winning in a tennis match, which is also in keeping with the research conducted by Filipcic et al. (2015), in which it was shown that the relevance of a quality serve and serve return for success in top-level tennis considerably increased during the period between 1991 and 2010.

## Conclusion

On the basis of the obtained results, it can be concluded that there are certain variables of serve and serve return that differ the match winner from the loser. In addition, the conclusions of this research refer to tennis matches played on a hard court surface and cannot be generalized for matches played on other courts, such as clay or grass surfaces. Knowledge attained from the obtained results can be applied by tennis coaches in their training programmes with the aim of their players becoming as successful as possible. Serve and serve return represent the most relevant game segments in tennis and should be brought to a high level of performance in order for a player to have better tools for winning a match.

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## HANDBALL PERFORMANCE INDICATORS OF WINNING TEAMS IN GROUP STAGE MATCHES OF THE 2016 OLYMPIC GAMES TOURNAMENT. IS THERE ANY DIFFERENCE BETWEEN THE WINNERS?

**Goran Bobić<sup>1</sup>, Snježana Schuster<sup>2</sup>, Mile Marinčić<sup>1</sup>**

<sup>1</sup>*College Ivanić-Grad, Croatia*

<sup>2</sup>*University of Applied Health Sciences Zagreb, Croatia*

### Abstract

The aim of the study was to determine performance indicators of winning teams of the Olympic handball tournament preliminary round and to analyse if there is any statistically significant difference between the winners in two groups. The sample of entities consisted of 28 games played during the group stage of the competition. The sample of variables described situational efficiency of a team and it was consisted of 20 items of performance indicators (16 of them are related to the attack phase and 4 of them to the play in defence). The differences between the two groups of winning teams were determined using Mann-Whitney U-test. Obtained results have shown statistically significant difference between winning teams in following variables: successful 7-metre throw, successful break-through – a goal scored and 2-minute suspension. It indicates that in one group there has been more confrontations between the opponent players in 1:1 situation which resulted in goals scored after breaking the defence wall or being awarded 7-metre throw accompanied with additional 2-minute suspension for the defence player. It would be interesting to research if this made any difference for the final outcome of the next phase in the tournament.

*Key words: team handball, Olympic games men, preliminary round, performance indicators*

### Introduction

Team handball is a very complex sport activity. It is defined by multivariable factors of structural characteristics which are influencing the final outcome of the performance of an individual player or a team in general. Because of that, the complexity of a handball training procedures needed to be organized with the aim of positive impact on development and maintenance of hierarchically defined basic and specific abilities of handball players. This also includes their technical and tactical knowledge in the long-term process of sports training during their sports career (Vuleta, Milanović, 2004). Today, these cannot be realized without strong influence of science and scientific researches. One of the main fields of exploring for scientist and experts in handball is performance. The hierarchical model of the structure of performance in handball describes action or situational efficiency, that is, performance of handball players at the third level of the pyramid defining the final outcome of a handball match and, consequently, their general sport achievements in a competition as well (Milanović, 1997; In Gruić et al., 2006). That situational efficiency of players, or of a team, can be observed in different phases and subphases of play in a match (Vuleta, 1997).

The aim of this study was to determine performance indicators of winning teams of the Olympic handball tournament preliminary round and analyse if there is any statistically significant difference between the winners in the two groups. It has been taken into consideration that there will be statistically significant difference between the successful national teams in the preliminary round of the competition.

### Methods

#### The sample of entities

The sample of entities consisted of 28 handball games which ended with victory of one team and were played in the preliminary round of the Olympic games. The 12 teams participated and were divided into two groups, each of them included 6 teams that played league system matches. In group A national teams who competed were: Croatia, France, Denmark, Argentina, Tunisia and Qatar. In group B there was: Germany, Slovenia, Brazil, Poland, Egypt and Sweden. The performance indicators from the winning teams of every group were analysed and then compared. The games without a winner were not included. In the end, there were 14 winning teams from group A and 14 winning teams from group B and their performance indicators were analysed and compared.

## The sample of variables

The collected data were obtained by the methods of objective registration of situational efficiency. The sample of variables consisted of performed technical and tactical elements of the handball game in phases of defence and attack. They are described by frequencies of successfully and unsuccessfully executed actions during the match. A total of 20 variables were included in the study. The 16 analysed variables were performance indicators from the phase of attack and 4 of them explained defence efficiency (Table 1).

Table 1.

Variables	Description
NOA	Total number of attacks in one game per team
ASE	Average scoring efficiency per team in attack phase
GOSC	The total number of goals scored in one game
6M+	Successful line shot taken from 6m line - a goal scored
6M-	Unsuccessful line shot taken from 6m line - a goal not scored
WING+	Successful wing shot taken from left or right position - a goal scored
WING-	Unsuccessful wing shot taken from left or right position - a goal not scored
9M+	Successful long - distance shot taken from the back – court position outside or from 9m line - a goal scored
9M-	Unsuccessful long - distance shot taken from the back – court position outside or from 9m line - a goal not scored
7M+	Successful 7–metre throw – a goal scored
7M-	Unsuccessful 7–metre throw – a goal not scored
FASTBREAK+	Successful fast–break shot – a goal scored
FASTBREAK-	Unsuccessful fast–break shot – a goal not scored
BT+	Successful break–through shot taken after a break through the defence wall – a goal scored
BT-	Unsuccessful break–through shot taken after a break through the defence wall – a goal not scored
AS	Assist
ST	Steals
BL	Blocked balls/shots
GORE	The total number of goals received in one game
2MIN	2–minute suspension

## Data analysis methods

The sample of variables are described by the means of descriptive statistics. The next central and dispersion parameters of the given variables were calculated: Mean, Median and Standard deviation.

To determine possible differences between winning teams in group A and in group B in given variables which are describing team performance indicators during the game we used the Mann–Whitney U test. The following parameters were included: U: value obtained by testing the statistically significant differences (calculation of statistics  $U1 = \sum R_{winn1} - n(n+1)/2$  and  $U2 = \sum R_{winn2} - n(n+1)/2$  where  $\sum R_{winn}$  is: sum of range values of the winning teams in group A and in group B and n is size of entities in each group; Critical values of the Mann-Whitney U test (determined by size of entities in each group and by level of statistical significance), p: statistical error allowing the acceptance of the hypothesis where the difference is statistically significant. The level of statistical significance was set at  $p = .05$ .

## Results

The results of descriptive statistics of the sample data variables as well as Mann–Whitney U test are presented in Table 2. Statistically significant differences are bolded.

Table 2.

Variables	Mean A Mean B	Median A Median B	S.D. A S.D. B	U1 U2	Critical value	Lower U ≤ crit. Value
NOA	52,78 51,64	52,5 52,5	4,20 4,71	82 114	55	82 ≤ 55
ASE	54,64 57,67	53,5 58,5	7,13 3,73	130,5 65,5	55	65,5 ≤ 55
GOSC	28,92 29,71	28 30,5	5,10 3,07	116,5 79,5	55	79,5 ≤ 55
6M+	6,42 7,07	6 6,5	2,73 2,23	115,5 80,5	55	80,5 ≤ 55
6M-	2,5 3,35	3 3,5	1,22 1,78	130,5 65,5	55	65,5 ≤ 55
WING+	4,92 4	5 4	2,52 2,48	76 120	55	76 ≤ 55
WING-	2,21 1,92	2,5 2	1,31 0,99	81,5 114,5	55	81,5 ≤ 55
9M+	7,78 7,35	7,5 7,5	2,69 3,77	91,5 105	55	91,5 ≤ 105
9M-	8,71 6,5	8 7,5	4,17 3,52	72,5 123,5	55	72,5 ≤ 123,5
<b>7M+</b>	<b>2,14</b> <b>3,92</b>	<b>2</b> <b>4</b>	<b>1,51</b> <b>1,38</b>	<b>163,5</b> <b>32,5</b>	<b>55</b>	<b>32,5 ≤ 55</b>
7M-	0,85 0,78	0,5 0,5	1,35 0,97	100,5 95,5	55	95,5 ≤ 55
FASTBREAK+	5,71 4,28	5,5 4	2,84 2,01	69 127	55	69 ≤ 55
FASTBREAK-	1,57 0,85	2 1	1,34 0,66	66 130	55	66 ≤ 55
<b>BT+</b>	<b>1,92</b> <b>3,07</b>	<b>2</b> <b>3</b>	<b>1,59</b> <b>1,43</b>	<b>142</b> <b>54</b>	<b>55</b>	<b>54 ≤ 55</b>
BT-	0,21 0,78	0 0	0,42 1,18	123,5 72,5	55	72,5 ≤ 55
AS	10,71 10,92	10,5 10	3,51 3,64	95,5 100,5	55	95,5 ≤ 55
ST	2,64 2,78	2 2,5	2,09 2,08	102 94	55	94 ≤ 55
BL	3,35 2,85	3,5 2,5	2,30 2,17	84 112	55	84 ≤ 112
GORE	23,57 25,78	23,5 25	3,36 3,61	135 61	55	61 ≤ 55
<b>2MIN</b>	<b>3,92</b> <b>7,14</b>	<b>4</b> <b>7</b>	<b>1,26</b> <b>2,56</b>	<b>170</b> <b>26</b>	<b>55</b>	<b>26 ≤ 55</b>

The test showed statistically significant difference between the winners in group A and B in the following variables: successful 7-metre throw – a goal scored, break-through shot taken after a break-through the defence wall – a goal scored, all in attack phase, and one which refers to a defence play and this variable was 2-minute suspension (2MIN).

## Discussion

The aim of this study was to appoint the differences between the winners in two groups of the preliminary round. The object of the research was performance indicator variables of each winner in each group stage game. In previous studies, it has been determined that fast-break efficiency makes a significant difference between European teams against their non-European opponents (Johansson, 2004; Pokrajac, 2010; In Bilge, 2012). Srhoj et al. (2001) concluded that the pivot position, the break-through and fast-break shots had a very important influence on final outcome of the game (Bilge, 2012). Sevim and Bilge (2007) concluded that European teams have superiority in men's handball and that the fast-break, pivot position and back court position efficiencies are contributing to this conclusion.

In this research we have found statistical differences between the winners in group A and B in the following variables: 7M+, BT+, all in attack phase, and one which refers to a defence play and this variable is 2MIN. The key difference found between the groups was in the variable break-through. Break-through explains the circumstances under which a

throw on a goal was made and they are: throws from the back court players after breakthrough in the 9 m zone without a defence player in front, throws of the pivot after 1:1 situations, throws from the left or right back after breaking through 1:1 situations (Meletakos, Vagenas and Bayios, 2017). Further, after being successfully performed, it often results with given 7m throw for the attacking team, if the goal is not scored after a breakthrough and with 2 MIN exclusion for the defending team. This creates disbalance in the number of players for the opponents during the game and can give an advantage for the team in front side of a court. This can indicate weaknesses in individual and group technical and tactical skills, or chosen system of playing in defence. In combination with aggressive approach of defence players it may often result with penalty throws and with 2 MIN exclusions for the opposite team. It can also mean that the teams in attack have chosen good strategies of using the positions and situations with the ball that have led to higher scoring efficiency. A good tactics in combination with very skilful attacking individuals in performing the feint, for example, possibly effected the final outcome of the game in the group B and characterised in some percentage the way of winning matches in this group.

## Conclusion

Based on the obtained results it may be concluded that there were some significant differences between the winning teams in parameters of situational efficiency which have possibly influenced the final outcome of their games. In general, the results, and previous studies analyses, appointed that the winning teams had a similar model in technical and tactical strategies providing them higher efficiency in the game. Further researches should include physical indicators of a match play (Michalsik et al., 2014; In Milanović, Vuleta, Ohnjec, 2018), but they also need to integrate information about intellectual and emotional characteristics of players (Manchado et al., 2013; In Milanović, Vuleta, Ohnjec, 2018). This will allow better understanding of multifactorial handball playing performance (Milanović, Vuleta, Ohnjec, 2018).

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## DIFFERENCES IN ANTHROPOMETRIC CHARACTERISTICS BETWEEN THE CROATIAN FEMALE WING HANDBALL PLAYERS OF DIFFERENT AGE CATEGORIES

**Lidija Bojić-Ćaćić<sup>1</sup>, Dinko Vuleta<sup>2</sup>, Dragan Milanović<sup>2</sup>**

<sup>1</sup>*Croatian Handball Federation, Zagreb, Croatia*

<sup>2</sup>*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

The aim of the research was to determine the structure and extent of the expected differences caused by age among 37 priority selected female wing players (U18, U16, U14) in 24 standard anthropometric variables pertaining to four latent factors: longitudinal and transversal skeleton dimensions, body volume and mass, and subcutaneous fatty tissue. ANOVA revealed significant global age differences in 10 variables ( $p < .01$  five;  $p < .05$  five). Ten significant particular age differences were obtained as well; two between juniors and cadets (knee and elbow diameters in favour of cadets), six between juniors and younger cadets (body height, arm length, arm span, body mass and flexed upper arm circumference – all in favour of juniors; and chest skinfold in favour of cadets), whereas only two differences were found between cadets in body height (in favour of cadets) and calf circumference (in favour of younger cadets).

**Key words:** handball, wing players, young age categories, youth players, cadets, anthropometry

### Introduction

Appropriate body built is a fundamental prerequisite of good performance in women's handball (Šibila & Pori, 2009), especially as regards position specific demands. Different demands emerge from the position specific technical-tactical activities players perform in handball game (Vuleta et al., 1999). For example, body height is more relevant for backs than for wings. Line players or pivots need balanced body height and volume since they play a whole match in body contact with the opponents, in attack struggling for front position for ball reception and goal shooting. Wings must be fast runners and quick in reactions; therefore, values of their body height, mass and volume can be lower (Moss et al., 2015). There are not many research studies on anthropometric characteristics of female handball players and few have treated younger age categories, especially youth players or cadets; also, there is a lack of comparative studies between various ages and play positions (Bojić-Ćaćić et al., 2018; Bon et al., 2015; Čavala et al., 2013; Milanese et al., 2011; Urban et al., 2011; Villa et al., 2011).

Therefore, the aim of the study was to determine differences and its structure among young age categories (U18, U16 and U14) in anthropometric characteristics of the selected female handball players in the position of wings. We hypothesized that both the global and partial age differences would be found.

### Methods

**Sample of participants.** Thirty-seven wing players, priority selected by their coaches and CHF instructors for the participation in the Croatian national selections' camp, belonged to three age groups: youth players (U18) = 7, cadets (U16) = 16, and younger cadets (U14) = 14.

**Sample of variables.** Well-known 24 anthropometric variables were chosen and measured according to the procedures defined by the IBP and Mišigoj-Duraković (2008). All anthropometric variables but skinfolds (which were measured three times) were taken in one measurement. Variables defining the factor of longitudinal skeleton dimensionality were: body height, arm length, leg length, and arm span; the factor of transversal dimensionality was represented by six variables: shoulder width, knee diameter, elbow diameter, wrist diameter, ankle diameter, and hip width; whereas six variables were used for body mass and voluminosity determination: body mass; extended relaxed upper arm circumference, flexed contracted upper arm circumference, forearm circumference, thigh circumference, and calf circumference. Also, eight skinfold thickness measures were used to assess the amount of body fat: subscapular skinfold, abdominal skinfold, triceps skinfold, thigh skinfold, lower leg skinfold, suprailiac skinfold, midaxillary skinfold, and chest skinfold.

**Statistical analysis.** Basic descriptive statistics was computed (arithmetic mean and standard deviations). Hypotheses on age differences among female wings were tested using univariate analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA). Data were processed by the statistical package Statistica for Windows, ver. 7.0.

## Results

In Table 1 the results of both the basic descriptive statistics and analyses of variances are presented. The age differences in anthropometric variables were established in certain variables among the Croatian female handball players in the position of wings.

Table 1. The basic descriptive parameters of the variables and the analysis of differences

WINGS	Mean±SD			Global diff.		JU-KA	JU-MK	KA-MK
	JU (n=7)	KA (n=16)	MK (n=14)	F	p	p	p	p
ALVT	168.16±5.5	165.40±3.62	160.65±3.14	10.24	<b>0.00</b>	0.30	<b>0.00</b>	<b>0.01</b>
ALDN	94.99±4.31	93.54±2.54	92.14±3.08	2.03	0.15	0.60	0.16	0.48
ALDR	72.40±3.10	70.43±1.90	69.03±2.26	5.13	<b>0.01</b>	0.18	<b>0.01</b>	0.26
ALRR	167.29±5.37	164.21±4.81	159.34±6.16	5.69	<b>0.01</b>	0.47	<b>0.01</b>	0.07
ATSR	37.30±2.45	37.46±1.62	36.79±3.06	0.30	0.74	0.99	0.90	0.75
ATDK	8.57±0.33	9.09±0.56	8.77±0.26	4.27	<b>0.02</b>	<b>0.04</b>	0.60	0.14
ATDL	6.00±0.19	6.38±0.24	6.21±0.28	6.03	<b>0.01</b>	<b>0.01</b>	0.22	0.17
ATDRZ	4.81±0.36	5.19±0.46	5.13±0.21	2.73	0.08	0.09	0.19	0.89
ATDSZ	6.84±0.22	7.07±0.50	6.76±0.31	2.42	0.10	0.46	0.90	0.12
ATSZ	26.86±1.76	27.82±1.22	27.34±3.46	0.41	0.67	0.68	0.91	0.87
AVTT	59.60±6.35	57.17±7.49	51.63±5.31	4.36	<b>0.02</b>	0.72	<b>0.04</b>	0.08
AVONADE	26.03±1.88	25.68±2.30	23.91±2.06	3.42	<b>0.04</b>	0.94	0.12	0.09
AVONADF	27.99±2.09	27.06±1.89	25.47±2.03	4.41	<b>0.02</b>	0.59	<b>0.03</b>	0.11
AVOPOD	23.77±1.38	23.12±1.54	22.50±1.18	2.06	0.14	0.59	0.15	0.48
AVONAT	55.20±3.81	50.29±9.86	50.66±3.75	1.26	0.30	0.33	0.40	0.99
AVOPOT	35.13±1.35	35.46±1.50	33.22±1.97	7.21	<b>0.00</b>	0.91	0.06	<b>0.00</b>
ANL	8.80±2.04	10.03±3.17	8.90±2.56	0.79	0.46	0.62	1.00	0.55
ANT	15.06±3.45	17.55±5.35	16.20±3.99	0.80	0.46	0.49	0.86	0.73
ANNAD	13.14±3.00	12.60±3.11	12.25±2.81	0.21	0.81	0.92	0.81	0.95
ANNAT	20.61±4.34	18.82±3.75	18.17±3.67	0.96	0.39	0.59	0.40	0.90
ANPOT	11.29±2.41	12.60±3.31	12.35±2.74	0.49	0.62	0.63	0.74	0.97
ANSIL	8.55±1.92	11.83±3.80	10.66±3.73	2.14	0.13	0.13	0.44	0.66
ANAKS	7.77±1.47	9.88±3.52	8.92±2.14	1.48	0.24	0.25	0.67	0.64
ANP	10.30±3.91	14.56±4.39	15.10±3.65	3.61	<b>0.04</b>	0.08	<b>0.05</b>	0.93

Note. JU – youth players; KA – cadets; MK – younger cadets; Mean – arithmetic mean; SD – standard deviation; F – results of F test; p – level of significance; ALVT – body height; ALDN – leg length; ALDR – arm length; ALRR – arm span; ALVT – shoulder width; ATDK – knee diameter; ATDL – elbow diameter; ATDRZ – wrist diameter; ATDSZ – ankle diameter; ATSZ – hip width; AVTT – body mass; AVONADE – extended, relaxed upper arm circumference; AVONADF – flexed, contracted upper arm circumference; AVOPOD – forearm circumference; AVONAT – thigh circumference; AVOPOT – calf circumference; ANL – subscapular skinfold; ANT – abdominal skinfold; ANNAD – triceps skinfold; ANNAT – thigh skinfold; ANPOT – lower leg skinfold; ANSIL – suprailiac skinfold; ANAKS – midaxillary skinfold; ANP – chest skinfold.

Ten global age differences among the Croatian female handball wings were established in the following variables: at the significance level of  $p < .01$  in body height, arm length, arm span, elbow diameter and calf circumference, whereas at the significance level of  $p < .05$  or the differences were obtained in knee diameter, body mass, extended upper arm circumference, flexed upper arm circumference, and chest skinfold. Besides, there were numerical differences in quite a number of variables, but they did not reach significance level.

## Discussion

The results confirmed the hypothesized age differences do exist among the Croatian female handball wings at the global level. We were further interested to see what the structure of these global differences was. Therefore, we analysed partial differences between the age groups.

Statistically significant age differences between juniors and cadets were established only in two variables of transversal skeleton dimensionality – elbow and knee diameters, both in favour of cadets. This difference should be observed as a mere consequence of players' growth and development. Not any other variable, out of the 24 measured, differed between junior and cadet wing players. Their body height was 168.16 cm and 165.40 cm for juniors and cadets, respectively. The tested juniors as well as most of the tested cadets have already completed the phase of pubertal growth spurt, therefore no significant differences were expected in their longitudinal dimensions. Urban and associates (2011, 2013) investigated female cadet and junior handball players, members of their national teams, at the European Championship and found that elite young wings were higher than their Croatian peers: 170.08 cm and 167.42 cm for the wings in the European junior and cadet national teams, respectively. Although higher body height has not been found a decisive performance characteristic for wing players in previous research cited in the text, a few centimetres more would not do any harm. Average body mass of Croatian junior wings was 59.60 kg and of cadet players it was 57.16 kg. Croatian female handball wings were lighter than their European peers, members of respective national teams (Urban et al., 2011, 2013): 64.75 kg and 61.92 kg was body mass of European juniors and cadets, respectively. Such a finding in the variable body mass was only partially expected due to the differences in body height. Tuma and Vozobulova (2011) measured 10 Czech handball wings, 17 years of age; Czechs, not belonging to the first tier of European handball players, were 166.6 cm high and had 61.98 kg. Our participants were higher and slimmer than their Czech peers.

Also, just two significant differences were established between cadets (U16) and younger cadets (U14). The Croatian wings of cadet and younger cadet age differed significantly in the variable body height: 165.40 cm and 160.65 cm, respectively. The age difference in body height was expected since these age groups were in different phases of growth and development—younger cadets were in the swing of their pubertal growth and maturation, whereas cadets were at the end of that stage. Namely, girls on average achieve 98 % of their final body height at the age of 16 and a half years (Mišigoj Duraković, 2008). The source of the other difference found (in calf circumference in favour of younger cadets) was not quite clear.

The partial age differences (six of them) in anthropometric variables between juniors and younger cadets had the greatest contribution to the global age differences. Even three variables belonging to the factor of longitudinal body dimensionality differed between them: body height, arm length and arm span, all in favour of junior wings. The chronological age difference of four years between junior and younger cadet wings made the established differences expected. Namely, juniors, who are considered young adults, had completed stage of their growth and development; their average body height was 168.16 cm. On the other hand, younger cadets, who were 160.65 cm high, were under a pronounced hormonal influence characteristic for puberty. This stage is known as pubertal growth spurt, characterised by intensive growth in height and sexual maturation. The greatest increase in growth girls usually experience at the age between 11 and 13 years (Mišigoj-Duraković, 2008), whereas after the 14<sup>th</sup> year adolescent growth decelerates gradually until the 16<sup>th</sup> year (and a half), when girls usually reach 98 % of their eventual body height. Observable growth in women stops on average around their 18<sup>th</sup> year (Mišigoj-Duraković, 2008). That means that younger cadets are yet to experience dramatical body transformations, among which is the expressed development of musculature; that expected development of muscles is yet to suppress musculoskeletal disbalance younger cadets were experiencing at the time of investigation. Not any variable of transversal differed significantly between youth players and younger cadets. Since girls of delicate body built are usually directed to the position of wings, this absence of differences was to be expected. Out of six variables that define the space of body voluminosity, significant age differences between youth players and younger cadets were established in two: body mass and flexed upper arm circumference, in favour of U18 players. Their body mass was 59.60 kg, whereas younger cadets had 51.63 kg on average. The difference in body mass was to be expected since there was the difference in body height. The increase in body mass is the greatest before the adolescent growth spurt, i.e. just prior to their 14<sup>th</sup> year in girls (Mišigoj-Duraković, 2008). During that period, between the 8<sup>th</sup> and 13<sup>th</sup> year of age, girls' body mass may increase by 2.25 to 2.75 kg per year. The described regularity of growth and development can explain the difference obtained in favour of younger cadets: younger girls demonstrated significantly larger values of subcutaneous fatty tissue than their youth colleagues in the variable chest skinfold thickness, but also, numerically, in several other variables.

## Conclusions

Both hypotheses were confirmed by the obtained results. At the global level, significant differences were established in 10 variables out of the measured 24 anthropometric variables: five variables were significant at  $p < .01$  and five at  $p < .05$ . The structure of these global differences was as follows: youth and cadet wings differed significantly in knee and elbow diameters (in favour of cadets); cadets and younger cadets differed significantly in body height (in favour of cadets) and calf circumference (in favour of younger cadets); whereas the most age differences were established, as expected, between youth players and younger cadets—only one variable differed the two groups in favour of younger cadets (chest skinfold thickness), whereas the rest of five variables were in favour of youth players: body height, arm length, arm span, body mass, and flexed upper arm circumference. The findings were in line with the findings of existing literature that is quite scarce.

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## ANALYSIS OF THE DEVELOPMENTAL TRENDS IN RESULTS OF DISCUS THROWERS IN CROATIA FROM 2008 TO 2020

Marko Cetinić, Stjepan Strukar, Sanja Ljubičić

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The aim of this research is to determine the developmental trends in men's and women's discus throw results in Croatia. The sample of examinees is comprised of all Croatian male and female discus throwers who took one of the first 10 places by season from 2008 to 2020, according to the national top lists. The research variables were male and female discus throw results. 2<sup>nd</sup> and 3<sup>rd</sup>-degree polynomial regression analysis was used as the main statistical method to define the trends of development and the prediction of the results. The results of the research point to the differences in the trends of development of the results in relation to gender. The trends of development of all men's results have a negative tendency, while women's have a positive one and a stable future, except for SB which has a negative tendency, but at a very high level. The predictions of the results indicate high values of results in both genders, but a degree of caution is needed when it comes to men's results, as they all currently have a negative tendency. The factors which may have influenced the positive development of women's results are quality coaching and expert work based on scientific methods and motivation of female throwers inspired by the best Croatian female discus thrower. The factors which may have caused the negative trends are very young discus throwers in Croatia and insufficient financial investments in the discus throw.

*Key words: discus throw, male and female throwers, seasonal results, prediction of results*

### Introduction

The competitors' results in all sports, as well as in athletics, depend on a large number of factors such as: age of athletes, functional and motor abilities of athletes, psychological preparedness, morphological characteristics, technical and tactical knowledge of athletes, and the like (Ljubičić et al., 2018; Milanović & Harasin, 2004; Pavlović & Radinović, 2010). By analysing results in throwing events at world level, some factors were determined which have influenced the development of their trends. Some of them are: differing financial investments in sports, the level of the development of athletes who achieve the top results, the availability of resources necessary for adequate preparation of the best athletes, tapering for target competitions and stricter doping controls (Milinović et al., 2013; Milinović & Harasin, 2008). Furthermore, the analyses of the results in throwing events from the Olympic finals demonstrate the increase in men's discus throw results from 1896 to the 1980s and almost a linear increase in results in women's from 1928 up to the 1980s. From the 1990s to the 2012 London Olympics, variable trends in the development of the results in discus throw can be observed in both genders (Cieszkowski & Przednowek, 2015; Milinović et al., 2013; Milinović & Harasin, 2008). From all of the previous the question on the status of certain throwing disciplines in Croatia arises. This paper analyses the trends in the development of results in discus throw in Croatia. Some of the questions this research will try to answer are: What is the current level of results of discus throw in Croatia? What do those results represent in relation to some national or international standards? What are the trends in the analysed results like? Do the trends in the development of the results differ between genders? and finally, What is to be expected from them in the future?

The aim of this research is to determine the developmental trends in men's and women's discus throw results in Croatia and recognise the possible factors which have influenced the defined trend in the analysed results.

### Research Methods

The sample of examinees is comprised of all Croatian male and female discus throwers (MDT and FDT) (N=130) who took one of the first 10 places by season from 2008 to 2020, according to the national top lists. All data on annual results of Croatian discus throwers' results and all entry standards for the Croatian Individual Senior Championship (CC) were obtained from the official website of the Croatian Athletics Federation. The standards for the 2<sup>nd</sup> and the 3<sup>rd</sup> category of Croatian athletes (2<sup>nd</sup> cat. and 3<sup>rd</sup> cat.) were obtained from the official website of the Croatian Olympic Committee and the entry standards for the 2021 Tokyo Olympics were obtained from the official World Athletics website. The variables of this research are male and female discus throw results. In this research, the trends of development were analysed of the season first result (SB), the average of the first 3 results (AM-1-3), and the average of the first 10 results (AM-1-



10), grouped based on male (M) and female (F) genders. The collected data were processed by Statistica 13.5. program package. To display the results, the following descriptive parameters were used: arithmetic mean (AM), minimum value (MIN), maximum value (MAX), total range (Range), and standard deviation (SD). Graphic displays of results were defined according to the 2<sup>nd</sup>-degree polynomial regression function model. The predicted values of the results for 2021 were obtained by approximation of the 10 best results of each season according to the 2<sup>nd</sup> and 3<sup>rd</sup>-degree polynomial regression function models.

## Results

Table 1. Descriptive statistics of the discus throw results in Croatia from 2008 to 2020

Variables	Gender	Discipline	N	AM	MIN	MAX	Range	SD
SB (m)	M	Discus throw	13	64,57	62,64	67,92	5,28	1,77
AM-1-3 (m)	M	Discus throw	13	62,32	59,44	65,11	5,67	1,47
AM-1-10 (m)	M	Discus throw	13	53,54	48,68	57,23	8,55	2,38
SB (m)	F	Discus throw	13	68,13	60,57	71,41	10,84	3,36
AM-1-3 (m)	F	Discus throw	13	57,61	51,85	60,73	8,88	2,64
AM-1-10 (m)	F	Discus throw	13	44,83	40,71	46,98	6,27	1,76

By observing Table 1, high values of average SB in men (64,57m) are noticed, which meets the standard of the 2<sup>nd</sup> cat. ( $\geq 63,50\text{m}$ ). The results which meet the standard for the OG ( $M \geq 66,00\text{m}$ ,  $F \geq 63,50\text{m}$ ) are noticed in the average SB in women (68,13m) and in MAX SB in men (67,92m). In relation to the 2<sup>nd</sup> cat. ( $M \geq 63,50\text{m}$ ,  $F \geq 56,00\text{m}$ ) the average AM-1-3 in men (62,32m) is slightly below, and in women (57,61m) it is slightly above the stated standard. By contrast, and in relation to the 3<sup>rd</sup> cat. ( $M \geq 53,20\text{m}$ ,  $F \geq 47,00\text{m}$ ), the average AM-1-10 in men (53,54m) is above, and in women (44,83m) is below that standard. This phenomenon shows that the differences in quality within the first 10 female discus throwers are greater than the differences between the first ten male discus throwers. On the other hand, it can be observed that MIN AM-1-10 in both genders is above the standard for the CC ( $M \geq 40,00\text{m}$ ,  $F \geq 32,00\text{m}$ ), which indicates that Croatia has a relatively good number of quality throwers in this discipline.

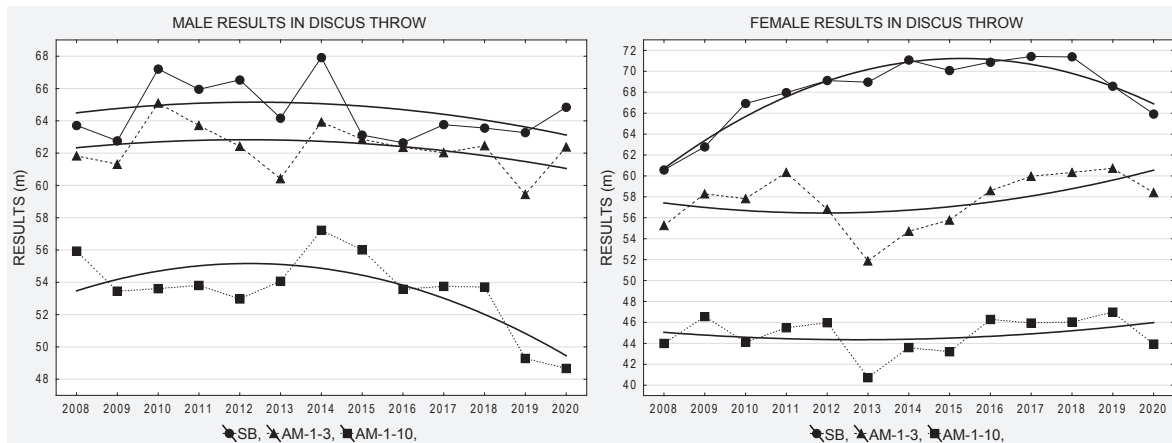


Figure 1. Male and female discus throw results and the prediction of results according to the 2<sup>nd</sup>-degree polynomial function regression model

The observed results in men's discus throw (Figure 1) show a stabilisation of results at a high level up to a half of the observed period. After that, the curves of all results assume negative trends. The curves SB and AM-1-3 are through the entire period of observation at a small distance from each other which indicates, with respect to the values of the results, that through the entire observation period few high-performing male discus throwers are demonstrating stability of performance. The curves of development of all male results end in negative trend. The cause for the negative trend in men may be the decrease in throwers' quality due to insufficient investment in them. In contrast to men's results, women's results are almost ideal and generally tend to develop positively. AM-1-3 and AM-1-10 are stable and growing through the entire observed period. SB has been slightly declining over the last 2-3 years but given the positive trend and a satisfactory distance of the AM-1-3 curve, high results and their stability at a high level should be expected in the near future. The curves SB-1 and AM-1-3 are very close-set and given the positive development of AM-1-3 an increase of all female discus throw results to a higher level is to be expected in the future.

Table 2. The original men's and women's discus throw results from 2008 to 2020 and the predicted values of results for 2021 according to the 2<sup>nd</sup>-degree polynomial regression function ( $b_0+b_1*x+b_2*x^2$ ) (2021<sup>2</sup>) and 3<sup>rd</sup>-degree polynomial ( $b_0+b_1*x+b_2*x^2+b_3*x^3$ ) (2021<sup>3</sup>)

Gender	MALE			FEMALE		
	SB (m)	AM-1-3 (m)	AM-1-10 (m)	SB (m)	AM-1-3 (m)	AM-1-10 (m)
2008	63,72	61,83	55,93	60,57	55,25	43,98
2009	62,76	61,32	53,44	62,79	58,29	46,55
2010	67,20	65,11	53,62	66,93	57,82	44,11
2011	65,95	63,70	53,80	67,96	60,34	45,48
2012	66,53	62,42	52,97	69,11	56,81	45,98
2013	64,17	60,42	54,08	68,96	51,85	40,71
2014	67,92	63,92	57,23	71,08	54,69	43,60
2015	63,11	62,85	56,01	70,08	55,79	43,20
2016	62,64	62,36	53,57	70,88	58,59	46,27
2017	63,76	62,02	53,74	71,41	59,95	45,95
2018	63,55	62,46	53,72	71,38	60,34	46,04
2019	63,26	59,44	49,28	68,58	60,73	46,98
2020	64,84	62,38	48,68	65,93	58,41	43,94
2021 <sup>2</sup>	62,56	60,58	47,89	64,83	61,64	46,47
2021 <sup>3</sup>	66,50	61,81	43,27	64,13	61,31	45,08

Observing the total results in discus throw with predictions for the year 2021 (Table 2), significantly high values of SB for both genders are demonstrated through the entire period of observation. Male SB should be observed with caution because the values of almost all results within the last 4-5 years have been decreasing. SB and AM-1-3 have been stabilised around 2<sup>nd</sup> cat. ( $\geq 63,50\text{m}$ ) and close to the Olympic standard ( $\geq 66,00\text{m}$ ) despite the decrease of values in recent years. On the other hand, SB in women has also been decreasing in recent years but AM-1-3 and AM-1-10 have been increasing. The predictions of all men's results are negative except for SB, according to the 3<sup>rd</sup>-degree polynomial regression function model, where an improvement in results is anticipated. The predictions of AM-1-10 in males show an expected low level of results most likely due to their very declining values last few years. In women's discus throw only the predictions for SB are negative, while for the other results the predictions are positive. This phenomenon is occurring because of a probable generational shift in women's discus throw within the next 2-3 years. However, bearing in mind that SB refers to FDT1, a double Olympic winner, a double world and five-time European champion, with six consequent Diamond Leagues won and being the most successful athlete of this discipline in the history, with another Olympics ahead of her, we can expect everything but the sudden decrease in preparedness and result.

## Discussion

In order to reverse the negative trend in men's discus throw and to maintain the positive trend in women's, more investment should be made to develop modal characteristics of young and perspective discus throwers (Milanović & Harasin, 2004). The scientifically-based training methods should be applied with all young discus throwers, especially the ones who are at the verge of competing in big international competitions. Despite the negative trend of the overall results and in terms of negligible development of more than the last ten OG (Cieszkowski & Przednowek, 2015), Croatia has at least two perspective male discus throwers (MDT1 and MDT2) who are still in their perspective throwing age ( $\leq 30$ ) and still have a chance for great international results in the future. In women's discus throw, alongside FDT1, the results can only be improved with, for instance, a young and perspective thrower FDT2 who is only 20 years old and displays results ( $>60\text{m}$ ) very close to the best world and OG results achieved in last more than forty years by the best world throwers (Milinović et al., 2013). Considering the slow development of discus throw results and their weak progressive predictions in more than the last ten OG (Milinović & Harasin, 2008) and with Croatian assets and the positive trends of AM-1-3 and AM-1-10 in the female discus throw, a further positive trend, better results, and more national throwers in the international competitions are to be expected. In relation to the results of this research, in the last decade the average of male seniors performing in senior athletic championships in Croatia is less than 5 (36,17%), and female is less than 3 (25,18%), due to the fact that throwers of younger age categories usually perform at these championships (Ljubičić et al., 2019). The presented data imply that male discus throwers in Croatia might be above that average. It is obvious that with such relatively high values of results worthy of the international level through the overall observed period, Croatia has a very good training system in this discipline and should maintain the quality of the work and invest more in young and perspective male and female discus throwers who are probably yet to achieve significant results.

## Conclusion

The trends of development of results in discus throw in Croatia differ in relation to gender. Female results generally display a positive trend, except for SB which has been declining recently but is still at a very high level. Considering that female AM-1-3 and AM-1-10 are developing towards positive trend at a rather high level, their stable future is anticipated. All male results are developing towards negative trend but are also still at a rather high level. The factors which could have influenced the positive development of female results are: quality coaching and expert work based on scientific methods, motivation of young female discus throwers encouraged by the best Croatian female thrower and finely selected young athletes according to the success factors. The factors which could have influenced the negative trends are: disinterest of young people in discus throw, young throwing population in Croatia and insufficient financial investments in discus throw. Croatia currently has high results' values worthy of the international scene in both genders and significant achievements can be expected in the future. The presented results mostly refer to the individuals who significantly influence the high value of SB, but also to the perspective discus throwers who could soon become successful on the international scene as well. Despite the negative trends of certain results, the predictions of discus throw results are still encouraging due to their high values.

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## THE EFFECT OF A FIVE-WEEK TRAINING ON UPPER LIMBS SPECIFIC ENDURANCE-SPEED MOTOR ABILITY IN ELITE ATHLETES OF QWAN KI DO MARTIAL ART

**Adrian Cojocariu, Beatrice Abalașei, Bogdan Ungurean, Petruța Martiņaș**

*Faculty of Physical Education and Sports-Interdisciplinary Research Centre in Human Movement Science,  
"Alexandru Ioan Cuza" University of Iași, Romania*

**Introduction:** The aim of the study was to highlight the effects of a five-week physical training program on specific endurance-speed combined motor ability in upper limbs, in Qwan Ki Do martial art.

We hypothesized that it is possible to improve the endurance-speed in upper limbs using an efficient planning and adequate means, which could contribute to an increasing of athletes' efficiency.

**Methods:** Eleven male and eight female elite athletes from the Romanian Qwan Ki Do national team were included in the study. The five-week program included long and Fartlek runs, intermittent runs and also general and specific force–endurance and endurance–speed circuits, during the preparatory phase. We proceeded to test both male and female groups two times (initial and the final) : 1. alternative direct punches – 60 seconds, respectively 2. alternative circular punches – 60 seconds. We processed the results statistically (using IBM SPSS Statistics 20 for Windows – Paired Sample T-Test and Independent Sample T-Test)

**Results:** The results reveal a significant progress ( $p < 0.05$ ) in both male and female groups, and also in both tests (test 1 male group:  $t = -2.341$ ,  $p = 0.041$ ; test 2 male group:  $t = -2.942$ ,  $p = 0.015$ ; test 1 female group:  $t = -2.695$ ,  $p = 0.031$ ; test 2 female group:  $t = -6.711$ ,  $p = 0.000$ ). On the other hand, we did not find significant differences between groups in both initial and final tests ( $p > 0.05$ ).

**Conclusions:** The overall results suggest the five-week program included into the study could improve the specific endurance-speed motor ability in upper limbs, related to martial arts.

On the other hand, the five-week program could have more significant effects on female group, in terms of circular punches.

**Key words:** *martial arts, physical training, planning, physical tests, specific training*

## DOES THE ARTISTIC SWIMMERS' PHYSICAL APPEARANCE INFLUENCE THE JUDGES' FIGURE SCORES?

Ivana Dabo, Mia Perić, Nera Budalica

*Faculty of Kinesiology University of Split, Croatia*

### Abstract

Artistic or synchronized swimming is an aesthetic sport that is characterized as acyclic multi-structural movements. In the competitive part, swimmers compete in routines and figures. The figures are a combination of basic body positions and transitions. In fact, those are isolated elements and are performed in a controlled motion, with no music background. Judges should only evaluate the quality of performed elements. The aim of this paper was to determine whether the physical appearance of the artistic swimmers influences the judges' scores in figures. The research was conducted on 74 young junior swimmers from all Croatian clubs. Their physical appearance was assessed using a segmental scale, which was evaluated by independent judges: the appearance of the feet and knees, the appearance of the whole legs and the overall visual impression. Using partial correlations, it was concluded that their physical appearance and rating of swimmers correlated with each other. We have proven over time that physical appearance has nevertheless made it influence on judges' ratings. Considering that this sport belongs to the group of those who prefer thinness, and also develops a risk of eating disorder, it is really necessary to pay attention to physical appearance and health of young swimmers in order to prevent the consequences of the trend of appearance in aesthetic sports.

*Key words: aesthetic sport, body appearance, BMI*

### Introduction

Artistic swimming is an Olympic discipline, a connection of water, music and nice body movement. Actually, a combination of sport and art, impressive motor structures characterized by beauty, elegance and harmony of movement (Perić, 2007). From kinesiological point of view, synchronized swimming belongs to polystructural acyclic aesthetic movements. Aesthetic activities include conventional activities that aim to achieve some aesthetic criteria by performing allowed movements, and are dominated by an acyclic movement type, performed by conventional system (Jurko, Čular, Badrić, Sporiš 2015). Every aesthetic sport, including artistic swimming, has certain aesthetic postulations of an "ideal" body appearance. Anthropologically speaking, a synchro swimmer should belong to the ectomorph group, with conspicuous muscles, a very small percentage of adipose tissue, thin legs and arms, elongated body and extremities. Anatomically, most synchro swimmers have apparent lumbar spine hyperlordosis, the pelvis is in the posterior tilt, the knees are in hyperextension, and the toes are in a very conspicuous plantar flexion as a result of prolonged extreme flexion. Mentioned parameters in aiming ideal appearance, might lead swimmers to developing eating disorders (Krentz & Warschburger 2011), (Francisco, Alarcão, & Narciso 2012). In this paper the figure scores were observed, because no artistic impression or difficulty are scored. Judges only evaluate the performance of the given element. The figure is a combination of basic body positions and transitions performed in order as specified in the FINA Rules Manual. Each figure is executed in a high and controlled manner, with uniformed motion and each position is clearly defined. In each figure, movement design (accuracy of all positions and transitions) and control are evaluated by judges. Motion control considers extension, height, stability, clarity of movement, uniform movement. Figures are executed in a stationary position and is desirable to maintain maximum height throughout the performance (FINA, 2017). Figure scores are given on-site after the performance with range from 0 to 10 (each grade has 9 tenths). To calculate the total score of judges, the highest and lowest marks in the committee are annulled, the remaining grades are summed up, and the score is divided by four or five depending on the number of judges in the committee. (FINA, 2017). The judging problem in aesthetic sports is a common theme. Although the judging rules are clearly defined, it is common that a factor, such as the visual appearance of a swimmer, though it shouldn't, partially affects the grade. Therefore, the aim of this paper was to determine whether the physical appearance of artistic swimmers influences the figure scores.



## Methods

The participants were 74 Croatian artistic swimmers, Age group competitors 13 – 15 years old, born in 2004., 2005. and 2006 and competing in national championship. The physical appearance of the synchronized swimmers was evaluated by 5 independent judges. They were also national first rank artistic swimming judges, but at this occasion, they evaluated the appearance of the swimmers. The appearance was evaluated according to divided body segments: feet appearance, knees appearance, full leg appearance and overall visual impression (all seen above the water surface, while performing the figures). Ratings 0-1-2, were used for each variable, where 0 was the lowest grade and 2 highest grade representing the “ideal” appearance. According to their BMI (Body Mass Index) variable, true measure of the swimmer’s appearance was evaluated. From four figures performed in this competition, figure *Jupiter* was selected to observe physical appearance at. while performing Jupiter, all the variables in physical appearance could be clearly observed. Statistica ver.13 software package was used to analyze the collected data. Maximum and minimum values, arithmetic means and standard deviations were calculated using descriptive statistics. To evaluate the reliability of the measuring instrument (judges scores for visual appearance), an Inter-item correlation was made and a Cronbach alpha coefficient was calculated.

## Results

Table1. Inter-item correlation and Cronbach alpha coefficient for judged variables.

	llr	C $\alpha$
<b>FEET</b>	0.72	0.92
<b>KNEES</b>	0.51	0.83
<b>LEGAPP</b>	0.67	0.90
<b>OVIZIMPR</b>	0.63	0.89
<b>SUM</b>	0.78	0.94

Legend: FEET - feett appearance, KNEES - knees appearance, LEGAPP - full legs appearance, OVIZIMPR - overall visual impression

Table 2. Descriptive statistics for some of the variables

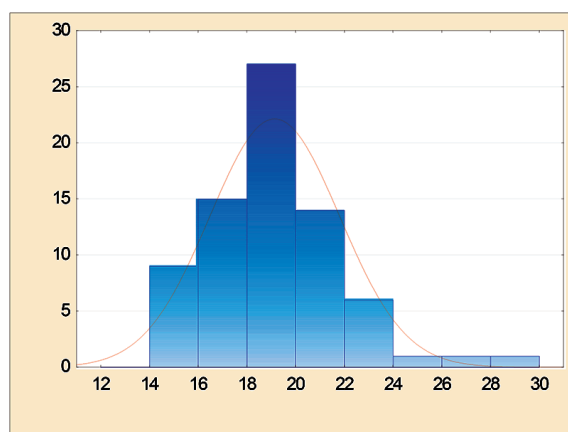
	AS	Min	Max	SD
<b>SUM</b>	22,51	0,00	40,00	8,92
<b>BMI</b>	19,14	14,42	28,73	2,66
<b>RANK</b>	36,89	1,00	74,00	21,21
<b>SCOJUP</b>	5,28	3,70	6,50	0,67

Legend: AS - mean, Min - minimum score, Max - maximum score, SD - standard deviation, SUM - total sum of marks for physical appearance, BMI - Body Mass Index, RANK - Ranking in competition, SCOJUP - official rating of judges in competition for figure Jupiter

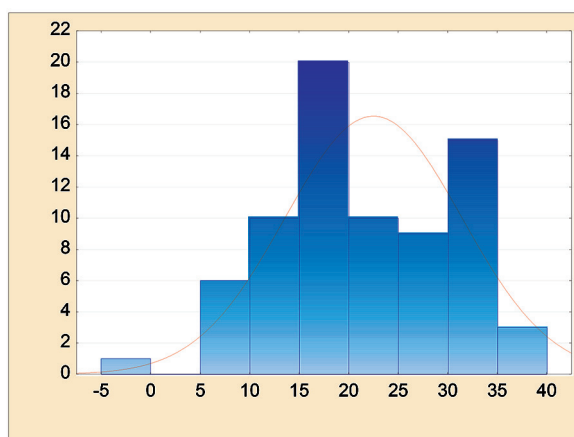
Tablica 3. Corealtion of the measured variables

	SUM	BMI	RANK	SCOJUP
<b>SUM</b>	1,00	-0,30*	-0,53*	0,52*
<b>BMI</b>	-0,30*	1,00	0,12	-0,08
<b>RANK</b>	-0,53*	0,12	1,00	-0,91*
<b>SCOJUP</b>	0,52*	-0,08	-0,91*	1,00

Legend: SUM - total sum of marks for physical appearance, BMI - Body Mass Index, RANK - Ranking in competition, SCOJUP - official rating of judges in competition for figure Jupiter, \*statistically significant



Picture 1. Graphic distribution for the results of BMI



Picture 2. Graphic distribution of the results for the total SUM of the grades for the appearance

## Discussion

Observing Table 1, we can read that the reliability of the measuring instrument, in this case independent judges to assess the appearance of swimmers is satisfying. Although the coefficient  $I_{lr}$  and  $C_{\alpha}$  are not high in all the evaluated variables, we can conclude that the judges evaluated them objectively. Also the evaluation scale for the appearance of the swimmers, like this one, could be used. Scores in the Jupiter figure ranged from 3.7 to a maximum of 6.5, which is the average of the ratings for this age category in Croatia (comparing to the results of the last few national competitions). The BMI values of the participants range from 14.72 to 28.73 (Table2). The mean value is around 19.14, which is normal (19-21) BMI for girls that age (WHO 2007). A total of 32.43% (24 of them) of swimmers have a low percentage of body mass index, while the number of swimmers with a pronounced high percentage of BMI (greater than 25) is significantly lower (only 3 swimmers). We can conclude that there is a trend of marked thinness in a part of the examined population of synchro swimmers. Comparing this with a study by Ferrand Magnan & Philippe (2005) or Perini et al. (2009), we conclude that they belong to a risky group for developing eating disorders. The SUM grades for the appearance of the swimmers was evenly distributed (Picture 2), but it is evident that the most swimmers were scored in the range of 15-20 (medium) and 30-35 (high). According to this, the majority of respondents “meet the criteria for the appearance of a synchro swimmer”. Despite the fact that this appearance is not defined anywhere, judges, coaches and swimmers prefer, above mentioned body appearance. Although there are dangers to eating disorders and the consequences that this disorder brings with it, a reduced percentage of adipose tissue is desirable in aesthetic sports (Leon et al. 2011). The lowest correlation coefficient is evident with the variables SUM and BMI. Most swimmers who scores better in the physical appearance, actually have a lower BMI. However, it is assumed that the poor correlation of these variables indicates that the overall rating was influenced not only by visual voluminosity but also by the other parameters evaluated. Regardless of the weak correlation, it should be emphasized that the sample of respondents is a group of children who are in their second phase of accelerated development. Most of them are influenced by the “ideal” look of a synchronized swimmer, which is actually a distorted picture of body appearance. So the question is, how low BMI is healthy and what is its lower limit, which is visually tolerated without indirectly harming the health of children? There is no correlation between BMI and total competition placement (RANK). Contrary to the correlation of the swimmer’s physical appearance (SUM) in which we observed parameters important in synchronized swimming as the appearance of feet and knees, BMI did not prove to be that important. Of course, swimmers with a very high BMI did not achieve a very high ranking, but a low

BMI is not a major prerequisite for a good final placement in the competition. It is much more important for a swimmer to have preferred shape of feet and knees, than a low BMI. While it may be easy to understand that a physical appearance influences the judgement in the free routines (Lundy 2011), especially for the artistic impression, the rating in the figures is purely “technical” (performance quality), which makes this research results particularly interesting.

## Conclusion

Synchronized swimming, like other aesthetic sports, has its own rules and regulations, same as the “ideal” body appearance of an artistic swimmer. Although this body shape is not defined anywhere, the preferred swimmers’ appearance is well known. The aim of this paper was to determine whether the physical appearance of artistic swimmers influences judges’ scores in figure sessions, which was proved by partial correlation. Although the FINA Judges Handbook states that every judge should be aware of what influences his decision-making, most judges are relatively unaware of how much his physical appearance affects his final grade. The form of the ideal body appearance in aesthetic sports is actually a distorted perception of the female body. Young girls suppose to have a body shaped in order to meet the aesthetic criteria of the sport. Although in this paper BMI had no effect on the overall ranking in the competition, we must note that its average value in the tested population has lower limit of normal values. Coaches, referees and kinesiologists should promote a healthy attitude to the body and exercise as a factor in the healthy development of a child, regardless of physical appearance.

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## HIGH INTENSITY TRAINING LOAD IMPACT TO MUSCLE OXYGENATION AND CONCENTRATION OF LACTATE IN KAYAK ELITE ATHLETES

Ruta Dadelienė<sup>1</sup>, Ricardas Nekrišius<sup>2</sup>, Stanislav Dadelo<sup>3</sup>

<sup>1</sup>*Vilnius University, Lithuania*

<sup>2</sup>*Lithuanian Sport University, Lithuania*

<sup>3</sup>*Vilnius Gediminas Technical University, Lithuania*

**Purpose:** to disclose the changes of muscle oxygenation and concentration of lactate in elite kayak athletes during HIT load.

**Methods:** Two world class kayak athletes were participated in this study. Athletes' aerobic capacity, muscle oxygenation, heart rate and concentration of lactate were determined. Athletes performed two different physical exercises.

**Results:** The process of oxygenation was very intense during special exercise, which were applied, in the muscles of the leg and chest of elite kayak athletes. It depended on the intensity and duration of physical work.

Working at high intensity, the oxygen in the leg muscles decreases even more than in the chest muscles.

It was observed that when kayakers performed repetitive exercises (6 times for 6 min at 220 W with rest for 6 min) and repeated repetitive exercises of the same volume, (6 times worked after 6 min resting between sections for 6 min. However, during 6 min of work he performed physical work capacity at 320 W interval special exercise for 15 s and working lightly at 100 W for 45 s). The concentration of lactate in the arterial blood of the kayak athletes increased equally.

**Conclusions:** The study reveals the importance of leg muscles work, for kayakers working at very high power, close to critical intensity. Thus, with the aim of bringing the muscle control and physical load capacity of kayak athletes closer to the competitive level, it is appropriate to apply short high-intensity interval work. There is the scientific interest to apply such research to a wider contingent of athletes; it can bring practical benefits to the training of athletes.

**Key words:** elite kayak athletes, muscles oxygen saturation, lactate, HIT

## TRENDS IN BEAM EXERCISE STRUCTURES OF ARTISTIC GYMNASTICS THROUGH FIVE OLYMPIC CYCLES

Sunčica Delaš Kalinski, Ana Kezić, Ana Penjak

*University of Split Faculty of Kinesiology, Croatia*

### Abstract

The main aim of the study was to investigate differences in the frequency of acrobatic and dance elements, as well as to present the overall elements on the beam over a period of five Olympic cycles (from 2000 to 2016). The sample included 40 senior category gymnasts who participated in the final Beam Apparatus Finals competition at five Olympic Games (OG). Experienced national judge counted the number of acrobatic and dance elements for each participant. Results showed an increase in number of elements from OG 2000 to OG 2012, while a small decrease was noted at the OG 2016. Gymnasts have been performing significantly higher number of acrobatic elements over dance elements until OG 2016 when an increase in dance elements has been noted. Also, gymnasts have been performing significantly more E acrobatic elements and less A dance elements over the years. The assumption is that at the following OG 2020 we might expect some decrease in the total number of performed elements, but it is very likely that the elements might have higher difficulty value and more points for connection values.

**Key words:** *Olympic Games, balance beam, difficulty value, execution value*

### Introduction

Artistic gymnastics is a conventional sport in which the performance of the composition (exercise) on individual apparatus is evaluated by a number of referees. Over the years, the number of elements performed on all gymnastics apparatus and their difficulty values have steadily increased. The first element classification occurred in 1962, when the elements were classified into three difficulty categories (A, B, and C). The Technical Committee of the International Gymnastics Federation, after each Olympic Games (OG) and for the new Olympic cycle, prescribed new-amended scoring rules (in relation to the previous scoring rules). In the period analysed in this paper, the following difficulty groups appeared chronologically in the women's gymnastics Code of Points (WAG CoP): difficulty group "F" in WAG CoP 2001-2004, difficulty group "G" in WAG CoP 2005-2008, difficulty group "H" in WAG CoP 2013-2016 (Donti et al., 2014). Currently (WAG CoP 2017-2020), there are 9 difficulty groups in women's gymnastics which have different difficulty values: from 0.10 for "A" to 0.90 points for "I" difficulty value.

Generally, we may classify all the elements performed on the beam in two groups: 1) dance and acrobatic elements and 2) mounts and dismounts. Dance elements include various jumps and leaps, turns, balances, body waves and acrobatic elements without the flight phase; acrobatic elements include: 1) elements where there is a contact with the apparatus (walkovers) and 2) elements done with flight (salto). The design, the structure and the composition of the beam exercise include a rich and varied selection of elements of different difficulty groups from the table of elements. There are general rules for evaluating exercises on the beam, which have not been changed over the analysed period 2000-2016, and that are mainly related to the duration of the exercise, remounting, beeping sound of the maximum time limit, and interruption in the exercise and similar. What has changed over this period are the difficulties and composition requirements. In other words, in the period 2002-2005, the beam exercise had to have at least five elements, while in the period 2006-2009 and 2009-2016, eight elements of the highest difficulty values were summed up for the final difficulty value of the exercise. The sum implied the difficulty values of a maximum of five acrobatic elements (including the dismount) and a minimum of three dance elements. When discussing about acrobatic and dance elements on the beam, the influence of some dance elements on the difficulty value of the exercise as well as on the final value were determined (Delaš Kalinski et al., 2011). On the other hand, no significant influence of acrobatic elements on the execution value was found (Miletić et al., 2011). All the studies so far have covered periods of one year or they focused on a single competition. This leaves us with scarce knowledge of the trend of exercise composition across multiple Olympic cycles as well as of the lack of input on numerous changes in the scoring rules.

Following the aforementioned, the aim of this paper was to investigate differences in the frequency of acrobatic and dance elements, as well as the overall elements on the beam over a period of five Olympic cycles.



## Methods

The sample included a total of 40 senior category gymnasts who participated in the final Beam Apparatus Finals competition at all Olympic Games (2000-2016). The names of the participants of the final competitions on the beam from the analysed Olympics were taken from <https://gymnasticsresults.com/> and the videos of the exercises were downloaded from various links on YouTube. Afterwards, the experienced national judge counted the number of acrobatic and dance elements for each participant, which represented the sample of variables.

The data processing methods included the calculation of basic descriptive statistics: mean values (Mean), standard deviations (SD), minimum (Min) and maximum (Max) values, values of the measure for symmetry (Skew) and curvature (Kurt) of the distribution of results. Chi-square tests were used to determine the significance of differences in the frequencies of acrobatic and dance elements within and between OG. All data were calculated using Statistics 12 data analysis software (StatSoft, Tulsa, Oklahoma, USA). A type one error ( $\alpha = 5\%$ ) was set for all the applied analyses.

## Results

Table 1. Descriptive statistical parameters for the sum of the performed elements on balance beam at the Apparatus Finals at OG 2000-2016

	OG	Mean	SD	Min	Max	Kurt	Skew
ALL PERFORMED ELEMENTS	2000	12.13	1.25	10.00	14.00	-0.30	0.15
ACRO ELEMENTS		7.38	1.06	6.00	9.00	-0.13	0.91
DANCE ELEMENTS		4.75	1.39	3.00	7.00	-0.55	0.16
ALL PERFORMED ELEMENTS	2004	12.38	1.19	11.00	14.00	0.39	-1.20
ACRO ELEMENTS		8.25	1.58	6.00	11.0	0.29	0.61
DANCE ELEMENTS		4.13	1.89	2.00	8.0	1.94	1.30
ALL PERFORMED ELEMENTS	2008	14.13	0.64	13.00	15.00	-0.07	0.74
ACRO ELEMENTS		8.88	0.83	8.00	10.0	-1.39	0.28
DANCE ELEMENTS		5.25	1.04	4.00	7.0	-0.45	0.39
ALL PERFORMED ELEMENTS	2012	15.13	1.64	13.00	17.00	0.25	-2.00
ACRO ELEMENTS		8.88	0.99	8.00	10.0	-2.36	0.3
DANCE ELEMENTS		6.25	1.04	4.00	7.0	3.14	-1.7
ALL PERFORMED ELEMENTS	2016	14.75	1.28	13.00	17.00	0.61	-0.02
ACRO ELEMENTS		6.88	1.25	5.00	9.00	0.15	0.30
DANCE ELEMENTS		7.88	1.13	6.00	9.00	-0.99	-0.49

A review of Table 1 and the basic descriptive parameters of the number of elements on beam exercises show an increase in the number of elements from OG 2000 to OG 2012, both total and individually acrobatic and dance. At OG 2016, the number of the performed and the acrobatic elements decreased somewhat, but in favour of the dance elements. The minimum and maximum results also show an upward trend in all five Olympic cycles.

Table 2. Differences in frequencies between and within certain structural groups of elements performed on balance beam routines in the period 2000-2016

	2000	2004	2008	2012	2016	$\chi^2(4) =$
$\Sigma$ ALL PERFORMED ELEMENTS	118	121	113	99	97	p
						4.409
$\Sigma$ ALL ACRO ELEMENTS	58	61	65	71	54	$\chi^2(4) =$
						2.76
$\Sigma$ ALL DANCE ELEMENTS	38	42	33	38	42	p
						1.43
$\chi^2(1) =$	4.167	3.505	10.449	9.991	1.500	
p	0.041	0.061	0.001	0.002	0.221	

Although certain numerical discrepancies were found in all three categories of the analysed elements, no significant differences were found between the frequencies of any of the analysed groups of elements in the entire period (Table 2). Significant differences were found, however, between the numbers of acrobatic and dance elements performed on OG 2000, OG 2008 and OG 2012. According to the frequency values, we concluded that gymnasts performed significantly more acrobatic than rhythmic elements.

Table 3. Differences in frequencies between and within certain difficulty value groups of performed elements on balance beam routines in the period 2000-2016

BALANCE BEAM													
	ACRO ELEMENTS					DANCE ELEMENTS							
OG	00	04	08	12	16	$\chi^2(4)$	OG	00	04	08	12	16	$\chi^2(4)$
						p							p
$\Sigma G$	0	2	1	3	1	3.71	$\Sigma F$	0	0	0	0	1	4.00
ACRO						0.45	DANCE						0.41
$\Sigma F$	2	3	3	3	3	0.29	$\Sigma E$	1	4	4	4	6	3.37
ACRO						0.99	DANCE						0.50
$\Sigma E$	3	3	5	10	11	9.25	$\Sigma D$	5	5	6	5	8	1.17
ACRO						0.05	DANCE						0.88
$\Sigma D$	16	25	27	20	24	3.45	$\Sigma C$	11	15	20	15	14	2.80
ACRO						0.49	DANCE						0.59
$\Sigma C$	15	9	10	16	4	8.78	$\Sigma B$	6	3	10	9	10	4.89
ACRO						0.07	DANCE						0.30
$\Sigma B$	19	19	19	19	11	2.94	$\Sigma A$	16	11	8	17	26	12.13
ACRO						0.57	DANCE						0.02
$\chi^2(6)$	47.28	63.97	66.92	40.90	55.41		$\chi^2(6)$	28.54	24.53	29.00	26.32	34.05	
p	<0.01	<0.01	<0.01	<0.01	<0.01		p	<0.001	<0.001	<0.001	<0.001	<0.001	

Based on the frequencies of certain difficulty value groups of elements, through all the analysed OG, we notice the constancy of the most frequencies of certain difficulty value group (Table 3). Significant differences in frequencies within certain difficulty value group has been established only within E acrobatic elements (whose sum of frequencies increase throughout the analysed period) and A dance elements (whose sum of frequencies have been decreasing from OG 2000 to OG 2008, and then again experience increase to OG 2016).

## Discussion

The change in the compositional requirements to a specific number of elements from individual groups of elements (i.e. 5 acrobatic and 3 dance elements) in 2006 might probably be the reason for the continuous increase of the average number of performed elements from OG 2000 to OG 2012. Namely, the gymnasts obviously tried to achieve maximum D value in their exercises by performing the prescribed number of elements of maximum difficulty values. After CoP 2013-2016 reduced the number of mandatory elements, a decrease in the average number of performed elements at OG 2016 occurred. This finding supports the results of the similar previously conducted studies (Delaš Kalinski et al., 2016; Kerr et al., 2015; Delaš Kalinski et al., 2017; Massidda & Calo, 2011), which also suggest that, because of higher error deductions and the introduction of the deduction for artistry in CoP 2009 (on the beam and the floor), the emphasis should be placed on the performance quality as it affects the results in the finals. If one considers that the result and the performance of the individual athlete is affected by the performance of the athlete, the performance of other competitors and the method of judging the competition (Tian, 2000), on the one hand, and that all of these impacts are increased as the level of the competition increase, on the other hand, then it would be advisable to consult the conclusions of this research in further research. This is needed because the sample of the respondents in the previous studies was significantly more heterogeneous in terms of the quality of performance (and the level of competition) compared to the sample of the respondents in this research. It is also evident that in the analysed period, in order to achieve higher D value, more attention was put on the dance elements. We know from experience that the primary concern is always on the structural improvement of the performance of jumps so that they might meet the prescribed compositional requirements. Similarly, when we increased the difficulty value of such jumps and when we added the value of the compositional requirement to the same, the value of a particular jump in the total value of the D grade became significant. The results of Delaš Kalinski

et al. (2011) study not only support the aforementioned conclusions on the significant influence of some dance elements on the difficulty value of the exercise, but they also emphasize its influence on the final value for the performance of beam exercise. The observed numerical “approximation” of the value of the performed acrobatic and dance elements with no significant differences between them at OG 2016, confirmed the previous assumptions: the finalists of the beam at OG 2016 decided to perform more dance elements (and their connections) since they were significantly easier to learn; by performing the same the finalists obtained the same difficulty values as when performing structurally significantly more complex acrobatic elements.

The acrobatic E group includes a total of nine flying elements. According to the authors, knowledge of the structure of performance and significantly heavier elements of the similar structure of movement on the ground is the reason for their inclusion in the beam exercise. The complexity and, consequently, high difficulty value of these elements primarily results from the need to perform such dynamic elements in a relatively short length (5 meters) and to perform securely to 10 cm in width (beam width). Since the participants are the trainees whose growth phase and, accordingly, the longitudinal movement of the centre of gravity of the body have ended, each repetition/refinement of the performance of such elements produces stable motor programs. Therefore, it is possibility that the gymnasts who perform them will execute them with as little influence of disturbing factors as possible. Accordingly, if one takes into consideration the fact that the average age of gymnasts has increased (Kerr et al., 2015; Baker-Ruchti et al., 2017; Atiković et al., 2017) and that the technical progress and the quality of performance increases with age, then the emergence of increasingly difficult elements in the final exercises on the beam is a logical outcome.

## Conclusion

The analysis of the best beam exercises at the Olympic Games shows the increasing trend in the number of the executed elements right up to OG in 2012. Certain decrease in the number of performed elements was determined at OG 2016. Given that these were recent OG, the assumption is that at the following OG in 2020 there will also be some decrease in the total number of the performed elements, but that those elements are likely to have higher difficulty value. Also, it is to be assumed that higher scores of the difficulty values of the exercises, thus higher values of the final scores, will be achieved by performing beneficial connections. However, these assumptions should be verified after OG 2020. The results of this research should serve as a guide for coaches and athletes who are striving for top results in beam performance at the following Olympic Games.

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## COMPARISON OF WINNING PLAYING MODELS ON THREE LEVELS OF COMPETITION IN THE VOLLEYBALL WORLD LEAGUE

Tomislav Đurković<sup>1</sup>, Maja Ban<sup>2</sup>, Mateja Krmpotić<sup>1</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>West Wood Club, Ireland

### Abstract

The aim of this research is to compare playing models of winning national teams on three different levels of competition in the Volleyball Nations League, as well as to verify if there is a statistically significant difference in the method for winning over their opponents. The sample included a total of 67 won sets that were played by three top-seeded national teams in each group: (France, n=26, Slovenia, n=22, Estonia, n=19). The variables that were observed during the matches were as follows: *Points Won By Spiking After Serve Reception – K1\_ATT*, *Points Won By Spiking After Defence – K2\_KATT*, *Points Won By Blocking – BLOCK*, *Points Won By Service – SERVE*, *Points Won By Opponent Error – OTF*. Descriptive indicators were calculated separately for each national team, while the difference between the groups was verified by using the Kruskal-Wallis test and the Mann Whitney U post – hoc test with the Bonferroni correction. The Kruskal-Wallis test registered a statistically significant difference between the playing models of the three winning national teams in the variable *BLOCK*,  $\chi^2(2, n=67) = 8,33, p=0,02$ . There is a statistically significant difference in the number of points won in the *BLOCK* variable. The reason for such results can be in the fact that the national team of Estonia played in the weakest group (the groups are formed according to the FIVB official ranking). Therefore, the block of the Estonian national team was not equally put to the test as the block of the Slovenia and France national teams.

**Key words:** volleyball, statistics, World League

### Introduction

The International Volleyball Federation is the supreme authority of the volleyball movement. It is the largest member (222 national federations) of the Olympic movement, and it is engaged in developing volleyball with the aim of positioning it as the leading sport in terms of media and entertainment. One of the tools in the achievement of the mentioned goal is the organization of competitions with global international character and top-level quality. Competitions of such quality are divided into those that are organized once every four years: Men's and Women's World Championship, Men's and Women's World Cup, World Grand Champions Cup and Olympic Games, as well as those that are organized each year: Nations League (former World League), Challenger Cup and Men's and Women's Club World Championship. The most attractive competition on an annual basis is certainly the Volleyball Nations League, which started far back in 1990 and maintained its quality and attractiveness during the years. The last edition of the World League took place two years ago (2017) and it included a total of 36 national teams that were divided into three groups of 12 teams according to the official world ranking. The third, nominally weakest group was composed of the following national teams: Chinese Taipei, Germany, Greece, Kazakhstan, Mexico, Montenegro, Qatar, Spain, Tunisia, Venezuela, Estonia and Austria. The winner of this group acquires the right to participate in the second group of the World League in the following year. The second or middle group according to their effectiveness included the following national teams: China, Czech Republic, Egypt, Finland, Japan, Korea, Netherlands, Portugal, Slovakia, Turkey, Slovenia, and Australia. The winner of this group acquires the right to participate in the strongest group of the World League in the following year. The first group consists of 12 most efficient national teams according to their ranking: Argentina, Belgium, Brazil, Bulgaria, France, Iran, Italy, Poland, Russia, Serbia, USA, and Canada. The three best teams in the strongest group win money prizes.

According to the official volleyball rules (FIVB, 2019), the winner of a volleyball match is the team that first wins three sets. Sets are played until 25 points are won, provided that each set must end with an at least two-point difference. The prospective fifth set is played until 15 points are won, also on condition that there is no less than a two-point difference. As a result of an ever-expanding quality in modern volleyball, many sets usually end with the mentioned two-point difference. This is also manifested in the latest FIVB data that indicates the item of "match tension" is increasing both in women and men's matches (FIVB, Picture of the Game, 2019). The result in such "close" matches depends on both team and individual player ability to perform various volleyball skills (Häyrinen et al., 2004). The possible 25 points (or more) are won by spiking after serve reception, spiking after defence, by block, serve or after opponent's errors, while the winning

model represents a specific “code” that allows one to learn the contribution of each of the above-mentioned methods. The aim of this research is to compare the winning “codes” of the first-placed national teams on three levels of competition in the Volleyball Nations League, as well as to verify if there is a statistically significant difference between them.

## Methods

Educated personnel at the Faculty of Kinesiology University of Zagreb conducted the measurements. The sample included a total of 67 won sets that were played by three top-seeded national teams in each group (France, n=26, Slovenia, n=22, Estonia, n=19). Only the sets won by the twenty-fifth point (without including the sets won by a two-point difference) by the mentioned three national teams were selected. The variables that were observed during the matches were as follows: *Points Won By Spiking After Serve Reception – K1\_ATT*, *Points Won By Spiking After Defence – K2\_KATT*, *Points Won By Blocking – BLOCK*, *Points Won By Service – SERVE*, *Points Won By Opponent Error – OTF*. Considering that the analysis included only sets that were not won by a two-point difference, the total number of points in a playing model should be 25. Descriptive indicators were calculated separately for each national team, while the difference between the groups was verified by using the non-parametric Kruskal-Wallis test and the Mann Whitney U post – hoc test with the Bonferroni correction.

## Results

Table 1. presents the descriptive values of the measured variables.

Table 1. Descriptive values of the measured variables

Team	Variable	M	SD	Min	Max	Percentiles		
						25 <sup>th</sup>	Md	75 <sup>th</sup>
France (N=26)	K1_ATT	8,58	2,20	3	12	7	9	10
	K2_KATT	4,77	1,63	2	8	3	5	6
	BLOCK	2,46	1,79	0	8	1	2	3
	SERVE	2,08	1,23	0	4	1	2	3
	OTF	7,15	2,60	3	14	5,75	7	8,25
Slovenia (N=22)	K1_ATT	9	2,58	0	12	8	9,5	11
	K2_KATT	4,64	2,15	0	8	3	5	6,25
	BLOCK	2,41	1,84	0	7	1	2	3,25
	SERVE	1,64	1,56	0	6	0	1	3
	OTF	5,77	2,96	0	12	3,75	6	8
Estonia (N=19)	K1_ATT	7,42	2,34	3	10	7	8	9
	K2_KATT	5	2,49	1	11	3	5	7
	BLOCK	3,53	1,35	0	6	3	4	4
	SERVE	1,47	1,39	0	4	0	1	3
	OTF	7,58	2,21	2	11	6	8	9

N=number of sets; Min=minimal result; Max=maximal result; M=arithmetic mean; SD= standard deviation; K1\_ATT – points won by spiking after serve reception; K2\_KATT – points won by spiking after defence; BLOCK – points won by blocking; SERVE – Points Won By Service; OTF – Points Won By Opponent Error

Table 2. demonstrates the results of the Kruskal-Wallis test.

Table 2. Results of the Kruskal-Wallis test

	K1_ATT	K2_KATT	BLOCK	SERVE	OTF
c <sup>2</sup>	5,38	,06	8,33	3,12	4,96
df	2	2	2	2	2
p	,07	,97	,02*	,21	,08

C<sup>2</sup> – chi square value; df – degrees of freedom; p – level of the statistical significance of the test, \*indicates statistical significance (p <0.05)



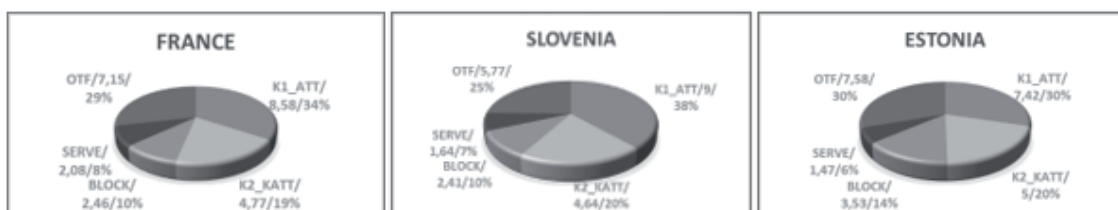
Table 3. shows the results of the Mann Whitney U post – hoc test with the Bonferroni correction.

Table 3. Results of the Mann Whitney U post – hoc test with the Bonferroni correction

BLOCK	France (n=26)
	Estonia (n=19)
MWU	131,00
Wilcoxon W	482,00
Z	-2,72
p	,01*

MWU – result of the Mann-Whitney U test; Wilcoxon W – result of the Wilcoxon W; Z – Z value; p – level of the statistical significance of the test, \*indicates statistical significance (p < 0.05)

Graph 1 presents winning playing models of France, Slovenia, and Estonia national teams.



K1\_ATT – points won by spiking after serve reception; K2\_KATT – points won by spiking after defence; BLOCK – points won by blocking; SERVE – Points Won By Service; OTF – Points Won By Opponent Error

Graph 1. Winning playing models of France, Slovenia, and Estonia national teams.

## Discussion

Upon overview of results in Table 1 and Graph 1, winning playing models can be identified for each of the three groups. The winning “code” of the **France national team** is as follows:  $K1\_ATT$  8,58 +  $K2\_KATT$  4,77 +  $BLOCK$  2,46 +  $SERVE$  2,08 +  $OTF$  7,15 points per set = 25. The winning “code” of the **Slovenia national team** is as follows:  $K1\_ATT$  9 +  $K2\_KATT$  4,64 +  $BLOCK$  2,4 +  $SERVE$  1,64 +  $OTF$  5,77 points per set = 25. The winning “code” of the **Estonia national team** is as follows:  $K1\_ATT$  7,42 +  $K2\_KATT$  5 +  $BLOCK$  3,53 +  $SERVE$  1,47 +  $OTF$  7,58 points per set = 25. Upon comparison of each separate variable, it can be registered that in the variable *Points Won By Spiking After Serve Reception* –  $K1\_ATT$  the highest number of points is won by Slovenia (9), followed by France (8,57) and Estonia (7,42). In the variable *Points Won By Spiking After Defence* –  $K2\_KATT$  the highest number of points is won by Estonia (5), followed by France (4,77) and Slovenia (4,64). In the variable *Points Won By Blocking* –  $BLOCK$  the highest number of points is won by Estonia (3,53), followed by France (2,46) and Slovenia (2,41). The highest numeric difference between the winners of each group can be noted in the afore-said variable. In the variable *Points Won By Service* –  $SERVE$  the highest number of points is won by France (2,08), followed by Slovenia (1,64) and Estonia (1,47). It is interesting to observe the average number of errors per set done by opposing teams against the mentioned three national teams. On average, the highest number of points per set is won (variable *Points Won By Opponent Error* –  $OTF$ ) by the Estonia national team (7,58), followed by the France national team (7,15) and Slovenia national team (5,77). The Kruskal-Wallis test registered a statistically significant difference between the playing models of the three winning national teams (1 – France, n=26, 2 – Slovenia, n=22, 3 – Estonia, n=19) in the variable **BLOCK**,  $\chi^2$  (2, n=67) = 8,33, p=0,02. The Mann Whitney U post – hoc test with the Bonferroni correction registered a statistically significant difference (p=0,007) in the variable **BLOCK** between the national teams of Estonia (Md=4,00, n=19) and France (Md=2, n=26), U=131,00, z=-2,72 with a medium effect (r=0,4) by the Cohen criterion (Cohen, 1988). According to Pallao et al. (2004) as well as Patsiaouras et al. (2011), blocking was identified as an element with significant effect on the final outcome of a match. In two variables ( $K1\_ATT$  and  $OTF$ ) numeric differences can be registered that nonetheless are not statistically significant. In the variable  $K1\_ATT$  it can be noted that the national teams of France (8,58) and Slovenia (9) win more points than the Estonia national team (7,42) which refers to a more efficient preparation of the first offence in the mentioned teams. The highest number of points in this variable is related to the performance quality of the serve reception (Barzouka et al. (2006); Asterios et al. (2009)), the setting in the offence phase (Costa et al. (2011), Costa et al. (2011) and by the number of blockers during the block phase (Afonso, J., Mesquita, I., & Palao, J.M., 2005), whereas on the highest level the average efficiency over the past 10 years is between 73 and 76%. (Picture of the game, FIVB, 2019).

In the variable **OTF**, it can be noted that opponents playing against Estonia make the highest number of errors (7,58 per set), somewhat less by opponents playing against France (7,15), and significantly less by opponents of the Slovenia national team (5,77). Such data support the fact that lower quality teams (in this case teams in the weakest group) make more errors than higher quality teams (Eom & Schutz, 1992; Patsiaouras et al., 2011), and therefore, it can be stated that the Estonia national team had to win less points than the two other national teams, while France, and especially Slovenia, had a more difficult task as the teams in their groups made fewer errors.

## Conclusion

Upon comparison of the playing “models” of the winners in three groups of the Volleyball Nations League, the conclusion can be made that there is a statistically significant difference in one out of the five measured variables. It is interesting that in the variable in question (BLOCK), the winning national team in the nominally weakest (third) group of the Volleyball Nations League wins more points than the other two national teams, which are better teams according to their ranking and group qualification, while also a statistically significant higher number of points than the France national team. The reason for this can be the fact that the Estonia national team played in the weakest group (the groups are formed according to the FIVB official ranking). Therefore, the block of the Estonian national team was not equally put to the test as the block of the Slovenia and France national teams. The above-mentioned data show that France and Slovenia had an average higher number of points per set in the first offence (K1\_ATT), i.e. the variable which according to all research wins the highest number of points. This points to the lower level of quality of the Estonia national team, which when competing with equally strong national teams wins the lowest number of points in this variable. This certified that opponents of the Estonia national team make the highest number of errors, which is hardly unusual considering that teams of lower quality more often make mistakes. An exception is in the relationship between the second and the first group, where it was proved that the number of direct errors by opponents of the Slovenia national team was substantially lower than that made by the opponents of the France national team. The reason for this phenomenon is in the greater pressure on the opponents in both complexes of the game by the France national team. From complex 1, pressure can be defined as a rapid and versatile offence after a precise serve reception which complicates playing the block – defence system and preparing an efficient counterattack. From complex 1, pressure can be defined as strong oppression by serve after which it is difficult to organize the first offence and indirectly a facilitated position for block and defence, as well as for organizing an efficient counterattack.

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## DIFFERENCES BETWEEN NATIONAL HOCKEY LEAGUE (NHL) AND KONTINENTAL HOCKEY LEAGUE (KHL) IN ATTACK ACTIONS – PILOT STUDY

Alan Franjković, Bojan Matković

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

*Background.* Performance indicators should relate to successful performance. The same principles of match analysis can be used in all invasive games, and typical performance indicators can also be easily translated from one sport to another. The purpose of this study was to determine differences between National Hockey League (NHL) and Kontinental Hockey League (KHL) in variables of attack (start, action and finish).

Sample of entities was extracted from 5 games each league and converted to 24 variables.

*Methods.* Situational efficiency variables that affected final outcome were comprised of 24 parameters. Differences between successful and unsuccessful teams were detected using Mann-Whitney *U*-test for nonparametric variables. Significant value was set at  $p \leq .05$ .

*Results.* Results showed overall statistical differences in parameters of attacks between NHL and KHL. The best variables that differed between teams were Number of attacks, Dump pucks, Giveaways and Regroup ( $Z = 3.67, p > .000$ ;  $Z = 3.44, p > .001$ ;  $Z = 3.44, p > .001$ )

*Conclusion.* NHL can be described as a faster, hard hitting game which is back up with more attacks and dump pucks, but in KHL there is more skating, more skills which is described by Controlled breakout and power play game.

**Key words:** notational analysis, attack, ice hockey

### Introduction

Hockey is well known as the fastest team game in the world and the most watched winter sport in the world, usually played in northern hemisphere. Ice Hockey is a fluid game where puck possession changes frequently, and where scoring can happen at any time. We take the point of view that scoring for each team is well modeled as a Poisson process (Breiman, 1986; Thomas, 2007). Statistically speaking, the winner of a hockey game will be the team whose Poisson random variable (number of goals scored) is larger than the other's.

As sports have entered the world of big data, there is increasing opportunity for large-scale machine learning to model complex sports dynamics. A Markov model is a stochastic model composed by a set of states to describe a sequence of events. It has the Markov property, which means that the process is memoryless, i.e., the next state depends only on the present state. A hidden Markov model (Rabiner, 1982; Rabiner, 1989) is a Markov model in which the states are partially observable.

Macdonald (2012.) used a variety of raw metrics (goals, shots, hits, hits against, and face-offs) to build a ridge regression model predicting the number of goals a player would score in the future. For Schuckers and Curro's (2013) Total Hockey Rating (THoR) it was found that forwards are, typically, responsible for more wins created than defensemen, with elite players producing over five wins per season.

Roith and Magel (Roith, J. and Miguel, R., 2014) demonstrated that, given a full season of data, only the total number of goals against, the total number of goals for, and the total number of takeaways are needed to accurately predict (87%) whether a team would make or miss the playoffs.

Additional efforts have been made to classify NHL players based on their style of play (Chan and Novati 2012.; Chan et al., 2012), as well developing visualization techniques to assess the various spatial properties of the game (Pileggi et al., 2012). However, as beneficial as the aforementioned research is, it has largely relied on univariate regressions; that is, even though there are multiple independent variables, there is only one dependent variable.

Given the diversity of invasion team sports, many assessment tools have been developed in an attempt to measure aptitude to, or performance in a variety of team sports. 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 (Grehaigine, Godbout, & Bouthier, 1997; Nadeau et al., 2008).

The best two leagues in the world are Northern America National Hockey League (NHL) and Russian Kontinental Hockey League (KHL). Because of the larger ice surface the style of play in Europe is much different, mostly. The players are typically smaller and faster and have good stickhandling. The playing style in NHL on the narrower ice makes that looks like a faster, harder hitting game. In the NHL there is something going on all the time – there are hits, there is something around the net. In the KHL there is more skating, more skills – but more skating without action. The aim of this study is to compare NHL and KHL leagues in types of attack by its beginning, action and types of ending.

## Methods

*Subjects.* The study was conducted on the sample of the 5 games in each league (20 teams) playing in the NHL and KHL 2018/19 playoff games. Games were selected by Research Randomizer on <https://www.randomizer.org/> website. Games with that number were considered. With notational analysis we took each segment of attack and give it its beginning, action and finish.

*Variables.* The variables that represent comprised 23 indicators in ice hockey game. 9 of them represent beginning of attack, 8 action of attack and 6 type of ending an attack. Variable *Number of Attacks* (N) represent number of attacks of a team during whole match.

*Face-offs* (FO) are always start of attacks at beginning of period or after stoppages of game. *Regroup* is a way of start attack after opposite team dups puck out of the defensive zone. *Control Breakout* (BO) is a way of start an attack when defending team is not having pressure or making a forecheck. *Breakout under pressure* (BO\_PR) it is a way of start an attack when defending team is making pressure and attacking team makes play to exit defending zone. *Rebound* (REB) is start of new attack after getting possession of a puck after shot on net. *Defensive rebound* (DREB) is a start of attack when defense come in possession of a puck after goalie makes a save and player makes attack with puck carry. *Takeaway* (T\_OZ, T\_NZ, T\_DZ) in offensive, neutral and defensive zone is start of attack when defending team makes a tactical action to reduce options of puck carrier and take away his puck.

*Straight attack* (SA) is an action of attack when players go straight on the net and try to score as quickly as they can. *Dump pucks* (DUMP) is an action of attack when players dump the puck in the attacking zone and with play of bodycheck and high pressure try to get possession back. That is known as safe play and usually ends with giveaway. *Offensive zone play* (OZP) is an action of attack when players try to keep possession in offensive zone by delaying with shot or attacking the net. *Power plays* (PP) is an action of attack when players have player or two advantage and try to score with set play of attack. *Defensive zone dumps* (DZD) is an action of attack when players dump the puck from their defensive zone. *Defensive zone plays* (DZP) is an action of attack when players try to play the puck out of their defensive zone but because of defending team pressure they make giveaway or takeaway. *Middle zone play* (MZP) is an action of attack when players try to pass or play through middle zone and it results with lost puck or stoppage of play.

*Attempt shot* (SHOT) is a type of finish action when player try to shot the puck but goalie doesn't make a save. *Shot on goal* (SOG) is an action of attack when players shot the puck but goalie touches the puck and make a save. *Stoppage of play* (SP) is an action of attack when referee stops the play because of an infraction of a rules (penalty, offside and icing), goalie makes a save or puck goes out of boundaries. *Takeaway* (TAW) is an action of attack when players lost possession by opponent's tactic action, usually starts with a bodycheck and then takeaway puck. *Giveaway* (GIV) is an action of attack when players give away possession by mistake or some action that results lost puck.

*Data analysis.* Data was analyzed with Statistica 12.0 software for Windows. For all parameters arithmetic mean and standard deviation were calculated. We used Mann-Whitney Test analysis for realize is there any differences between NHL and KHL in faze of attack. Significant value was set at  $p \leq .05$ .

## Results

At the end of notational analysis there was 3945 attacks in 10 considered games. We transfer those data in 23 variables described earlier. Descriptive parameters of all variables are shown in Table 1. Because of small sample of games we use Mann-Whitney U Test for nonparametric statistics to realize group differences. Statistically NHL and KHL differs in variables Regroup, Rebound, Defensive Rebound as starting attack variables, Dump Puck variable as action and Takeaway and Giveaway variables for finish the play. Results of Mann-Whitney U Test are shown in Table 2.

Table 1. Descriptive statistic of selected variables

	n	NHL				KHL			
		mean	S.D.	min	max	Mean	S.D.	min	max
N	10	214.60	15.01	195.00	241.00	179.70	15.20	153.00	196.00
FO	10	27.90	4.89	21.00	37.00	32.00	8.64	22.00	45.00
REG	10	26.90	6.06	19.00	37.00	16.90	5.11	10.00	25.00
BO	10	13.00	4.08	8.00	23.00	15.60	4.17	8.00	20.00
BO_PR	10	37.40	6.11	30.00	46.00	31.20	7.21	21.00	40.00
REB	10	20.10	5.15	13.00	28.00	11.80	3.99	7.00	16.00
DREB	10	9.30	4.06	4.00	17.00	3.10	1.66	1.00	6.00
T_OZ	10	25.90	7.89	15.00	40.00	25.70	7.59	18.00	37.00
T_NZ	10	11.80	4.34	5.00	18.00	10.20	2.94	6.00	15.00
T_DZ	10	37.90	9.33	26.00	55.00	32.90	11.95	19.00	49.00
SA	10	21.90	4.95	14.00	29.00	18.20	5.20	8.00	27.00
DUMP	10	31.40	3.92	26.00	37.00	20.80	4.47	13.00	29.00
OZP	10	63.20	19.10	37.00	88.00	54.90	18.53	33.00	92.00
PP	10	14.30	7.20	4.00	28.00	19.40	9.43	5.00	33.00
DZD	10	29.40	7.68	19.00	44.00	22.40	7.95	10.00	35.00
DZP	10	21.50	5.58	15.00	32.00	17.70	4.99	10.00	25.00
MZP	10	26.40	6.15	16.00	38.00	23.10	7.81	12.00	35.00
MZC	10	4.50	2.27	2.00	9.00	2.70	2.21	0.00	7.00
SHOT	10	29.00	6.39	16.00	39.00	26.60	10.55	15.00	42.00
SOG	10	33.80	9.68	18.00	45.00	32.20	7.55	20.00	42.00
SP	10	10.30	2.58	7.00	15.00	10.60	4.09	7.00	18.00
TAW	10	26.00	6.63	19.00	40.00	18.00	6.29	12.00	34.00
GIV	10	113.10	12.45	90.00	131.00	89.20	8.19	79.00	103.00

Table 2. Mann-Whitney test results

variable	Mann-Whitney U Test (obradenipodaci) By variable League Marked tests are significant at $p < .05000$									
	Rank Sum Group 1	Rank Sum Group 2	U	Z	p-value	Z adjusted	p-value	Valid N Group1	Valid N Group2	2*1sided exact p
n	154.00	56.00	1.00	3.67	0.0002	3.67	0.0002	10	10	0.0000
FO	93.50	116.50	38.50	-0.83	0.4057	-0.83	0.4048	10	10	0.3930
REG	146.50	63.50	8.50	3.10	0.0019	3.10	0.0019	10	10	0.0007
BO	85.50	124.50	30.50	-1.44	0.1509	-1.44	0.1489	10	10	0.1431
BO_PR	128.00	82.00	27.00	1.70	0.0890	1.71	0.0879	10	10	0.0892
REB	144.00	66.00	11.00	2.91	0.0036	2.92	0.0034	10	10	0.0021
DREB	151.00	59.00	4.00	3.44	0.0006	3.46	0.0005	10	10	0.0001
T_OZ	106.50	103.50	48.50	0.08	0.9397	0.08	0.9395	10	10	0.9118
T_NZ	116.50	93.50	38.50	0.83	0.4057	0.84	0.4027	10	10	0.3930
T_DZ	117.50	92.50	37.50	0.91	0.3643	0.91	0.3625	10	10	0.3527
SA	125.00	85.00	30.00	1.47	0.1405	1.48	0.1385	10	10	0.1431
DUMP	151.00	59.00	4.00	3.44	0.0006	3.45	0.0006	10	10	0.0001
OZP	117.00	93.00	38.00	0.87	0.3847	0.87	0.3831	10	10	0.3930
PP	88.50	121.50	33.50	-1.21	0.2265	-1.21	0.2261	10	10	0.2176
DZD	129.00	81.00	26.00	1.78	0.0757	1.78	0.0753	10	10	0.0753
DZP	124.00	86.00	31.00	1.40	0.1620	1.40	0.1602	10	10	0.1655
MZP	117.50	92.50	37.50	0.91	0.3643	0.91	0.3640	10	10	0.3527
MZC	130.00	80.00	25.00	1.85	0.0640	1.88	0.0606	10	10	0.0630



variable	Mann-Whitney U Test (obradenipodaci) By variable League Marked tests are significant at $p < .05000$									
	Rank Sum Group 1	Rank Sum Group 2	U	Z	p-value	Z adjusted	p-value	Valid N Group1	Valid N Group2	2*1sided exact p
SHOT	110.50	99.50	44.50	0.38	0.7055	0.38	0.7049	10	10	0.6842
SOG	113.00	97.00	42.00	0.57	0.5708	0.57	0.5699	10	10	0.5787
SP	109.00	101.00	46.00	0.26	0.7913	0.27	0.7895	10	10	0.7959
TAW	142.00	68.00	13.00	2.76	0.0058	2.77	0.0056	10	10	0.0039
GIV	151.00	59.00	4.00	3.44	0.0006	3.44	0.0006	10	10	0.0001

## Discussion

The purpose of our study is to compare best ice hockey leagues in the world by its attack. The bigger ice surfaces bring some differences between two leagues. Beyond main differences between NHL and KHL in rink size and some playing rules (NHL, 2018. IIHF, 2018.), there are differences in some game situations. The best way to record those situations is by notational analysis. This analysis usually results in a statistical description of what happened during one event or a series of events, with the complexity of the analysis and the content of the coding open to choice (James, 2006). Normal statistical data that is shown on official league pages doesn't give us so much information on what is going on the ice. With notational analysis we get much deeper data especially when situations are well described. It is well known, that without objective, validate and reliable measure instruments isn't possible to define player fitness or his elements of transformed processes in sports (Milanović, 1999).

The main differences is in number of attacks that describes description from introduction that NHL looks like faster hard hitting game. In normal statistical data there are much more hits in NHL that describe faster game from one side and less place because of narrower rink. The next variable is regroup which describes that NHL players wants to go as fast as they can back to offensive zone while KHL players try to get puck behind net and try to play controlled Breakout and try to enter offensive zone.

The other variable that differentiate this two leagues is Dump Puck. Because of the much narrower ice there is no so much space to individually enter the offensive zone players dump the puck in and chase it to get possession of a puck. This is related with variable Giveaway because the most pucks that are given to opponent with dumping out of defensive zone or by dumping the puck into the offensive zone. Because of the higher pace and forecheck, offensive players make more takeaways by making more pressure on defensive players during the game.

As we said earlier in NHL it is higher pace so there is much more pressure on the goalie and after shot there are more deflected pucks that goes to on one side like Rebound Play but on the other side like Defensive Rebound Play because of good defensive players that pick up the "trash".

In KHL there are much more stoppages of play that results more beginning of attack by Faceoff. Also there are more Penalties which result with more Power Play actions. At beginning of attack in KHL there are much more used Controlled Breakouts. This is probably related to number of Power play attacks, which are more in KHL, when attacking players don't make pressure especially when player is behind the net with the puck.

## Conclusion

Normal statistic data that can be found on official webpages doesn't give us some much information about differences between leagues. Some data goes on side of a winning team like assists, shot on goal and Saves by goalie. But we are expecting that because more shots taken on goal gives us bigger probability for scoring (Franjković at al., 2017). With this work we sow some diferences between best two leagues in the world not only in normal statistical patameters like everybody does, but specific parameters extracted from attack (beginning, action and finish). In that case we can prepare players better for some specific demands that each legue have. In future it will be good to take how long does attacks last and how many passes are in each attack.

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## TEAM HANDBALL - STATE OF THE ART

Igor Gruić

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

Team handball is an Olympic sport and complex kinesiological discipline, played by around 19 million people (Mangela 2019, Saavedra 2018) on the Globe. In contemporary scientific communication on 'state of the art' of research in handball (Ibáñez et al, 2020; Mangela, 2019; Saavedra, 2018, Gruić, 2019), important framework for future scientific discourse was set. Handball terminology (example offered in Omrčen et al, 2011), synchronized with bibliographical tools and the research methodology offers solid platform for fluent progress of 'world of handball' in all aspects. Successfulness with regard to handball is a multilayer concept often measured by different cumulative impacts of various parameters within competition arrangements. In most narrow perspective, layers of reductive anthropometric, morphological, functional, physiological, biomechanical, motor and information data are confronted to constructive psycho-social, economic, notation analysis, strategic and tactical solutions, all the way to competition arrangements and referees' influences on match and competition courses.

*Key words: handball, sport science, kinesiology, review*

### Introduction

Team handball is an Olympic sport and complex kinesiological discipline, played by around 19 million people (Mangela 2019, Saavedra 2018) on the Globe.

In contemporary scientific communication on 'state of the art' of research in handball (Ibáñez et al., 2020; Mangela, 2019; Saavedra, 2018, Gruić, 2019), important framework for future scientific discourse was set. Handball terminology (example offered in Omrčen et al., 2011), synchronized with bibliographical tools and finally the research methodology offers solid platform for fluent progress of 'world of handball' in all aspects.

Successfulness with regard to handball is a multilayer concept often measured by different cumulative impacts of various parameters within competition arrangements. It is possible to be a winner in one competition, and loser in other. It is possible to offer best performance and presentation in one specific match, and lose the game unexpectedly, and vice versa.

In reviews and regular scientific contributions with regard to match analysis in general (Ferrari et al, 2019), or with regard to competition arrangement or 'winning formulas' and features of succes (Bilge, 2012; de Paula et al., 2020; Saavedra et al., 2017; Maciej&Bartosz, 2017; Skarbalius et al., 2013; Ferrari et al., 2014; Ferrari et al., 2020; Almeida et al., 2020; Gruić et al., 2006; Schoreret al., 2020, etc.), it is possible to track possible models for success. However, dominant conclusion for practical implication of most findings were that every competition for specific age, sex or level of competition brings new 'winning formula', even at/for top-level competitions.

Since controllability of dominant winning formula trough time is most demanding task for team managers, selectors and coaches, it is a goal of this contribution to unveil some facts and myths in underlying research and practice within the 'world of handball'.

In most narrow perspective, layers of **reductive** anthropometric, morphological, functional, physiological, biomechanical, motor and information data are confronted to **constructive** psycho-social, economic, notation analysis, strategic and tactical solutions, all the way to competition arrangements and referees' influences on match and competition courses.

Understanding handball trough scored goals and their accumulation is reserved more for generally 'receptive' observer. Understanding patterns and key points of individual, group and team(s) performance is an open quest within versatile dynamics of progress, as a path for dedicated proactive researcher, passionate practitioner, or likewise. Patterns which were quantified, collected and catalogized after motion analysis (e.g. in Lopez&Platen, 2005), or kinematic and kinetic analysis (Marković et al., 2019; Skejō et al., 2019), or via different automatic sensing procedures in handball and its derivatives (Sánchez-Sáez et al., 2021; van den Tillaar et al., 2021; Zapardiel&Asín-Izquierdo, 2020; Gomez et al., 2014; 8. Iannaccone et al., 2021), etc., offer deeper insight into liminal performances. Therefore, advantageous position for convergence of this knowledge into training protocols transposes into advantageous position while competing with opposing teams.

Teaching and learning methodology, in top level sport and PA intertwined, rules, marketing and handball derivatives (beach handball, mini handball, Wheelchair handball, etc.), are additional developmental categories covered by interest among scientists, practitioners, institutionalized and open citizens initiatives, with financial public and private enrollments included.

Different approaches in differentiation of individual contributions within team performance (Wagner et al., 2014), of static and dynamic perspective within match analysis (Prieto et al., 2015) open different perspectives for understanding roles of players and their potential, or even ‘talent’ (Serrien et al., 2018; Fernández-Romero et al., 2017).

## Reductive Handball

Within rules of the game, physical laws present only one layer of barriers and plateaus of possible performances. There is a certain ‘general knowledge’ about inclusion parameters for top level handball, i.e. there are no real obstacles for ones with good health and consistent good growth in training and competing outcomes. Players may have versatile complex of abilities and knowledge – it is not a barrier if one is higher or not, faster or slower, etc. However, there are certain minimal prerequisites.

Mostly, but not exclusively, information about height, weight, BMI are presented with relation to attacking playing positions. Specialization of some players for defensive tasks differ winning teams from losing ones, therefore this argument solely requires reinterpretation of blurry concept of dominant features of morphology ‘predestined for success’

When anthropology of handball players is explained through health, motor, functional or other equivalent characteristic, directly by units of SI measurement system, or indirectly within some regression model - it reduces handball player and (temporarily) detaches him/her from knowledge on strategy, tactics, some highly specific and situational variation of techniques. This information matrix, however, offers frame for consistency of performance on desired level – e.g., 1) body composition, anthropometry, morphology in general and with various specificity with relation to age, sex, level (Martínez-Rodríguez et al., 2020; Cavedon et al., 2018; Bon et al., 2015; Hoppe et al., 2017; Ortega-Becerra et al., 2020; Camacho-Cardenosa et al., 2018), and within information about certain attributes ‘models’ (e.g. Massuça et al., 2014, Manchado et al., 2013), furthermore 2) motor abilities predominantly related to throwing and jumping abilities (Vila&Ferragut, 2019; Martínez-García et al., 2021, Bragazzi et al., 2020; Ramirez-Campillo et al., 2020 ), 3) endurance within different basic and situational perspectives (Camacho-Cardenosa et al., 2019; Póvoas et al., 2014; Pueo et al., 2017), and 4) other abilities with special importance of understanding their interrelation (Ziv &Lidor, 2009, Gruić, 2019).

Maximally exerted and controlled force (controlled, canaled and converted into power, speed, strength or agility) may present a sole complex of indicators of possible difference between teams – colloquially – ‘those who jump higher and shoot more forcefully - score better’. On the other hand, those with knowledge about structure of game phases and sub-phases also have strong argument for beating this quasi-scientific, almost colloquial attitude. Biomechanics of handball techniques, in laboratory surroundings with conservative kinematics, kinetics and sEMG, are related more to medical features of performance – prevention and rehabilitation, rarely narrowly concentrated to structure classification and to individual and general improvements directives within training. Functional abilities are often presented through absolute and relative VO<sub>2</sub>max, aerobic and anaerobic threshold, or high lactate response, running speeds in specific tasks, etc. Indirect laboratory measurements also often had high motivational impact, therefore, flawless conclusions may have been found as nearly impossible. Many generations of winning individuals carried lack of preparedness due to various objective and subjective reasons (‘old injury’, incomplete or inconsistent training and competing periodization among clubs and national teams, unhealthy habits like smoking, etc.).

## Constructive Handball

Simultaneously, conservative and contemporary strategic, tactical, task-oriented behaviors and decision patterns in handball analyzed from different perspectives (e.g. Prudente et al., 2019; Krahenbühl et al., 2019; Gümüş&Gençoğlu 2020; Bento et al., 2021; Tilp, 2019, etc.), provokes and disturbs the fine balance between innovativeness in preparation for next competition and stability of performance basic technical and tactical patterns. Too much innovation may destabilize standard performance, and to conservative standard performance can’t guarantee success. On this fine delineation many psychosocial and motivational moments were recognized as important (Kristjánsdóttir et al., 2018; Granero-Gallegos et al., 2017; Solovey et al., 2020; Martínez-Rodríguez et al., 2021; Gómez-López et al., 2020; Gómez-López et al., 2019). Due to non-protected body during maximal exertion of explosive power, medical moments also came to focus of scientist and medical practitioner. Analyses of mechanisms of injuries, preventive protocols and best rehabilitation and rest practices were covered through, e.g. inspection of muscle asymmetries (Lijewski et al, 2021), obesity (Hermassi et al, 2020), gender and age related differences (Raya-González et al., 2020), contact features (Luig et al., 2020), overtraining, old injury, dehydration repercussions (Kim&Park, 2021; Garcia&Bebetsos, 2014; Slodownik et al., 2020) – numerous with rather conservative conclusions, but rare ones, especially in comparable studies of maximal exertions in team sports, with rather provocative ideas about postponing cellular ageing (Hagman et al., 2021).

At the end, notational analysis and events management overlays each other from many perspectives due to intertwined outcomes – winning formula via 1) ‘niches’ within performances of players within the match, and 2) ‘niches’ for cultivation of continuous interest and involvement in ‘world of handball’ activities. Notational analysis gives info e.g. about distances, duration or repetitions of certain patterns of individual or group behaviors – covered by rules, or by measures of advantage (scored goals), or else. There are different methodologies – official statistics based on expert registry, sensor-based equipment, hybrid solutions. However, inconsistency in practicing the rules of the game - is a key obstacle for future research. Notation analysis is, inversely, becoming one of key tools for disintegration of that inconsistency.

## Scope and limitations

This contribution had no intention to explicitly present key features and models of success in handball, i.e. related to anthropometry of functional and motor status of top-level players, nor features of match phases, offensive, defensive or transitional events that successful teams perform more, or likewise. Data, of course, may be extracted from presented sources in order to create some future winning formulas in forthcoming competitions. Economic and deeper societal and political aspects were omitted intentionally.

Main idea of this review was to sketch contemporary handball scientific frame approachable to contemporary scientist in field of sport science. Important basic and applied research has been intentionally omitted with the argument that references included within presented systematic reviews, literature reviews, meta-analysis, original scientific papers cover dominant framework, in relevant research bases, IHF, EHF, national, and scientific and teaching handball institutional platforms.

Finally, in order to retain *global imprint* of this contribution, it was the most difficult mission to limit the *local content* by not presenting very productive and fruitful (and valuable) Croatian scientific handball ‘circle’, together with Slovenian scientific handball ‘circle’, within wider cooperation, projects, and co-authorships. Among many contributions covering game and player features, next ones may represent only an imprint of circle of Croatian science in handball - Vuleta et al., 2003; Rogulj et al., 2004; Srhoj et al., 2002; Gruić et al., 2006; Ohnjec et al., 2008; Bojić-Čaćić, 2018; Foretić et al., 2010; Čavala&Katić, 2010 – with strong relations to other sources, e.g. Šibila et al., 2011; Sporiš et al., 2010, etc.

## Conclusion

Important data with regard to success in handball game is well presented in scientific research. Best data compiled into concepts for winning formula in not well presented, at least not to the extent which would ensure equivalent outcomes compared to invested resources, energy and determination. For top level handball, the main argument for that is the fact that ‘secrets’ of success have been revealed only after the specific competition. Selectors, coaches, players bring innovations in every forthcoming competition. Key obstacle for further development of game stem from wide range of possible interpretations of rules of the game, even during the match, and not from scientific tools for understanding advantages or disadvantages of features of the game and players. In the other recourse, integrating moment of handball techniques bring benefits to physical and conditioning praxis, and in private and public PE as well.

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## PRIORITIES AND RANKINGS FOR OFFENSIVE BASELINER TENNIS PLAYER: THE ANALYTIC HIERARCHY PROCESS (AHP)

Mladen Hraste<sup>1</sup>, Nikša Đurović<sup>2</sup>, Ljubica Stanišić<sup>3</sup>

<sup>1</sup>Faculty of Science, University of Split, Croatia

<sup>2</sup>Tennis Academy Stobreč, Stobreč, Croatia

<sup>3</sup>Health Centre, County of Split-Dalmatia, Split, Croatia

### Abstract

The aim of this study was to establish and explain priorities for offensive baseliner tennis players in offence and defence. Based on the expertise performed by seven tennis experts, the relative importance coefficients in regard to offensive baseliner style were determined for eighteen overall performance evaluation criteria. From each given matrix, important coefficient vectors defined by each of the experts were calculated by means of the Geometric Mean Method and used to form an importance coefficient matrix for an offensive baseliner player. Vectors of the arithmetic means, and standard deviations were computed from the obtained indices. Top of the offensive hierarchical structure indicates that the *quality of taking initiative in rallies* and *quality of first serve* have very high importance (AM 0,171; AM 0,167) and *quality of offensive forehand* has high importance (AM 0,140). Top of the defensive hierarchical structure indicates that the *quality of second serve return* has very high importance (AM 0,192), and *quality of defensive forehand*, *quality of baseline movement / defensive task*, *quality of defensive backhand* and *quality of first serve return* have medium to high importance (AM 0,159; AM 0,149; AM 0,147; AM 0,136). The results of this research can be applied by coaches for the selection of the most efficient tactical solutions and the optimization of the training process among elite tennis players.

**Key words:** elite tennis, hierarchies in sport, multi-criteria decision making

### Introduction

Many sports matches are complex systems consisting of at least two players, and each player has a large number of alternatives (options) for how to react at a particular point in the match (Lames and McGarry, 2007). The cited authors believe that such complex systems consist of a subsystem in which dynamic interactions predominate. The interactions are of dynamic nature because they are changing during the whole match. Therefore, tennis can be classified into those sports that involve two parties (couples or singles matches), which dynamically act in order to win points and simultaneously to prevent the opponent from achieving points (Lames, 1991). A new way of thinking about the behaviour of sports games in terms of the theory of dynamic systems, is gaining more importance among scientists (McGarry et al., 1999, McGarry et al., 2002), as well as in Palut and Zanone (2005) for a demonstration of tennis as a dynamic system. Accordingly, in order to explain the above dynamic interaction processes, it is necessary to connect the quantitative research which dominate in sports games with qualitative research. Namely, some authors (Denzin and Lincoln, 1994) believe that qualitative approaches have an interpretative and reconstructive view of the social reality which is considered appropriate for mastering the steps needed to analyse the practical success. While quantitative hypotheses are tested through numerous statistical analyse and interpreted as phenomena as an objective image independent of the observer's vision, the qualitative method examines phenomena in the natural environment, giving meaning to them based on the meaning given to humans (Lames and McGarry, 2007). Given that it is not possible to explicitly form theories and models in kinesiology without a standard error, it is possible to conclude that there is no single model of tennis match success that represents the kinesiological reality completely (Trninić et al., 2009). In this regard, in order to increase the predictive value and validity of tennis players' performance models, a greater number of sport-specific variables and external factors should be covered.

This study is a continuation of research efforts that deal with construction and evaluation of methods of overall quality assessment for elite tennis players (Đurovic et al., 2015). In modern tennis, coaches and scientists can clearly distinguish four dominant types of motor behaviour (Roetert and Kovacs, 2011).

In this study, priorities for "offensive baseliner" style using the hierarchical AHP method were analysed. By observing elite tennis players, from the "Open Era" to date, the number of specialists who prefer "offensive baseliner" style is relatively high.

## Material and Methods

The hierarchical AHP model for the assessment of tennis offensive baseliner players' overall quality was proposed and described in detail by Djurovic et al. (2015) study. Proposed criteria for the assessment of overall quality of tennis players are ten criteria for the assessment of overall quality of top-level tennis players on offence (quality of first serve; quality of second serve; quality of netgame movement; quality of netgame shots; quality of baseline movement / offensive tasks; quality of offensive forehand; quality of offensive backhand; quality of taking initiative in rallies; quality of transition attack; quality of playing multiple styles) and eight criteria for the assessment of overall quality of top-level tennis players on defence (quality of first serve return; quality of second serve return; quality of passing shots; quality of baseline movement / defensive tasks; quality of defensive forehand; quality of defensive backhand; quality of performance in long rallies; quality of uncommonly situation shots).

Persons regarded as tennis experts/judges (seven) in this research were coaches who had met at least one of the three required conditions: I. one of the top four places at the global competition (Fed Cup, Davis Cup, Grand Slam, Hopman Cup); II. one of the first four places in the tournament ITF Pro Circuit; III. one of the top two spots in the National Championship as a head coach.

Coefficients of importance within the defined set of criteria for the overall quality of offensive baseliner tennis players on defence and offence were determined by means of the AHP (Analytic Hierarchy Process) method for the multi-criteria decision making (Saaty, 1987; Dezman et al., 2001; Hraste et al., 2008). Application of the AHP method was executed through the following four steps: 1. Every tennis expert numerically evaluated the importance of each criterion by comparing it with the other ones in pairs and registering the relative importance for offensive baseliner players. For example, if the criterion A is twice as important as the criterion B, then in the matrix of pairwise comparisons value 2 was assigned at the position AB, while  $\frac{1}{2}$  was assigned at the position BA. Thus, each tennis expert produced a square reciprocal matrix of grades for all serve-volley players; 2. From each matrix, the criterion coefficient of importance was completed by employing the geometric mean method (GMM). In that way one vector of the coefficient of importance for each criterion was obtained from every expert and the matrix of coefficients of importance was formed for all offensive baseliner players; 3. Vectors of the arithmetic means and standard deviations of the importance coefficients for this particular style of play were then computed from the obtained matrices (1 vector for defence, 1 vector for offence). 4. Vectors of the arithmetic means of the coefficients of importance were then rescaled in the manner that their sum equals one. The reliability of the established importance coefficients (weights) of the performance criteria for "offensive baseliner" style was determined by computing: correlation means of experts' (RMS – rank means scores) agreement (inter-observers' agreement) and Cronbach's reliability coefficient ( $\alpha$ ).

## Results

Table 1 presents arithmetic means (AM) and standard deviations (SD) of grades, obtained from the 7 judges, for the relative importance of 18 criteria per offensive baseliner tennis player on offence and defence. Average Cronbach's measure of reliability ( $\alpha$ ) per offence play is 0.974 and per defence play is 0.976. The average correlation of judges amounts per offence play is 0.901 and per defence play is 0,874. These results indicate a high degree of inter-observers' agreement.

Offensive baseliner player (defence) – QSSR the quality of second serve return has very high importance (AM 0,192), QDF quality of defensive forehand, QBM-DT quality of movement / defensive tasks, QDB quality of defensive backhand and QFSR quality of first serve return have medium to high importance (AM 0,159; AM 0,149; AM 0,147; AM 0,136), QPLR quality of performance in long rallies has low to medium importance (AM 0,098), QPS quality of passing shots and QUSS quality of uncommonly situation shots has low importance (AM 0,071; AM 0,047).

Offensive baseliner player (offence) – QTIR quality of taking initiative in rallies and QFS quality of first serve have very high importance (AM 0,171; AM 0,167), QOF quality of offensive forehand have high importance (AM 0,140), QBM quality of baseline movement / offensive tasks has medium to high importance (AM 0,114), QSS quality of second serve and QOB the quality of offensive backhand have medium importance (AM 0,097; AM 0,096), QPMS playing multiple styles have very low importance and QTA quality of transition attack have low importance (AM 0,070; AM 0,066), QNS quality of net shots and QNM quality of net game movement have very low importance (AM 0,043; AM 0,036).



Table 1. Arithmetic means (AM), standard deviations (SD) the relative importance coefficients of the grades given by experts for the relative importance of eighteen performance evaluation criteria, as well as the correlation means of experts (RMS) & Cronbach's alpha ( $\alpha$ ) per offensive baseliner tennis player on offence and defence

OFFENCE	AM	SD	DEFENCE	AM	SD
QTIR	0,171	0,033	QSSR	0,192	0,023
QFS	0,167	0,012	QDF	0,159	0,019
QOF	0,140	0,036	QBM-DT	0,149	0,029
QBM-OT	0,114	0,010	QDB	0,147	0,020
QSS	0,097	0,012	QFSR	0,136	0,021
QOB	0,096	0,021	QPLR	0,098	0,010
QPMS	0,070	0,010	QPS	0,071	0,008
QTA	0,066	0,007	QUSS	0,047	0,003
QNS	0,043	0,002			
QNM	0,036	0,002			
RMS	0,901		RMS	0,874	
$\alpha$	0,974		$\alpha$	0,976	

Legend: QTIR - quality of taking initiative in rallies; QFS - quality of first serve; QOF - quality of offensive forehand; QBM-OT - quality of baseline movement - offensive tasks; QSS - quality of second serve; QOB - quality of offensive backhand; QPMS - quality of playing multiple styles; QTA - quality of transition attack; QNS - quality of netgame shots; QNM - quality of netgame movement; QSSR - quality of second serve return; QDF - quality of defensive forehand; QBM-DT - quality of baseline movement - defensive tasks; QDB - quality of defensive backhand; QFSR - quality of first serve return; QPLR - quality of performance in long rallies; QPS - quality of passing shots; QUSS - quality of uncommonly situation shots

## Discussion

Based on the results obtained, it can be concluded that the primary task of the offensive baseliner player in offence is to try to finish the point in the shortest possible time by putting pressure on the opponent through service and forehand (Fernandez et al., 2006). Such constant pressure involves a high level of movement on the baseline that would enable a quality performance forehand. Due to their offensive characteristics, these players, on average, have the highest number of direct points but also unforced errors compared to other types of players (Djurovic et al., 2009). Due to their movement close to the baseline and the frequent hit of the ball in the climb to reduce the reaction time in the recovery phase, they achieve their best results on fast surfaces (ATP, 2020). Practice shows that, of all types, their play is, however, the most dependent on the current sense of stroke of the ball, which can be disturbed by internal and external conditions. Therefore, there are frequent defeats in matches of much lower ranked tennis players as well as victories over much better ranked tennis players (ATP, 2020). In women's tennis, this type of player usually presses on both sides of the opponent, while in men's competition the quality level of the offensive forehand is the most powerful weapon of the game from the baseline. Accordingly, the author's assumption is that the results of the most important weighted predictors of an individual's technical and tactical quality would differ significantly between men's and women's tennis (O'Donoghue, 2002). Based on the results obtained, it can be concluded that the primary task of offence baseliner player on defence is to respond to return requests in order to neutralize the opponents' initial initiative and to balance the points below. Given that the second service is much slower than the first service (Djurovic et al., 2009), it is easy to conclude that for these players, the quality of the second service return is the most important criterion in the game of defence. Namely, players with high levels of this criterion have excellent anticipation of kick and slice service and consequently use their strongest strike (forehand) in order to take their own initiatives at the points. In order to disable quality forehand solutions of offence baseliner player, opponents most often use tactical solutions on their backhand side. Given that their movement due to the offensive style during rallies takes place on the baseline, these players have a large number of unforced errors (Djurovic et al., 2009). Namely, during the movement outside the base line (up to 1m) in defensive tasks it is extremely difficult to establish a balance in the points if at the same time the aim is to reduce the reaction time of opponents on the future impact (Liu, 2014). This is the reason these players hold the high (significant) importance of all defensive shots from the baseline. Comparing the primary tasks of defensive baseliner (Djurovic et al., 2015) and offensive baseliner player, it can be concluded that these are two completely different types of players. Previous studies also show satisfactory values of objectivity coefficients for all positions in the game (Trninic et al., 2000; Hraste et al., 2010). Also, the conventional methods of explaining the success in the sports games ignore dynamic interactions of which the sports games are composed (Lames and McGarry, 2007). The authors claim that the present assumptions ignore the interaction between the player and the opponents, as important sources of variability within the sports games. Therefore, future research may investigate non-linear, hybrid systems, detection of neurotransmitter and hormonal factors, and factors of diversity of motor programs that determine individual quality differences in elite players (Trninic et al., 2010). A limitation of this research is that only seven tennis experts were included in the research, which should be considered in future research.

It is very important to design the training process in a way to merge the most important offence criteria with the most important defence criteria, while simultaneously working on specific psychosocial criteria (Djurovic et al., 2014). The presented training system which connects physiology, psychology, biomechanics and tennis criteria allows new neural programs development and training progress measurement. The fitness program must be shaped according to the characteristics of the game of offensive baseliner players.

## Conclusion

Measuring the overall performance of a player in a tennis match is a challenge that scientists and coaches face. The hierarchical AHP model to solve multi-criteria decision helps to choose the best solution among several alternatives across multiple criteria. The current investigation has found offensive baseliner player's priorities for offence and defence. Also, it is important to find priorities for other styles of play and make a comparative analysis. The proposed model is not final but should be regarded as a starting point for empirical investigations, based on which the model could be changed and upgraded.

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## TOP LEVEL FLOOR ROUTINES STRUCTURE AT THE OLYMPIC GAMES: THE IMPACT OF ACROBATIC AND DANCE ELEMENTS

Ana Kezić, Sunčica Delaš Kalinski, Ana Penjak

University of Split Faculty of Kinesiology, Croatia

### Abstract

The main aim of this paper was to investigate the influence of the number of acrobatic and dance elements on different exercise scores in five apparatus finals in the Olympic Games (OG) from 2000 to 2016. The sample included a total of 40 participants of the Apparatus Finals Competitions from the last five OG. The results revealed the following trends: 1) a decrease of D score from OG 2000 up to OG 2012 and then its slight value increase at OG 2016; 2) continuous decrease of E score and final score value from OG 2000 to OG 2016. ANOVA revealed significant differences between years for D, E and final score. Also, for acrobatic and dance elements, ANOVA revealed significant differences over the years. Results of regression analyses show that only a few scores obtained in floor finals at OG from 2000 to 2016, have been under the impact of certain group of elements. Despite different scoring rules that were valid in the analysed competitions, specific group of elements had a significant impact on a particular score but only in some competitions.

**Key words:** artistic gymnastics, difficulty value, execution value, women

### Introduction

Artistic gymnastics is a sport in which the result directly depends on a subjective judge's assessment although the assessment is rarely totally reliable (Bučar et al., 2012; Bučar et al., 2013). The performance of the exercises is evaluated by two commissions of judges: D commission evaluates the difficulty of the exercise and gives a D score, while E commission evaluates the performance of the exercise, i.e. records the deductions made during the performance of the elements. In addition to errors in the performance of the elements, the judges of E commission evaluate the aesthetic impression, artistry, tempo, musicality and other aspects of choreography. The sum of deductions is subtracted from the maximum score of 10.00 and E score is obtained. The final score is the sum of points of the two commissions.

The Code of Points in women artistic gymnastics (WAG CoP) is one of the most frequently changed rulebooks of all sports. Significant changes occur almost every two to three years, with small changes every year. The apparatus on which those changes significantly influence and in which the crowd enjoys the most is certainly the floor. Besides the WAG CoP, what has also changed over the period of five Olympic cycles (2000-2016) are the composition requirements for the floor routine. The number of those requirements declined over the years. From 2000 to 2004, composition requirements (technical elements) fulfilled a start score of 9.00, while from 2006 to 2008, only ten highest value elements performed entered D score. In 2009, the WAG CoP changed and D score was made out of maximum eight elements (five acrobatic and three dance elements), while the year 2013 brought more flexible decision: minimum of three dance elements, three acrobatic elements and two elements of free choice. This change has made tactics indispensable in artistic gymnastics, as in any other sport as well, especially on big competitions. The choice and the number of performed elements have been more and more significant over the years as it turned out that acrobatic and dance elements performed on the balance beam significantly influence D score, but not E score of the exercise (Delaš Kalinski et al., 2001; Miletić et al., 2011). Also, the authors suggest that gymnasts tend to finish their exercises with attractive dismounts in order to impress the judges and the audience, but also, to increase the difficulty of the exercise (Milčić et al., 2017). Similar studies have not been found in floor routines, and therefore, the main aim of this research is to investigate the influence of the number of acrobatic and dance elements on different exercise scores in five apparatus finals in Olympic Games (OG) from 2000 to 2016. Additionally, authors also focus on differences in different scores and elements between five OG.

### Methods

The sample included a total of 40 participants of the Apparatus Finals Competitions at the last five OG (2000-2016). Data about the gymnasts and official scores were retrieved from <https://gymnasticsresults.com/>. Their floor routines, performed on the analysed competitions, have been reviewed on the YouTube channel and noted with gymnastics symbols by one Croatian (national) WAG judge. Accordingly, information about the number of performed elements (acrobatic, dance and total) has been obtained.

The data processing methods included the calculation of basic descriptive statistics: mean values (Mean), standard deviations (SD), minimum (Min) and maximum (Max) values, values of the measure for symmetry (Skew) and curvature (Kurt) of the distribution of results. Multiple One-way ANOVA (with post hoc Bonferroni test) was used to identify the differences in different scores and elements between OG (2000, 2004, 2008, 2012, 2016). Regression analyses were applied to determine the impact of certain group of elements (acrobatic or dance) on different scores (D, E and final) in each OG. All calculations were performed using data analysis software system Statistica v.13 (Dell Inc., Tulsa, Oklahoma, USA).

## Results

Table 1. Descriptive statistical parameters of different scores and performed elements in floor routines in the Apparatus Finals at OG (2000-2016); the results of ANOVA with Bonferroni post-hoc test

	OG YEAR	Mean	Min	Max	SD	Skew	Kurt
D SCORE	2000	9.98	9.80	10.00	0.07	-2.83	8.00
E SCORE		9.57	9.01	9.85	0.29	-1.23	0.78
FINAL SCORE		19.52	18.81	19.85	0.34	-1.40	1.94
TOTAL FLOOR ELEMENTS		9.50	7.00	11.00	1.31	-0.76	0.88
ACROBATIC ELEMENTS		4.75	2.00	7.00	1.58	-0.33	-0.04
DANCE ELEMENTS		4.75	3.00	6.00	1.04	-0.39	-0.45
D SCORE	2004	9.86 <sup>08,12,16</sup>	9.50	10.00	0.18	-1.52	1.79
E SCORE		9.34	8.50	9.75	0.37	-1.92	4.85
FINAL SCORE		19.15 <sup>08,12,16</sup>	17.90	19.75	0.56	-1.85	4.36
TOTAL FLOOR ELEMENTS		9.88	7.00	12.00	1.81	-0.34	-0.93
ACROBATIC ELEMENTS		4.63 <sup>08</sup>	4.00	6.00	0.74	0.82	-0.15
DANCE ELEMENTS		5.25	3.00	7.00	1.49	-0.91	-0.57
D SCORE	2008	6.25	5.80	6.50	0.22	-1.28	1.85
E SCORE		8.85	8.25	9.23	0.37	-0.94	-0.72
FINAL SCORE		15.08	14.13	15.65	0.52	-0.91	0.00
TOTAL FLOOR ELEMENTS		10.38	9.00	12.00	1.19	0.39	-1.23
ACROBATIC ELEMENTS		6.25	5.00	7.00	0.71	-0.40	-0.23
DANCE ELEMENTS		4.13	2.00	6.00	1.25	-0.30	0.15
D SCORE	2012	6.13	5.60	6.50	0.28	-0.70	0.78
E SCORE		8.68	8.03	9.10	0.36	-0.62	-0.03
FINAL SCORE		14.73	13.33	15.60	0.66	-1.28	2.95
TOTAL FLOOR ELEMENTS		10.63	10.00	12.00	0.74	0.82	-0.15
ACROBATIC ELEMENTS		5.88	5.00	7.00	0.84	0.28	-1.39
DANCE ELEMENTS		4.75	4.00	6.00	0.71	0.40	-0.23
D SCORE	2016	6.29	5.40	6.90	0.43	-1.05	2.67
E SCORE		8.34	6.70	9.07	0.72	-1.97	4.89
FINAL SCORE		14.59	11.80	15.97	1.23	-1.85	4.65
TOTAL FLOOR ELEMENTS		10.25	9.00	12.00	1.04	0.39	-0.45
ACROBATIC ELEMENTS		5.00	3.00	6.00	1.07	-0.94	0.35
DANCE ELEMENTS		5.25	4.00	7.00	1.04	0.39	-0.45

Legend: <sup>08,12,16</sup> – significantly different from results determined at OG 2008, OG 2012 and OG 2016

The following trends can be observed throughout the analysed period within different scores: 1) a decrease of D score from OG 2000 up to OG 2012 and then its slight value increase at OG 2016; 2) a continuous decrease of E score and FINAL score value from OG 2000 to OG 2016 (Table 1). When looking at the frequencies of the elements, the following is noticed: 1) a trend of increasing frequencies of total floor elements from OG 2000 up to OG 2012, its slight decrease at OG 2016; 2) a mutable trend of frequencies of acrobatic elements (decrease of their frequencies from OG 2000 to OG 2004, increase of their frequencies at OG 2008, decrease of their frequencies on OG 2012 and further on OG 2016); 3) changeable trend of frequencies of dance elements from one OG to another (increase of their frequencies from OG 2000 to OG 2004, decrease of their frequencies at OG 2008, increase of their frequencies on OG 2012 and further on OG

2016). The majority of Skewness values of all analysed variables indicates a shift in distribution of the results towards the results that are higher than the average result. According to Kurtosis values, larger groupings of results were found in distributions of the results of different scores.

The ANOVA revealed significant differences between years for D score ( $F_{35,4}=468.005$ ;  $p<0.001$ ); E score ( $F_{35,4}=9.894$ ;  $p<0.001$ ) and the FINAL score ( $F_{35,4}=93.516$ ;  $p<0.001$ ). Also, for acrobatic ( $F_{35,4}=3.859$ ;  $p=0.011$ ) and dance elements ( $F_{35,4}=1.345$ ;  $p=0.273$ ), ANOVA revealed significant differences through years. Bonferroni post-hoc test established significant difference between D score at OG 2004 and OG 2008/2012/2016, respectively to the FINAL score at OG 2004 and OG 2008/2012/2016. Further, Bonferroni post-hoc test determined significant differences between frequencies in all acrobatic elements from the OG 2004 to OG 2008.

Table 2. Regression analysis: the impact of acrobatic and dance elements on different scores obtained for floor routines over last five OGs

		REGRESSION ANALYSIS		$\beta$	SE( $\beta$ )	b	SE(b)	p
2000	DS	R=0.79 R <sup>2</sup> =0.63 Adjusted R <sup>2</sup> =0.48 F(2,5)=4.21 p=0.08	ACROBATIC	0.96	0.33	0.04	0.02	<b>0.04</b>
			DANCE	0.44	0.33	0.03	0.02	0.24
	ES	R=0.88 R <sup>2</sup> =0.77 Adjusted R <sup>2</sup> =0.68 F(2,5)=8.46 p=0.02	ACROBATIC	1.06	0.26	0.19	0.05	<b>0.01</b>
			DANCE	0.52	0.26	0.15	0.07	0.10
	FS	R=0.89 R <sup>2</sup> =0.79 Adjusted R <sup>2</sup> =0.70 F(2,5)=9.34 p=0.02	ACROBATIC	1.08	0.25	0.23	0.05	<b>0.01</b>
			DANCE	0.63	0.25	0.21	0.08	0.05
2004	DS	R=0.78 R <sup>2</sup> =0.61 Adjusted R <sup>2</sup> =0.45 F(2,5)=3.93 p=0.09	ACROBATIC	0.53	0.29	0.13	0.07	0.12
			DANCE	0.46	0.29	0.06	0.03	0.17
	ES	R=0.62 R <sup>2</sup> =0.39 Adjusted R <sup>2</sup> =0.14 F(2,5)=1.585 p=0.29	ACROBATIC	0.42	0.36	0.21	0.18	0.30
			DANCE	0.38	0.36	0.09	0.09	0.34
	FS	R=0.696 R <sup>2</sup> =0.485 Adjusted R <sup>2</sup> =0.279 F(2,5)=2.35 p=0.19	ACROBATIC	0.50	0.33	0.38	0.25	0.19
			DANCE	0.38	0.33	0.14	0.12	0.30
2008	DS	R=0.82 R <sup>2</sup> =0.68 Adjusted R <sup>2</sup> =0.55 F(2,5)=5.33 p=0.06	ACROBATIC	0.83	0.27	0.26	0.09	<b>0.03</b>
			DANCE	0.02	0.27	0.00	0.05	0.95
	ES	R=0.70 R <sup>2</sup> =0.49 Adjusted R <sup>2</sup> =0.29 F(2,5)=2.41 p=0.18	ACROBATIC	0.74	0.34	0.39	0.18	0.08
			DANCE	0.14	0.34	0.04	0.10	0.70
	FS	R=0.86 R <sup>2</sup> =0.74 Adjusted R <sup>2</sup> =0.64 F(2,5)=7.30 p=0.03	ACROBATIC	0.87	0.24	0.64	0.18	<b>0.02</b>
			DANCE	0.02	0.24	0.01	0.10	0.94
2012	DS	R=0.47 R <sup>2</sup> =0.22 Adjusted R <sup>2</sup> =-0.09 F(2,5)=0.69 p=0.52	ACROBATIC	0.01	0.47	0.00	0.16	0.99
			DANCE	-0.46	0.47	-0.18	0.19	0.37
	ES	R=0.64 R <sup>2</sup> =0.41 Adjusted R <sup>2</sup> =0.18 F(2,5)=1.77 p=0.26	ACROBATIC	-0.40	0.41	-0.17	0.18	0.38
			DANCE	-0.77	0.41	-0.39	0.21	0.12
	FS	R=0.60 R <sup>2</sup> =0.36 Adjusted R <sup>2</sup> =0.11 F(2,5)=1.42 p=0.33	ACROBATIC	-0.22	0.43	-0.18	0.34	0.62
			DANCE	-0.69	0.43	-0.65	0.40	0.17
2016	DS	R=0.65 R <sup>2</sup> =0.42 Adjusted R <sup>2</sup> =0.19 F(2,5)=1.82 p=0.25	ACROBATIC	0.30	0.40	0.12	0.16	0.49
			DANCE	-0.45	0.40	-0.19	0.17	0.31
	ES	R=0.58 R <sup>2</sup> =0.33 Adjusted R <sup>2</sup> =0.07 F(2,5)=1.26 p=0.36	ACROBATIC	0.17	0.43	0.12	0.29	0.70
			DANCE	-0.47	0.43	-0.33	0.30	0.32
	FS	R=0.62 R <sup>2</sup> =0.38 Adjusted R <sup>2</sup> =0.14 F(2,5)=1.55 p=0.30	ACROBATIC	0.21	0.41	0.24	0.47	0.64
			DANCE	-0.49	0.41	-0.58	0.49	0.29

Legend: DS – difficulty score, ES – execution score, FS – final score

Results of the regression analyses show that only a few scores obtained in floor finals at OG from 2000 to 2016, have been under the impact of certain group of elements (Table 2): 1) frequencies of the acrobatic elements had a significant influence on E score and the FINAL score at the OG 2000; 2) frequencies of the acrobatic elements had a significant influence on D score and the FINAL score at OG 2008. The impact of all the other frequencies of acrobatic and dance elements, performed in all floor routines in floor finals at OG from 2000 to 2016, on D score, E score and F score have not been determined as significant.



## Discussion

Trainees' attempts to achieve as higher D score as possible, despite the constant reduction of difficulty values (elements of the highest difficulty values) and the increased deductions for technical and/or aesthetic errors in the performance of the elements (both redefined with each new CoP) resulted in the continuous increase in the average number of the performed elements (from OG 2000 to OG 2012). The slightly lower values of the average number of the performed elements at OG 2016 compared to OG 2012 are probably due to changes that occurred in CoP 2013-2016 (International Gymnastics Federation, 2013). Namely, allowing gymnasts to select the groups of elements from which they will perform two elements of the highest difficulty values independently enables them to perform the elements that are the most appropriate ones for them (given their anthropological characteristics and preferences). The same has caused a decrease in the number of mandatory elements and probably also a certain numerical decrease in the average number of performed elements in OG 2016. Considering the established trend of D score, we could assume that the increased values of D score in OG 2000 have been reached by performing higher number of elements, while the decrease of the number of the performed elements on the following two OG (2004 and 2008) could have caused a decrease in the value of D scores. However, the same would only be partially correct, since we cannot state that differences in the values of D scores in 2000/2004 compared to 2008/2012/2016 (which were determined to be significant), were merely a consequence of a decrease in the total number of performed elements. Namely, this result is also an outcome of a different way of calculating the D score in OG 2000 and 2004 (when the D score comprised of 10 most difficult elements from the exercise) when compared to OG 2008, 2012 and 2016 (when D score consisted of eight the most difficult elements from the exercise). Regardless of the smaller number of elements performed and the lower D scores, the aforementioned values confirm the quality of finalists of the analysed competitions. The numerical similarities of this parameter in all OG confirm that, regardless of the performance of acrobatic and dance elements of different difficulty values, D scores of the finalists of OG were very similar. Since these are the final competitions and since they are comprised out of the best participants from OG, this result is logical. Furthermore, the quality of the floor exercises is constantly improving, as is confirmed by the results from OG 2016. According to those results, there has been an increase in D score despite the decrease in the number of performed elements and the difficulty values of a certain number of elements. The trend in E score, which indicates a numerical (statistically insignificant) decrease in the value from OG 2000 to 2016, shows that stricter judging had negative impact on the value of execution. Considering the more rigorous way of evaluation and constantly reducing the difficulty values of the elements, it can be concluded that the exercises of the finalists on the analysed OG, in particular in the last three OG, tended to include the elements of the highest difficulty values, which were technically and aesthetically performed with minimal or non-existent errors. Such level of performance, from the standpoint of performance quality, is realistically expected at this level of competition, and given that it is constantly progressing, it also indicates general improvement in the quality of exercise on this apparatus, as well as in gymnastics, in general.

The importance of the performance quality versus the number of performed elements is also evident from the results of the regression analyses. Namely, the values of certain scores depended significantly on the number of the acrobatic elements performed but only at two OG (2000 and 2008). By not identifying significant effects of acrobatic and dance group of elements on D, E or final score on the other OG we identify the tactics of the finalist (the fact that they "did not exaggerate" in the number of a particular group of elements, or that their exercises were generally uniform in terms of acrobatic and dance elements). This might be due to the rules that were applied at these OG, which the FIG Technical Committee sought to balance out performances of different groups of elements and, accordingly, contribute the creation of as varied floor routines as possible.

## Conclusion

Within five Olympic cycles, there was a significant change in the way the final score was calculated for each apparatus, as well as a stricter judging. Despite different scoring rules that were valid in the analysed competitions, specific group of elements had a significant impact on particular score but only in some competitions. This confirmed the uniformity of the scoring rules in terms of the performance requirements, but also the structural non-distinction of the finalist floor exercises. The results of this study provide guidance to the training processes of future potential Olympians, in particular those who tend to enter the final floor competitions. The performance of structurally complex routines, with both acrobatic and dance elements, with minimal performance errors, should be an imperative in their training.

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## YOUTH BASKETBALL AND HANDBALL PLAYERS: DIFFERENCES IN DYNAMIC BALANCE TEST PARAMETERS

Damir Knjaz, Vedran Dukarić, Mateja Očić, Ivan Bon, Maja Horvatin

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

Non-contact mechanisms, such as landing from a jump, frequently lead to joint or ligament injuries, that are probably the result of strength deficits or impaired stability and balance. Basketball and handball have a lot of similarities regarding movement structures (jump shot, change of direction, take-offs and landings). These movement structures require a high dynamic balance level which can improve performance and reduce risk of injury. Although, there are a lot of similarities in take-off and landing techniques, the purpose of this study is to identify whether there are differences in dynamic balance between basketball and handball players. Sample consists of 14 basketball youth players and 13 handball youth players. Measuring was conducted with the use of Optojump Next system. Drift protocol is predefined test that uses jump results to evaluate dynamic balance level. Differences between two groups were determined with the use of multivariate analysis of variance (MANOVA). Results of MANOVA showed that there is no overall difference between basketball and handball players in dynamic balance test used in this study. However, some differences are noticed when observing each variable individually. Contact time and area covered during jump presented significant differences between basketball and handball players in jumps performed with left and right leg (Tcont\_Left –  $p=0,04$ ; Tcont\_Right –  $p=0,01$ ; Area\_Left –  $p=0,05$ ; Area\_Right –  $p=0,04$ ). Height of the jump did not show any significant differences between handball and basketball players.

*Key words: drift protocol, injuries, unilateral jump*

### Introduction

Balance is a key component of motor skills ranging from maintaining posture to executing complex sport skills and is defined as the process of maintaining the center of gravity within the body's base of support (Davlin, 2004; Guskiewicz, 2011). Postural control or balance can be defined statically as the ability to maintain a base of support with minimal movement and dynamically as the ability to perform a task while maintaining a stable position (Bressel & Joshua, 2007). Non-contact mechanisms, such as landing from a jump, frequently lead to joint or ligament injuries, that are probably the result of strength deficits or impaired stability and balance (Wikstrom, Powers & Tillman, 2004). In team sports dynamic balance is very important for performance of different technical elements such as passing and shooting. These elements are often accompanied by physical contact when player try to make a shot during the game, which usually put players body out of balance. Therefore, if players don't have a good balance ability, it will not only affect their sport performance, but may also lead to injuries. In development of young player coaches often neglect specific balance programs that are fundamental for technical movement and injury prevention (Ricotti, 2011). McGuine, Greene & Best (2000) noted that youth male and female basketball players with poor balance had about seven times more sprained ankles than players with higher balance level. Additionally, several studies concluded that poor balance ability was more likely to cause ankle ligament injuries (Willems et al., 2005; Hrysomallis, McLaughlin & Goodman, 2007). Also, deficits in strength of lower extremities and postural control have been associated with a high risk of sport-related injuries (Mery et al., 2005; Wang et al., 2006). Programmed 8-week strength training based on developing subjects lower body muscles strength have positive effect on increasing dynamic balance level of teenage handball players (Salehzadeh et al., 2011). Changes in sensory and motor systems influence balance performance and can be more effective if induced in children (Weineck, 2001). Balance ability can be significantly improved by balance training (30 minutes, twice a week) with unstable boards (Boccolini et al., 2013). Also, combination of balance and speed training can improve the common agility performance of the athletes (Bayraktar, 2017). As mentioned above, basketball and handball have a lot of similarities regarding movement structures (jump shot, change of direction, take-offs and landings). These movement structures require a high dynamic balance level which can improve performance and reduce risk of injury. Although, there are a lot of similarities in take-off and landing techniques, the purpose of this study is to identify whether there are differences in dynamic balance between basketball and handball players.

## Methods

**Participants:** Sample consists of 14 basketball (age=15,32 ± 0,76; weight=82,02 ± 16,36; height=190,89 ± 5,93) and 13 handball (age=15,85 ± 0,82; weight=79,05 ± 16,54; height=184,89 ± 7,50) youth players (BSU national selection) that were all healthy during testing and gave written consent for testing procedure. All subjects were male with dominant left leg (leg mainly used for take-off in specific situations).

**Testing procedure:** Before testing protocol, athletes performed standardized warm up consisted of basic athletic drills and unilateral jumps that are used in measuring protocol. Measuring was conducted with the use of Optojump Next system (Glatthorn et al., 2011). Drift protocol is predefined test that uses jump results to evaluate dynamic balance level. Protocol consists of twenty unilateral jumps. 5 jumps with the use of hands are performed with each leg parallel and perpendicular according to measuring device. Main goal of test is to jump high with fast contact time and try to maintain body close to starting position.

**Variables:** Variables observed in this research: height of the jump (H), contact time (Tcont), area covered (Drift\_area). Mean values of variables were used for further analysis.

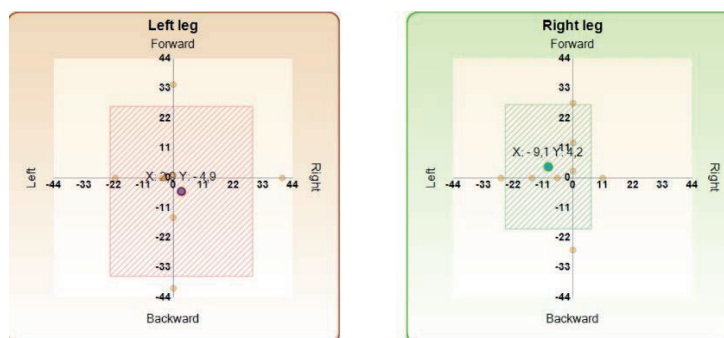


Figure 1. Area covered during drift protocol

**Statistical methods:** The statistical analysis was performed with Statistica v13.5 software package. Basic descriptive parameters (mean, minimum, maximum, standard deviation) were calculated for all variables. Differences between two groups (basketball and handball players) were determined with the use of multivariate analysis of variance (MANOVA). Results were considered significant when  $p < 0.05$ .

## Results

Basic descriptive parameters were obtained for left and right leg jumps.

Table 1. Basic descriptive parameters

Variable		Mean	Minimum	Maximum	Std.Dev.
H_left (cm)	Basketball	17,63	10,50	25,70	4,77
	Handball	18,75	13,90	25,90	3,68
H_right (cm)	Basketball	17,86	11,90	22,80	3,72
	Handball	18,78	11,70	30,00	5,11
Tcont_left (s)	Basketball	0,327	0,258	0,392	0,04
	Handball	0,373	0,227	0,486	0,07
Tcont_right (s)	Basketball	0,324	0,238	0,409	0,04
	Handball	0,374	0,268	0,500	0,06
Area_left (cm <sup>2</sup> )	Basketball	645,52	181,30	1434,10	365,45
	Handball	1323,39	47,80	3659,00	1142,37
Area_right (cm <sup>2</sup> )	Basketball	499,97	212,60	1268,40	324,99
	Handball	905,42	195,50	2125,60	626,90

\*H – left and right leg jump height; Tcont – left and right leg contact time; Area – left and right leg area covered

Handball players had higher values of jump height when test is performed with left (B=17,63; H=18,75) and right leg take-off (B=17,86; H=18,78). Results of contact time are showing smaller values of basketball players in relation to handball for left (B=0,327; H=0,373) and right leg (B=0,324; H=0,374) jump. Area covered during unilateral jumps was greater in handball players in both cases left (B=645,52; H=1323,39) and right (B=499,97; H=905,42) jump.

Table 2. MANOVA for measured variables

	Test	Lambda value	F	p
criteria	Wilks	0,69	1,53	0,22

Results presented in Table 2. does not show significant differences between basketball and handball players (F= 1,53;  $p=0,22$ ).

Table 3. ANOVA for measured variables

Dependent Variable	F	p
H_Left	0,46	0,50
H_Right	0,29	0,60
Tcont_Left	4,65	0,04*
Tcont_Right	6,91	0,01*
Area_Left	4,45	0,05*
Area_Right	4,55	0,04*

\*marked values are significant when  $p<0,05$

Contact time and area covered during jump presented significant differences between basketball and handball players in jumps performed with left and right leg (Tcont\_Left –  $p=0,04$ ; Tcont\_Right –  $p=0,01$ ; Area\_Left –  $p=0,05$ ; Area\_Right –  $p=0,04$ ). Height of the jump did not show any significant differences between handball and basketball players.

## Discussion

Results of MANOVA showed that there is no overall difference between basketball and handball players in dynamic balance test used in this study. However, some differences are noticed when observing each variable individually. Basketball players had shorter contact time duration when test is performed with right and left leg in relation to handball players (Tcont\_Left –  $p=0,04$ ; Tcont\_Right –  $p=0,01$ ). As this test is mainly vertical, results of contact time can be related to different take off direction in sport specific movements. Results of area covered during test execution with each leg are significantly higher in handball players (Area\_Left –  $p=0,05$ ; Area\_Right –  $p=0,04$ ) and can indicate that their level of dynamic balance is lower than in tested basketball players. Basketball players had lower but not significantly different values of jump height. Low mean values of jump height with left (17,63 and 18,75) and right leg (17,86 and 18,78) could relate to poor body strength. For example, the study of Tsukagoshi et al. (2011) concluded that level of core strength had certain relationship with dynamic balance. When observing differences between dominant and nondominant leg there were no difference in jump height and contact time but results of area covered are showing that there are differences between legs in both handball and basketball. There results are similar with the results presented in a study of Fort-Vanmeerhaeghe et al. (2015) They reported that there were significant differences between dominant and nondominant leg in various tasks, especially while performing vertical single leg countermovement jump.

## Conclusion

Results presented in this research showed significant differences in contact time and area covered parameters among basketball and handball youth players. Mean values of jump height for both teams were low if compared to Croatian national team players (Dukarić i sur., 2020) which in combination with slow contact time and high values of area can have high risk of injury. Drift protocol was used for the purpose of determining difference of balance level in this research. Limitations include small sample size and lack of influence of motor knowledge on testing results as correct technique is very important for obtaining best results. Future investigation should consider observing between leg asymmetry in each sport and on determining effect of strength and balance training on drift protocol parameters.



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## ANALYSIS OF THE TECHNICAL CHARACTERISTICS OF WORLD ELITE WOMEN TAEKWONDO HEAD SCORING—A CASE STUDY

**Jiamin Kong**

*Beijing Sports University, China*

**Purpose:** This research uses taekwondo athlete Ruth's video recordings of the 2018 Grand Prix, the 2019 World Championships and the 2019 Grand Prix as the research material. Distance, etc. summarizes Ruth's head scoring technique, and analyzes the main characteristics of Ruth's head scoring technique.

**Methods:** Literature data method, mathematical statistics method, logical analysis method, video observation method.

**Results:** Ruth scored 17 points for head shots, 5 times for scoring, and 3 times for cross kicks with hind legs. When using the technique, the athlete scores a total of 4 times by hitting the head and 1 time after hitting the head. The total score is 17 points. Athletes' combo skills accounted for a relatively large number of combo techniques, with a total of 5 times, scoring 17 points. Athletes are more likely to score from the right side than the left side, and the right open side is easier to score than the right closed side. The number of hits is 4 times under the right closed position.

**Conclusion:** Ruth's main head shot scoring technique is a cross kick with the back leg, and the number of shots from the side of the head is the most scoring. Use the combined technique to score more points with the back leg cross kick technique. The ability to score from a right-handed head shot is stronger than that of a left-handed head, and it is easier to score with a right-hand head shot than a right-hand shot. In the first game, the head shot skills were few. When the score is leading, the front leg cross kick hits the most points. The main head shot scoring technique for active offense at mid-range is the back leg cross kick, and the secondary head shot scoring technique is front cross kick and back spin kick.

**Key words:** *New rules, Taekwondo, Women-67Kg, Head shot, Scoring*

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## ANALYSIS OF THE TECHNICAL CHARACTERISTICS OF WORLD ELITE WOMEN TAEKWONDO ATHLETE RUTH GBAGBI HEAD SCORING

Jiamin Kong

Beijing Sports University, China

**Purpose:** After the implementation of the new rules of Taekwondo competition in 2018, the characteristics of athletes' heading skills have changed greatly. When watching the world's outstanding women's Taekwondo-67Kg athletes, Ruth's headshot scoring skills have obvious personal characteristics. Ruth is China's main opponent of Mengyu Zhang, a key female athlete preparing for the Tokyo Olympics, is worth studying. This study uses the new rules of the world's outstanding female Taekwondo-67Kg athletes in the 2018 Grand Prix, 2019 World Championships and 2019 Grand Prix. The game video is used as a research material to analyze Ruth's head-scores one by one, summarize and summarize Ruth's head-scoring techniques from different stances, leading moves, battle situations, battle conditions and distances, and analyze Ruth's head-scoring techniques. The main features of the game provide a certain theoretical basis for Chinese athlete Mengyu Zhang to prepare for the Tokyo Olympics.

**Methods:** Documentary data method, mathematical statistics method, logical analysis method, video observation method (using Ruth's 2018 Grand Prix, 2019 World Championships and 2019 Grand Prix competition videos as the analysis material, played through the storm audio and video software, and passed Play slowly, observe Ruth's hit scoring technique one by one, and perform statistics according to the indicators to obtain the data needed in this article).

**Results:** Through the statistics of the athlete's game video, the head shot score is 17 points, and the number of scores is 5 times. The number of cross kicks with the hind leg is 3 times, accounting for 60% of the total number of points scored, and is the main head scoring technique. When athletes use the technique, they score a total of 4 times by hitting the head and get 1 time after hitting the head. The number of hits on the head is the most. The total score is 5 times, and the total score is 17 points. In the combo technique of athletes, the combined technique score accounted for a relatively large amount, a total of 5 times, the total number of times accounted for 100%, and the score was 17 points, which accounted for 100% of the total. Athletes are more likely to score from the right side than the left side, and the right closed position is easier to score than the right open position. The number of hits in the right closed position is 4 times. In the first game, the athletes have less head-scoring techniques and are more concentrated. The main head-scoring technique is the back leg cross kick technique, followed by the front leg cross kick technique. In the second game, the head-scoring technique is the back leg cross-kick technique. In the third game, the main head-shot scoring technique was a back spin kick. Athletes get the most head shots when the score is leading, and when the score is leading, the head shot of the back leg kick is very prominent, and it accounts for 100% of the number of points scored when the score is leading. The head scoring is mainly concentrated in the middle distance, and the main head scoring technique at the middle distance is the back leg kick.

**Conclusion:** Ruth's main head shot scoring technique is a cross kick with the back leg. When using technique, the number of points scored by hitting the head is the most. Use the combination technique to score more points with the back leg cross kick technique and have a strong scoring ability. The ability to score from a right-handed head shot is stronger than that of a left-handed head, and it is easier to score with a right-handed head shot than a right-handed head shot. In the first game, the head shot skills were few. When the score is leading, the front leg cross kick hits the most points. The main head shot scoring technique for active offense at mid-range is the back leg cross kick, and the secondary head shot scoring technique is front cross kick and back spin kick.

**Key words:** *New rules, Taekwondo, Women-67Kg, Head shot, Scoring*

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- Jiao Li , Yao Xiao & Shanjun Bao(2021). Analysis of the influence of electronic protective gear on taekwondo competition[J] Wushu Research.DOI:10.13293/j.cnki.wskx.008924

## ANALYSIS OF THE TREND OF RESULTS DEVELOPMENT IN THE DISCIPLINES OF BREASTSTROKE TECHNIQUE FOR SWIMMERS AT WORLD CHAMPIONSHIPS

**Goran Leko, Dajana Karaula, Lucija Kralj**

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

Breaststroke, as one of the four basic swimming techniques, has undergone many changes in styles and rules: from lateral breaststroke, dolphin arm movement, swimming below the surface of the water, dolphin kicks to the last version of breaststroke technique with oscillating body position and very strict rules. The aim of this research is to analyze the development trends and to determine the curve of the development of results in the disciplines of breaststroke technique for female swimmers at the world championship from 1998 to 2017. The sample consists of female swimmers from different countries who have competed in the finals of the World championship in the selected period. The variables in this study are the disciplines 50 m breaststroke, 100 m breaststroke, and 200 m breaststroke. The data were collected in the form of official results from International Swimming Federation (FINA) website. The collected data were processed by the method, algorithm, and program for trend analysis with the software package Statistica 13. The polynomial regression analysis analyzed the trend of development of the average final results. For the analyzed races, single-dimensional changes in the status of swimmers were shown over the years, during which a change in one quantitative variable is registered over a period of time. An analysis of the trend of development showed a linear increase in results of breaststroke disciplines for female swimmers at world championships, which is an indicator of the application of new rules, technological advances, and adequate long-term sport preparation and provides coaches and national federations with information on the forecasted results for the next competitive year.

**Key words:** *swimming, FINA, rules, technological advances*

### Introduction

The question often arises: “When will the results begin to stagnate and where are the limits of human abilities?” It takes a hundredth of a second to determine the outcome of a race, which is the reason why solutions are constantly sought to swim a particular section in the shortest possible time. Historians have even referred to the breaststroke technique as the oldest and most important swimming technique, stating that in the beginnings of competitive swimming, almost everyone swam using different types of the breaststroke technique (Biro, Revesz, & Hidvegi, 2015).

The breaststroke technique, as a competitive discipline, first appeared in 1904 at the Olympic Games in St. Louis as the first and only discipline to be swum in yards: 440 yards, which equaled 402.34 m (Poirier-Leroy, 2018). Four years later, the men’s 200 m breaststroke discipline was introduced at the 1908 Olympics, while it wasn’t until 1924 that the same women’s discipline was introduced at the Paris Olympics (Raab, 2018).

The beginning of the 21<sup>st</sup> century saw the revolution of overall competitive swimming with the emergence of fast swim suits, which helped swimmers achieve better results, set new world records, and “out of this world” levels of professional swimming.

Science and mathematics, which contain descriptions and predictions of a particular movement, give us the ability to make accurate and precise predictions of the results of top athletes at the elite level of sport. Being able to access different results from the Olympics, world records, and best results within a given year allows us to analyze different performances at different levels of competition and within different time periods. Previous studies of trend development analysis have attempted to determine future results at the Olympic Games in swimming and athletic disciplines based on the results achieved at previous Olympic Games (Heazlewood, 2006). There is a lot of scientific research carried out worldwide that tries to determine the trend of development of results in various swimming competitions. One such example is the scientific research work of Wolfrum et al. (2014); they sought to identify differences and trends in the development of results from 1994 to 2011 at national and international competitions in the disciplines of freestyle and breaststroke technique.

Some research is based on the assumption that running and swimming speeds increase linearly, along with the chronological year. However, a number of authors approximate the aforementioned linear assumption. For example, some authors have applied the polynomial regression method to world swimming, skating, and cycling records, while others have applied models of nonlinear regression of time or world record speeds. All this points to the great importance of scientific research of this kind, because, according to Mason and Formosa (2011), analysis of competitions or a greater number of them within a certain period of time enables coaches and professional teams to develop a strategy that will enable them to win or achieve the desired swimmer placements at the most important competitions and each training session, as well as an individual swimmer's training day, must be closely linked to competitive conditions. The goals of this paper were to analyze the development trends and to determine the curve of the development of results in the disciplines of breaststroke techniques for swimmers at World Championships from 1998 to 2017 and to show the trend of development of results at the mentioned competition level based on statistical data processing and information obtained.

## Research methods

### Sample of participants

The sample of participants in this research consisted of swimmers from different countries. The requirement was that the swimmers competed in the World Cup finals from 1998 to 2017, i.e., the sample of participants for each World Cup held is defined by the set.

### Sample variables

The variables in the study were the following swimming disciplines: 50 m breaststroke, 100 m breaststroke, and 200 m breaststroke. The data were collected in the form of official results from the International Swimming Organization (FINA) website.

### Methods of data processing

The collected data were processed by the method, algorithm, and program for trend analysis using Statistica 13. The polynomial regression analysis analyzed the trend of development of the average value of final and semi-final results. For the disciplines analyzed, one-dimensional changes in the status of swimmers will be shown over the years, during which a change in one quantitative variable is registered over a period of time. In trend analysis, a functional relationship between one dependent variable (score string) and the independent variable (time points) is sought. Such dependence can be expressed by an appropriate mathematical model in the form of an equation called regression function. One of the fundamental objectives of trend analysis is to determine the causal relationship of variables and to predict the possible values of the dependent variable based on the change in the independent variable (Harasin, 2002).

## Results

### Discipline 50 m breaststroke

Table 1. Statistical data processing in the 50, 100, and 200 m breaststroke discipline from the first to eighth place (finals) at World Championships between 1998 and 2017

50 m breaststroke	Multiple R	R <sup>2</sup>	b	p
Linear	0.92	85.1%	229.63	0.00
Years			-0.09	0.00
100 m breaststroke	Multiple R	R <sup>2</sup>	b	p
Linear	0.92	84.6%	385.90	0.00
Years			-0.16	0.00
200 m breaststroke	Multiple R	R <sup>2</sup>	b	p
Linear	0.86	74.5%	732.28	0.00
Years			-0.29	0.00

Key : Multiple R- correlation coefficient, R<sup>2</sup>- determination coefficient, b- regression coefficient, p- statistical significance <0.01



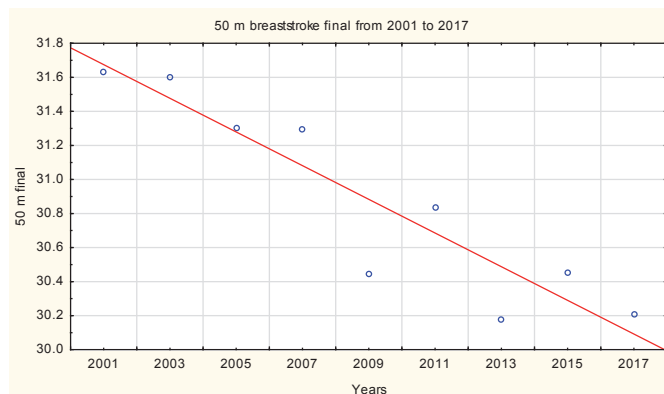


Figure 1. Approximation of the results average for female swimmers in 50 m breaststroke from the first to the eighth place (finals) at World Championships between 2001 and 2017 according to the linear regression analysis equation

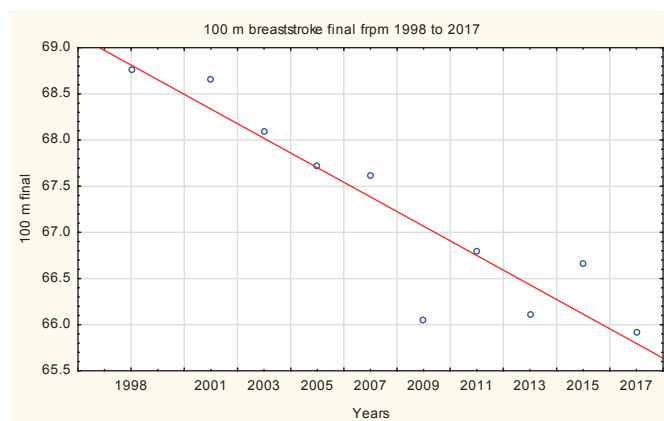


Figure 2. Approximation of the results average for female swimmers in 100 m breaststroke from the first to the eighth place (finals) at World Championships between 1998 and 2017 according to the linear regression analysis equation

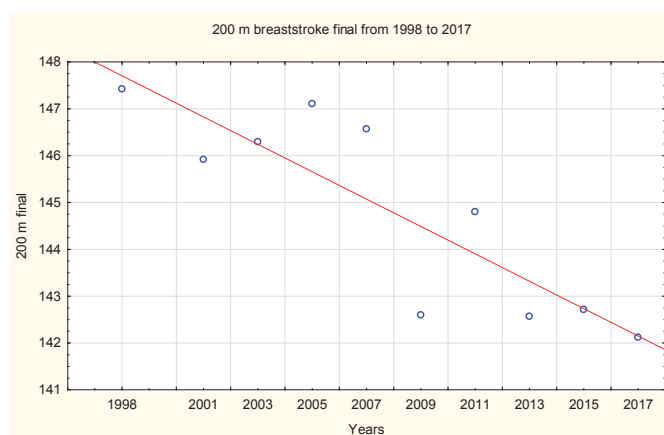


Figure 3. Approximation of the results average for female swimmers in 200m breaststroke from the first to the eighth place (finals) at World Championships between 1998 and 2017 according to the linear regression analysis equation

Table 1 and Figure 1 show the data used to explore the development of the results average in the finals of the 50 m breaststroke discipline between 2001 and 2017. There is a noticeable jump in results in 2001 at the Fukuoka World Championships in Japan, with a 31.63 second average in the final, while that same average amounted to 30.20 seconds at the last World Championship in Budapest in 2017. We notice a sharp improvement in the results in 2009 compared to the previous and subsequent competitions in 2007 and 2011. The coefficient of determination shows a high correlation between the results ( $R^2$  -85.1%), while the statistical significance (.000) indicates their constant shift.

Table 1 and Figure 2 show the data used to explore the development of the results average in the finals of the 100 m breaststroke discipline between 1998 and 2017. The rapid growth in results is evident with a drastic jump in 2009, followed by stagnation of results until 2017. The coefficient of determination shows a high correlation of results ( $R^2$  -84.6%), while the statistical significance (.000) indicates a constant shift in results.

Table 1 and Figure 3 show data used to explore the development of the results average in the finals of the 200 m breaststroke discipline between 1998 and 2017. We can observe a large dispersion of results with many fluctuations over different time periods. The highest jump in results appeared in 2009, while the best average was achieved in 2017. However, a huge jump in results over the observed period (from 147.4 to 142.1) is noticeable. The coefficient of determination shows a slightly lower correlation of the results ( $R^2$  -74.5%), but the statistical significance (.001) still indicates their constant increase.

## Discussion

An analysis of the results achieved in the three selected disciplines for women over the period between 1998 and 2017 has revealed a linear increase in results. Competitive swimming is known to have made steady and significant progress over the last half century, and the reasons are many: advancement of the process of sports preparation, more sophisticated methods of athlete selection, improvement of rowing mechanics, standardization and change of swimming rules (pool depth, strip types, height and angle of starting blocks, water temperature) as well as fast swim suits (Arellano et al., 2004; Chatterjee, Laudato, 1996; Costa, 2010; O'Connor, Vozenilek, 2011).

However, the percentage of progress, as well as the results themselves, varies from competition to competition in the four-year Olympic cycle as well as in swimming of different lengths. Such variations of results are evident in the statistical representations of tables and graphs (Table 1 and graphs 1, 2, and 3) in this research. On this basis, the question arises as to why such variations occur and what causes them. In this regard, we can distinguish three groups of factors that significantly affect the variability of results over the time period observed.

The first group is made up of quick swim suits that have been manufactured and used since 2000, with the peak of their use at the 2009 World Championships in Rome when 43 new world records were set. Never before have so many world records been broken in such a short period of time. The graphs in this research show an extreme increase in results in 2009. Of course, the reason were the polyurethane swim suits that covered almost the entire body. Shortly afterwards, in 2010, FINA banned the use of such suits and strictly defined the rules for using them (O'Connor, Vozenilek, 2011). Also, the sharp decline in the results at the next World Championship in 2011, when these suits were banned, indicates that the results in 2009 were achieved mainly at the expense of technologically advanced suits.

The second group consists of the Olympic cycle and related world championships. Each Olympic cycle contains four years and the World Swimming Championships are held on the first and third years of that cycle. The graph shows a decrease in results in year 3 of the Olympic cycle, i.e., the pre-Olympic year, in 2007, 2011, and 2015 in all disciplines shown. Similarly, in the first year of the Olympic cycle, after the previous Olympic Games, an increase in results was observed (2009, 2013, and 2017). The analysis of the results in this paper has determined that the drop in the results in the pre-Olympic years is caused by the tempo of the sports form for the Olympic Games, and that the increase in the results in the years after the Olympic Games can be explained by the maintenance of the sports form until the World Championship, but we cannot draw this conclusion with certainty.

The third group is the improvement of the overall system of sports preparation. With the development of this system and all its segments, and based on the advancement of sports sciences, there is an increasing possibility that athletes, with a higher level of safety, will achieve better results. The development of high-end sports is a consequence of the greater investment of social work in the process of generating results. Sometimes the result of an athlete depended solely on his or her own effort, investment, time, will, and talent. Nowadays, not only athletes but also experts of various profiles play a key role in achieving top results: from teams of coaches, psychologists, doctors, pharmacists, geneticists, physical therapists, to experts in the design and selection of sports equipment, facilities, equipment, conditions for competition, preparation, and training. Sport research institutes have been created to find new mechanisms to achieve top results.

## Conclusion

The presented trend of development of results at the last ten World Championships, as well as a more detailed analysis of all disciplines, can gather the data needed for more detailed and precise planning and programming of the process of sports preparation, which would serve swimming coaches and sports experts of various profiles as guidelines for further work.

Of particular importance is the work of this kind for Croatian swimming, which is lacking from a scientific point of view. Of course, Croatian swimming results will not only depend on the number of scientific professional papers, but also on the provision of material conditions and resources that will enable the process of sports preparation at the world level to be carried out, on the training of personnel who follow such a process at the desired level, on investing in youth sports and change a school system that would allow the emergence of professional top swimmers. Croatian swimming has been stagnant on the world swimming scene for the last few years, but younger generations tend to achieve top results, so it is important to make further scientific and professional progress in the field of this basic sport.

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## ANALYSIS ON THE SCORING TECHNICAL CHARACTERISTICS OF WORLD HIGH-LEVEL FEMALE TAEKWONDO ATHLETE MATEA JELIC

Jiaqi Liu

*Beijing Sport University, China*

**Purpose:** Matea Jelic is a Croatian Taekwondo athlete of women -67kg, ranking first in the world in this category. This article takes Matea Jelic's 2018 and 2019 game scoring technology as the research object and analyzes its scoring technology. The results can help athletes of this category improve their scoring ability.

**Methods:** (1) Literature Review Method. (2) Video Observation Method: Download the required video materials through the official website of the World Taekwondo, use the scoring technology as the research object of Matea Jelic's 12 games in 2018 and 2019, observe the game video for statistics, and obtain the data needed for this article. (3) Mathematical Statistics Method: Collection and sorting of data according to the designed indicators. (4) Logical Analysis Method.

**Results:** (1) Matea Jelic scored the most in a front roundhouse kick, scoring 23 times, accounting for 43.40% of the total score times. (2) Matea Jelic has 57.50% of the scoring technique, which is manifested as direct scoring using technique, and 32.50% of the scoring technique is scoring under the guidance of footwork. (3) Matea Jelic scored 49 times in the left stance, accounting for 92.45% of the total number of points, a total of 115 points. (4) Matea Jelic's back roundhouse kick and front side kick scored second only to the front roundhouse kick in the three innings and all the back kick technical scores appeared in the third round when the score was behind.

**Conclusion:** Matea Jelic's main scoring technique is roundhouse kick. Matea Jelic has a strong technical direct scoring ability, mostly scoring from the left stance. In the third round, Matea Jelic's scoring ability of the front side kick and the back roundhouse kick is equal in the three rounds and she had a strong back kick-scoring ability. When the score is behind, Matea Jelic's back kick has a lot of scoring potential.

**Key words:** *Taekwondo, women, Matea Jelic, scoring technical*

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## THE ANALYSIS OF DEVELOPMENTAL TRENDS IN THE OLYMPIC RESULTS OF WOMEN'S HIGH JUMP

Sanja Ljubičić, Ljubomir Antekolović, Marijo Baković

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

The aim of this research is to predict the achievements at the 2020 Tokyo Olympics based on the analysis of the winners' results achieved at the 1948-2016 Olympics, and the comparison of winners' results at the 2020 Tokyo Olympics and the season's best results. Analyses of total training performed, results achieved at a particular competition as well as prediction of results represent a major role for the optimal guidance of planning and programming, training periodization and tapering. Prediction of results for the 2020 Tokyo Olympics was conducted by approximation of the winners' results from previous years. In accordance with the 2<sup>nd</sup> degree polynomial, the predicted result is 199.22 cm, and in accordance with the 3<sup>rd</sup> degree polynomial 197.01 cm. The predicted results are in accordance with the stagnation and the slight drop in the winner's result. The arithmetic mean of ten best results has proven best at the 1996 Atlanta Olympics (197.80 cm) and the lowest at the 1948 London Olympics (158.10 cm), as expected. In accordance with the secondary aim, it has been determined that there is no statistically significant difference between winners' results achieved at the Olympics (201.45) and the season's best result achieved during the same season (203.00 cm), starting with the 1976 Montreal Olympics and ending with the 2016 Rio de Janeiro Olympics.

*Key words: women's high jump, the Olympics, prediction of results*

### Introduction

World athletics today draws attention of numerous sports fans due to the number, diversity and attractiveness of disciplines it offers: running, jumping and throwing groups of disciplines. Thus achieved results present the limits of physical capabilities and, at the same time, a challenge for many athletes. Performing at the Olympics is a long-term goal of every top-class athlete and the medal won at this competition is valued as the most important sports achievement (Milanović, 2010). The history of high jump is extremely interesting because it has gone through many changes in techniques, all on behalf of the search for the most efficient one. Today, the athletes jump using the Fosbury flop technique, which was preceded by legs up, scissors, eastern cut of or sweeny, horine or western roll and straddle techniques. Similar studies and analyses were conducted in the disciplines of long jump (Ljubičić, Antekolović and Dukarić, 2017), men's javelin throw (Milinović, Milanović and Harasin, 2008) and women's shot put (Milinović, Milanović and Harasin, 2009). Chen (2013) also dealt with predicting the Olympic results by applying block growth prediction model for men and women in the discipline of high jump at the 2012 London Olympics. Zjača (2010), for instance, used the artificial intelligence model to predict the results of sports matches and analysed the influences of different statistical features on the outcomes of matches. All methods lead to the fact that prognostication of results with a 100% precision is difficult to achieve. Systems of competitions, internal and external factors and unpredictable situations which affect an athlete or an entire team at a given moment may be significant for the final outcome. The results obtained from this research can provide for good guidelines for athletic coaches and teams regarding the jumping level which an athlete should reach in order to fight for the Olympic medal. Analysis of total training performed and results achieved at a particular competition along with prediction of results represent a major role for the optimal guidance of planning and programming, training periodization and tapering. The primary aim of this paper is to predict the winning result at this year's Tokyo Olympics, based on the winners' results of the 1948-2016 Olympics. In addition, the secondary aim is to determine whether there is a statistically significant difference between the best result at the Olympics and the season's best result or not.

### Methods

*Sample of subjects* – 18 female high jumpers, winners of the Olympic Games from the 1948 London Olympics to the 2016 Rio de Janeiro Olympics, are included in this research. In order to achieve the secondary aim, the sample includes 11 Olympic winners and 11 high jumpers who achieved season's best results in the Olympic years, starting with the 1976 Montreal Olympics.



*Sample of variables* – in order to achieve the primary aim, the set variables are high jump results for the first 10 places over 18 Olympic years. In order to achieve the secondary aim, the set variables are the best results in high jump at the Olympics over 11 Olympic years and the season's best results for high jump in the same 11 years.

*Data processing* – statistical data processing was conducted using the IBM SPSS 25 software. The descriptive parameters were calculated: the arithmetic mean (M), standard deviation (SD), minimum (MIN), maximum (MAX) and range. The prognostication of the best result at the 2020 Tokyo Olympics was conducted by approximation of the best results from previous Olympic years based on the polynomial models of 2<sup>nd</sup> and 3<sup>rd</sup> degree regression functions. It has been examined whether the average winners' results at the Olympics differ from the average season's best results achieved in the same season. The normality of distribution was examined by Shapiro-Wilk test, and the dependent sample t-test was used to examine the statistical significance of difference.

## Results and discussion

Table 1 shows descriptive statistics of the 10 best results for women at the Olympic Games. The arithmetic mean indicates that the highest results in average were achieved in 1996 in Atlanta (197.80) and the lowest, which is to be expected, in 1948 in London (158.10). Since 1948 in London to 1964 in Tokyo, the dominant techniques in high jump are the ones preceding the Fosbury flop technique. The 1948 winner was using the western roll technique, which is nowadays considered inefficient because of the ratio of the rise of the centre of mass and the rise of the bar. The first time the Fosbury flop technique appeared was at the 1968 Mexico Olympics, when Dick Fosbury won the gold medal by clearing 224 cm. Table 1 shows the rise in average results after the application of the new technique (after 1986), although it took a certain transitional period for it to take root among athletes. The smallest range of the 10 best results was achieved at the last 2016 Rio de Janeiro Olympics. The stated fact may suggest the adequate preparation of the athletes, strong competition and the attractiveness of the competition which boosts the ratings and the attractiveness of the discipline itself. Figure 1 shows the graph with the results of the Olympic winners. The curve is mostly rising and despite the evident drop in the best result at the 1968 Mexico Olympics, Figure 1 shows that the best results are not lagging, but that they are rising as in each previous year. Certain stagnation in the best results can be observed in the period between 1984 and 1992. Since the 1996 Atlanta Olympics, a rise and stagnation in winning results has been recurring up to today. During the last 30 years the best results have varied within 4 cm, which can suggest that the limits of human physical capabilities have been reached and that the winning result will mostly depend on the mental preparation of female athletes.

Table 1. Descriptive statistics of the results achieved in the Olympic high jump finals

Olympic year	Location	N	Range	Min	Max	M	SD
1948	London	10	18	150	168	<b>158.10</b>	6.28
1952	Helsinki	10	12	155	167	159.50	4.09
1956	Melbourne/ Stockholm	10	12	164	176	167.00	3.46
1960	Rome	10	<b>20</b>	165	185	169.10	6.23
1964	Tokyo	10	19	171	190	174.80	6.29
1968	Mexico	10	11	171	182	177.00	3.65
1972	Munich	10	10	182	192	185.40	3.20
1976	Montreal	10	6	187	193	188.80	2.20
1980	Moscow	10	12	185	197	191.00	3.46
1984	Los Angeles	10	14	188	202	193.90	4.70
1988	Seoul	10	13	190	203	194.80	4.76
1992	Barcelona	10	14	188	202	194.20	4.37
1996	Atlanta	10	12	193	205	<b>197.80</b>	4.08
2000	Sydney	10	8	193	201	196.70	3.16
2004	Athens	10	13	193	206	197.30	4.72
2008	Beijing	10	12	193	205	196.90	4.70
2012	London	10	16	189	205	196.70	4.95
2016	Rio de Janeiro	10	<b>4</b>	193	197	194.60	2.07

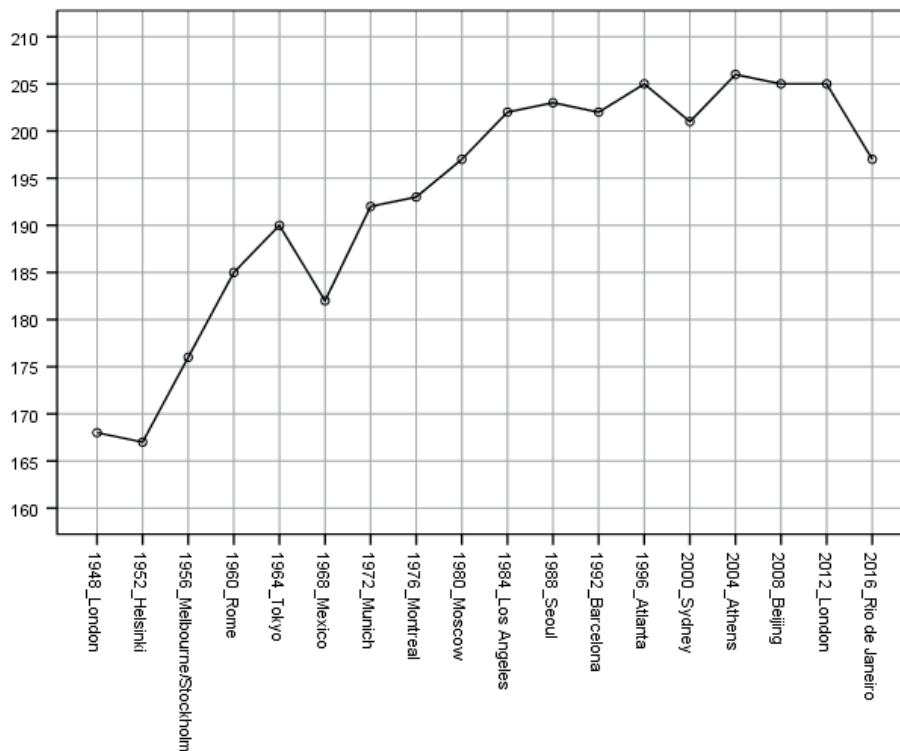


Figure 1. Graphic representation of the best results in high jump at the Olympic Games

The prediction of the best result for high jump at the 2020 Tokyo Olympics was conducted by approximation of the best results from previous Olympic years based on the polynomial models of 2<sup>nd</sup> and 3<sup>rd</sup> degree regression functions (Tables 2 and 3). Both models have high correlation and explained variance (2<sup>nd</sup> degree polynomial  $R=0.969$ ,  $V=93.957\%$ , 3<sup>rd</sup> degree polynomial  $R=0.971$ ,  $V=94.191\%$ ). The prognosticated result is 199.22, according to the 2<sup>nd</sup> degree polynomial regression model and 197.01, according to the 3<sup>rd</sup> degree polynomial model. According to the 3<sup>rd</sup> degree polynomial model, the prognosticated result is in accordance with the best result from 2016 in Rio de Janeiro (197 cm), and for the first time after 1984, the prognoses are lower than 2 m. From the 1984 Los Angeles to the 2012 London Olympics, the winners' results vary within 4 cm, and the result achieved at the 2016 Rio de Janeiro Olympics (197 cm) is at the same level as the result from the 1980 Moscow Olympics. In accordance with the above stated facts and despite the advancement in methods and training models as well as the sophisticated technology, a more significant growth in winner's results has not been made in the last 40 years. Women's world record is 33 years old and in recent years only Anna Chicherova (207 cm) in 2011 and Blanka Vlašić (208 cm) in 2009 have managed to come near it.

Table 2. Results of approximation of the results of the Olympic women's high jump winners based on polynomial models of 2<sup>nd</sup> and 3<sup>rd</sup> degree regression functions

$y = b_0 + b_1 \cdot x + b_2 \cdot x^2$			$y = b_0 + b_1 \cdot x + b_2 \cdot x^2 + b_3 \cdot x^3$			
R=0,969315			R=0,970519			
Explained variance=93,9572%			Explained variance=94,1907%			
b0	b1	b2	b0	b1	b2	b3
159,68628	6,17854	-0,21569	161,89379	4,94753	-0,05801	-0,00553

Table 3. Prognosticated values and residuals for the results of the Olympic high jump winners based on the 2<sup>nd</sup> and 3<sup>rd</sup> degree polynomial analyses of regression functions

	ORIG.RES.	2 <sup>ND</sup> DEGREE POLYNOMIAL		3 <sup>RD</sup> DEGREE POLYNOMIAL	
		PROG.RES.	RESIDUAL	PROG.RES.	RESIDUAL
1948_London	168.00	165.65	2.35	166.78	1.22
1952_Helsinki	167.00	171.18	-4.18	171.51	-4.51
1956_Melbourne/Stockholm	176.00	176.28	-0.28	176.06	-0.06
1960_Rome	185.00	180.95	4.05	180.40	4.60
1964_Tokyo	190.00	185.19	4.81	184.49	5.51
1968_Mexico	182.00	188.99	-6.99	188.30	-6.30
1972_Munich	192.00	192.37	-0.37	191.79	0.21
1976_Montreal	193.00	195.31	-2.31	194.93	-1.93
1980_Moscow	197.00	197.82	-0.82	197.69	-0.69
1984_Los Angeles	202.00	199.90	2.10	200.04	1.96
1988_Seoul	203.00	201.55	1.45	201.93	1.07
1992_Barcelona	202.00	202.77	-0.77	203.35	-1.35
1996_Atlanta	205.00	203.56	1.44	204.25	0.75
2000_Sydney	201.00	203.91	-2.91	204.61	-3.61
2004_Athens	206.00	203.83	2.17	204.38	1.62
2008_Beijing	205.00	203.33	1.67	203.54	1.46
2012_London	205.00	202.39	2.61	202.06	2.94
2016_Rio de Janeiro	197.00	201.02	-4.02	199.89	-2.89
2020_Tokyo		199.22		197.01	

Furthermore, it has been examined whether the average winning results at the Olympics differ from the average season's best results achieved in the same season. A statistically significant difference has not been calculated ( $t_{(10)}=2.08$ ,  $p>0.05$ ), which may point to successful tapering. The dynamics and successfulness of sports fitness depend on the competition calendar and in order to maintain it, it is important to constantly collect data regarding the state of athlete's fitness, mental, technical and tactical abilities and characteristics, so that they could be influenced upon with the purpose of improving or maintaining the competitors' results (according to Milanović, 2010). Managing fitness entails excellent understanding of athlete's organism, theoretical knowledge and practical experience. Grivas (2018) and De Lacey et al. (2014) agree that tapering is the basis of training strategy for the improvement of athletic performances and the achievement of success in the major competition. Grivas (2018) also points out that tapering is achieved by managing training variables such as intensity, volume and frequency. According to De Lacey et al. (2014) and Murach and Bagley (2015), tapering is defined as a period which is marked by the decrease of training load, which allows the athlete to rest from the stress caused by training and thus contributes to the athlete's preparation for the competition.

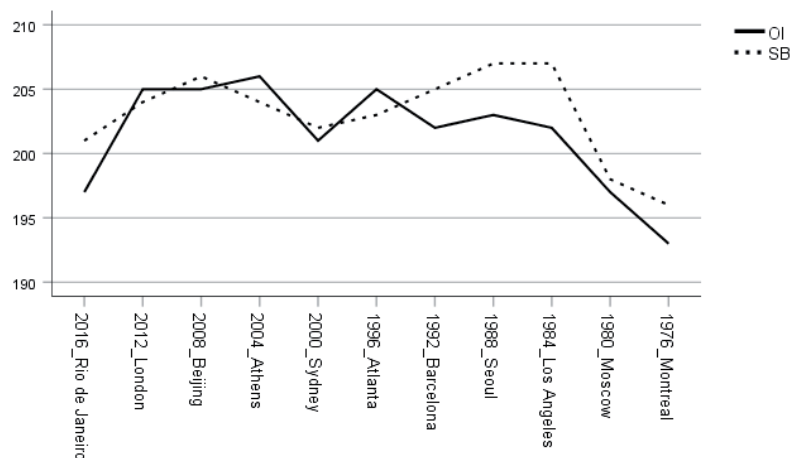


Figure 2. The best Olympic results (OI) and season's best results (SB) achieved in the same season

Table 4 Descriptive statistics for the best results at the Olympics and the season's best results in the same season, including a t-test result

	N	Range	Min	Max	M	SD	t	df	p
Winner's result at the Olympics	11	13	193	206	201.45	4.16	2.08	10	0.06
Season's best result	11	11	196	207	203.00	3.55			

## Conclusion

This paper, based on the analysis of the best results achieved at the Olympic Games from 1948 to 2016, prognosticated the achievements at the 2020 Tokyo Olympics and compared the best results achieved at the Olympics and the season's best results in the same season. The prediction of the winner's result was conducted by approximation of the best results according to the polynomial models of 2<sup>nd</sup> and 3<sup>rd</sup> degree regression functions. The values indicate that both models have high correlation and explained variance (2<sup>nd</sup> degree polynomial  $R=0.969$ ,  $V=93.957\%$ , 3<sup>rd</sup> degree polynomial  $R=0.971$ ,  $V=94.191\%$ ). The predicted result equals 199.22, according to the 2<sup>nd</sup> degree polynomial regression model and 197.01 according to the 3<sup>rd</sup> degree polynomial model. Furthermore, between the winning results at the Olympics and the results achieved in the same season, there was no statistically significant difference ( $t_{(10)}=2.08$ ,  $p>0.05$ ). Competition systems, the effect of internal and external factors and unpredictable situations can be crucial for the final outcome, therefore, prognostication of results with a 100% precision is limited. Nevertheless, the analysis of total training work, results achieved at a certain competition as well as prognostication of results, present a major role for optimal guidance of planning and programming, training periodization and tapering. Work with top athletes demands constant monitoring and analysing so that the operational capability and preparedness of athletes would be at their highest, in time for major competitions.

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## CORRELATION BETWEEN SELECTED ANTHROPOMETRIC VARIABLES AND QUALITY OF UNDERHAND SERVE RECEPTION PERFORMANCE IN VOLLEYBALL

Nenad Marelić<sup>1</sup>, Marko Marelić<sup>2</sup>, Tomislav Đurković<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>School of Medicine University of Zagreb, Croatia

### Abstract

The aim of this research is to verify if there is a correlation between certain anthropometric variables of the upper extremities and the quality of underhand serve reception performance in volleyball. The research was conducted with 93 male examinees, first-year students at the Faculty of Kinesiology University of Zagreb (n=93). The examinees completed their first semester of studies that included the course Volleyball. The sample of examinees included only individuals with no prior experience in training volleyball. For each of the variables descriptive statistics were calculated (minimum and maximum result, arithmetic mean and standard deviation). The independent set included 10 anthropometric variables measured according to the IBP. For the purpose of this study, the numerically defined variable *Assessment of Underhand Serve Reception /USR/* was isolated as a dependent (criterion) variable. The correlation between independent and the criterion variable was calculated by using the non-parametric Spearman correlation. A statistically significant correlation can be noted between the criterion variable *Assessment of Underhand Serve Reception /USR/* and independent variables – *Arm Length /AL/* and *Wrist Diameter /WD/*. The conclusion can be made that there is a statistically significant effect of the variables *Arm Length /AL/* and *Wrist Diameter /WD/* on the variable *Assessment of Underhand Serve Reception /USR/*. The relation is positive and low impact. Simply put, it can be said that a better assessment was achieved by the examinees who, while preparing for the underhand serve reception, formed a longer and wider platform that enabled them an easier correction immediately prior to contacting the ball.

**Key words:** anthropometry, volleyball, underhand serve reception, AirCAT Volleyball Machine, measurement

### Introduction

Game models of top-level male and female senior teams, as well as those of teams in younger age categories, imply that the highest number of points in a set is won by spiking the ball (between 15 and 16 points out of 25). For a team to have the opportunity to win the mentioned number of points by spiking, it is necessary to implement certain preconditions. Primarily, a given hitter must be passed a precise ball, while it is also preferred that he is confronted by a weaker blocker or at least fewer opposing blockers (one blocker or a double block that is not well connected). In case the afore-stated takes place, a positive outcome is to be expected for the player, i.e. team that is spiking the ball. However, in order for the hitter to be passed a precise and tactically justifiably raised ball, the setter must also be given a precise pass from the receiving or defensive part of the court. Considering that between 85 and 90% of serve reception and 95% of defensive passes are performed by the “two-hand bump”, i.e. by connected forearms, certain anthropometric measurements such as arm length, forearm length and scope and distance between elbows when the forearms are connected (“two-hand bump”) are extremely important as the connected forearms form a platform against which the ball bounces towards the goal. It can be assumed that a player who has a larger platform surface can be more precise when bouncing the ball to the goal. The importance of the mentioned serve reception and defence phase in volleyball is also manifested in the rules of the game. In 1999, the FIVB adopts the rule of introducing the playing role of the libero – a defence and serve reception specialist who substitutes players in the back zone that are not specialists in the mentioned phase of the game (most often middle blockers) – with the aim to increase the number of retrieved balls while in defence, i.e. to reduce the over-efficient (approx. 70%) initial offense (Fournier, 2005). This reinforced the principle of specialisation that implies a precisely defined role for each player in relation to a specific separation of tasks, i.e. activities, in which one participates. The idea of creating more balance was not a success considering that the defensive improvement brought by the libero was eliminated with the increased offensive efficiency that resulted from the more precise serve reception, also generated by the libero. Faced with the inability to reduce the efficiency of the first offense, the International Volleyball Federation decides (FIVB, 2012) to allow the teams to introduce a second libero player who would be a subspecialist exclusively for defence. As part of serve reception tactics, in addition to the libero, serve reception is also performed by two receiver-hitters (rarely



during very strong rotation jump serves, a fourth – diagonal player – also joins in). As the players are of younger age and their experience is poorer, so does increase the number of players engaged in the serve reception phase. Thereby, in beginners who just started playing on the large court, serve reception is performed by 5 players. The following step includes a formation of serve reception with four players positioned in a curve, after which it is moved on to a system of serve reception with three players which is practised by all top-level teams in the male and female competition. In recent volleyball history, the serve reception system was composed of only two players, however, as a result of increasingly aggressive serves (topspin and jump float serve), teams returned to the system with three players as the serve receivers system. The reason for using an increased number of players in serve reception was the performance complexity of the technique itself, which implies a proper selection of the position on the playing court in the initial phase of the serve reception, a quick “reading” of the direction and speed of the volleyball, as well as the bounce technique of the volleyball into the primary setting zone. According to the opinion of the authors, this is the most complex technique in volleyball. It is quite often that errors are made in beginner players when passing the ball by using the “two-hand bump” and in serve reception. The errors can occur in each of the four performance phases. In the initial phase, it is most often the wrong choice of the starting position for the reception, as well as an incorrect starting position. In the preparation phase, the most often error is incorrect movement (elevating the centre of gravity while moving) and a premature grip when connecting the forearms or while moving with the joint forearms. During the basic phase, it is possible that contact takes place with the wrong part of the body – upper part of the forearm or the palms, as well as a sudden lifting in the knees that results in an uncontrolled bounce with the forearms. In the final phase of the “two-hand bump”/serve reception, the most often error is extending the knee joint all the way and elevating the forearms too high, which results in disrupting of the so-called serve reception angle (angle between the trunk and the hands that should remain at around 90°). Difficulties in forming the proper platform for the bounce can also be genetically conditioned. Certain players cannot connect the extended forearms, which often results in selecting such players to playing roles that primarily do not require serve reception performance. In fact, it would be ideal if the players could connect the forearms from the wrist to the medial epicondyle of the upper arm. The opinion of the author Selinger is quite interesting, as in 1986 he pointed out that the mentioned spacing in male volleyball players should not be bigger than 2,5 centimetres. Based on the many years of experience by the authors of this research, the effect of the ability to connect the forearms becomes strongly highlighted in beginner players and lower level competitors, as their serves and hits directed by the opponents are not too fast, so that a quality prepared platform for the underhand serve reception (“two-hand bump”) provides for a more precise bouncing of the volleyball. It is important to emphasize that techniques of bouncing the ball by using the underhand serve reception differ in accordance with the speed of the oncoming volleyball. For this research, the authors focused exclusively on the technique of serve reception of faster balls by using the volleyball bump, when one eliminates (reduces) the elevation in the knees (certain other reasons, such as volleyball rotation in spiking and serving, shall not be discussed in this research paper). Numerous researchers referred to anthropometric measurements in determining their importance for player selection or defining playing positions in volleyball (Đurković et al., 2008, 2012; Marelić et al., 2010; Joao et al., 2014; Tsoukos et al., 2019), however, not also for their correlation and effect on performance. The aim of this research is thus to verify if there is a correlation between certain anthropometric variables of the upper extremities and the quality of underhand serve reception performance in volleyball.

## Material and Method

The research was conducted with 93 male examinees, first-year students at the Faculty of Kinesiology University of Zagreb (n=93). The examinees completed their first semester of studies that included the course Volleyball. The sample of examinees included only individuals with no prior experience in training volleyball. The anthropometric parameters were measured in accordance with the recommendations of the International Biological Program (IBP – Mišigoj et al., 1995). Pursuant to the aim of this research, the authors selected a set of independent variables for which they assume could be related with the performance of the underhand serve reception. The set of independent variables represents as follows: *Body Height /BH/*, *Shoulder Width /SW/*, *Arm Span /AS/*, *Hand Span /HS/*, *Distance Between Elbows When Connecting Forearms /DBE/*, *Arm Length /AL/*, *Forearm Length /FL/*, *Elbow Diameter /ED/*, *Wrist Diameter /WD/*, *Forearm Circumference /FC/*. The variable *Distance Between Elbows When Connecting Forearms /DBE/* was measured in such a manner that the examinee would form the “two-hand bump” while sitting in a chair, while the measurer used an anthropometer to measure the distance between the elbows (medial epicondyle of the upper arms). For this study, the numerically defined variable *Assessment of Underhand Serve Reception /USR/* was isolated as a dependent (criterion) variable. Description of the test: The examinee is in basic volleyball stance in zone 6, 6 meters away from the net. On the other side of the net, behind the end line in the middle of the court (behind zone 6), the automatic device **AirCAT Volleyball Machine** is placed. *By using the mentioned training machine, the authors achieved a consistency in the strength and trajectory of the served volleyball, which removed the potential effect of an imprecise service on behalf of a potential demonstrator.* At the audible signal, the training machine was started by the measurer pressing the remote controller to throw the volleyball without rotation (imitating the float serve) towards the examinee, who thus bounces the volleyball by using the technique of the underhand forearm bounce (“two-hand bump”). The examinee attempts to

bounce the ball into the primary zone for serve reception where there is an assistant, in an attempt to meet the criteria for precision and sufficient height of the ball trajectory. The performance is repeated three times, while the average grade is used for analysis. The quality of the serve reception is assessed by 2 evaluators – teachers with many years of teaching and coaching experience, and expressed on a scale of 4 degrees (assessments between 2 and 5). The grade 5 represents the highest level of performance, while 2 represents the poorest performance. For each of the variables descriptive statistics were calculated (minimum and maximum result, arithmetic mean and standard deviation). The correlation between independent and the criterion variable was calculated by using the non-parametric Spearman correlation (some variables deviated significantly from the normal distribution).

## Results

Table 1. demonstrates the descriptive values of the measured variables.

Table 1. Descriptive statistics of the set of variables

	N	Min	Max	AM	SD
Body Height /BH/	80	165,00	199,00	181,23	7,35
Shoulder Width /SW/	80	28,00	48,00	39,69	2,78
Arm Span /AS/	83	166,90	201,50	184,94	8,54
Hand Span /HS/	86	18,20	25,80	22,14	1,62
Distance Between Elbows When Connecting Forearms /DBE/	83	0,00	8,60	2,37	2,23
Arm Length /AL/	72	70,00	88,20	78,99	4,07
Forearm Length /FL/	83	20,50	29,70	24,95	2,39
Elbow Diameter /ED/	84	6,00	9,10	7,28	0,61
Wrist Diameter /WD/	82	4,90	6,30	5,69	0,31
Forearm Circumference /FC/	82	17,20	30,30	26,75	1,85
Assessment of Underhand Serve Reception /USR/	93	2,00	5,00	3,49	0,95

N=number of examinees; Min=minimum result; Max=maximum result; AM=arithmetic mean; SD= standard deviation.

A large range of results can be observed in all of 10 measured variables, which indicates the heterogeneity of the group of subjects. Given the aim of the that heterogeneity is desirable.

Table 2. demonstrates the results of the correlation between the variable *Assessment of Underhand Serve Reception /USR/* and the measured anthropometric variables.

Table 2. Correlation analysis of anthropometric variables and underhand serve reception performance technique

	USR	FC	FL	AL	AS	DBE	ED	WD	HS	SW	BH
$\rho(ro)$	1.00	0.01	0.13	<b>,26*</b>	0.20	-0.11	0.09	<b>,22*</b>	0.09	0.04	0.13
p		0.89	0.25	<b>0.03</b>	0.06	0.32	0.40	<b>0.05</b>	0.38	0.76	0.24

$\rho(ro)$ = Spearman correlation coefficient; \*indicates statistical significance ( $p<0.05$ )

Statistically significant positive correlation of two independent variables (Arm length and Wrist diameter) with the criterion variable (*Assessment of Underhand Serve Reception*) variable can be registered.

## Discussion

The data presented in Table 1 clearly show that the average height of examinees was 181,23 centimetres. Out of the total 80 examinees, the lowest participant was 166,90 centimetres, while the highest was 199,0 centimetres. The highest deviation from the arithmetic mean can be noted in the variable *Arm Span /AS/* (8,54) and *Body Height /BH/* (/7,34). The average value for the dependent variable *Assessment of Underhand Serve Reception /USR/* was 3,49, while the average deviation from the arithmetic mean was 0,95. The variable *Distance Between Elbows When Connecting Forearms /DBE/* was approximately 2,37 cm, a criterion that was determined to be negative according to Selinger in 1986. A statically significant correlation can be registered between the criterion variable *Assessment of Underhand Serve Reception /USR/* and two independent variables – *Arm Length /AL/* and *Wrist Diameter /WD/*. A weak positive correlation was also calculated between the criterion variable and the independent variable *Arm Length /AL/*,  $\rho(ro)=0,26$ ,  $n=93$ ,  $p=0.03$ , where upon an increase in the value of the variable *Arm Length /AL/*, the value of the dependent variable *Assessment of*

*Underhand Serve Reception /USR/* also increases. Likewise, a weak positive correlation was also calculated between the criterion variable and the independent variable *Wrist Diameter /WD/*,  $\rho(r_o)=0,22$ ,  $n=93$ ,  $p=0,05$ , where once again upon an increase in the value of the variable *Wrist Diameter /WD/*, the value of the dependent variable *Assessment of Underhand Serve Reception /USR/* also increases.

## Conclusion

By using the *AirCAT Volleyball Machine* device with the aim to achieve a precise serve, the authors attempted to maximally reduce the movements in the preparation phase of the serve reception in order to reduce the impact of footwork in the performance of the technique for the *Underhand Serve Reception /USR/*. Based on the obtained results, the conclusion can be made that there is a statistically significant effect of the variables *Arm Length /AL/* and *Wrist Diameter /WD/* on the criterion variable *Assessment of Underhand Serve Reception /USR/*. This relationship is positive and of low impact (Cohen, 1988). Such data is simple for interpretation as these are variables defining length and width and therefore the compactness of the player's platform that encounters the ball in the serve reception. Simply put, it can be said that a better assessment was obtained by the examinees who when forming the "two-hand bump" had a longer and wider platform for bouncing the ball that allows them to correct themselves more easily immediately before contact with the volleyball. Special interest was directed towards the variable *Distance Between Elbows When Connecting Forearms /DBE/*, as it can be assumed that a smaller gap or a total absence of one improves the compactness of the platform. The coaching experience of the authors of this research implies that the examinees with a bigger gap between joined arms might also obtain a lower grade in the variable *Assessment of Underhand Serve Reception /USR/*. It is clear that on this sample of examinees (beginners) the variables *Arm Length /AL/* and *Wrist Diameter /WD/* proved themselves as the variables with the most impact. Considering the fact that the variable *Distance Between Elbows When Connecting Forearms /DBE/* is reversely scalable (with a bigger gap there is a lower assessment – this yields a negative correlation), the conclusion can be made that a smaller distance between medial epicondyles of the upper arm (elbows) assists the efficiency of serve reception which is registered in a higher average grade, even though the mentioned correlation was not statistically significant.

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## CHANGES IN PHYSICAL DEMANDS BETWEEN GAME PARTS OF JUNIOR FEMALE HANDBALL GAMES

Rasa Mikalonytė, Rūtenis Paulauskas

*Vytautas Magnus University Education Academy, Lithuania*

The aim of our study was to analyze young (U-18) female handball players physical demands during simulated handball game. 28 female junior handball players (n=14 players in two teams) participated in this study. Both teams were playing handball game in the same court based on International Handball Federation (IHF) rules and started with 15-minute warm-up, based on ball dribbling, shooting, specific mobility and dynamic stretching exercises. The motion demands were quantified only when the players were competing on court using the global positioning system device (OptimeEye X4 Catapult, Australija). We recorded total distance covered (m), players load (AU), player load per minute, player load sideways (AU), forward and up (AU), number of changes of directions (CoD), distance covered in 5 speed zones (m), Borg's scale for rating of perceived exertion (RPE) was used. Descriptive statistics were used to compute means and standard deviations (SD), the t-test at the level of significance of  $p < 0,05$ , for dependent samples. Based on the results it was concluded that significant difference between playing time changes occurs in total distance covered player's load moving sideways, IMA CoD left, right medium ( $2.5 - 3.5 \text{ m}\cdot\text{s}^{-1}$ ) measures, CoD right low ( $1.5 - 2.5 \text{ m}\cdot\text{s}^{-1}$ ) and CoD right high ( $>3.5 \text{ m}\cdot\text{s}^{-1}$ ). No statistical differences between the first and second half of the match were found in RPE, but the fatigue was greater after the second half of the match. Findings of our research indicate that young female handball players, during simulated game perform very similar number of actions in both teams. The data of player load, covered distances through the game may be helpful for handball coaches or physical conditioning trainers who can using these parameters select the specific training methods.

**Key words:** *Speed zones, player's load, rate of perceived exertion*

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## STANDARD PERFORMANCE INDICATORS AS FACTORS OF MEN'S TEAM PERFORMANCE AT THE 2019 WORLD HANDBALL CHAMPIONSHIP

Andrija Mikša<sup>1</sup>, Marko Milanović<sup>2</sup>, Tonći Jerak<sup>3</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Zagreb University of Applied Sciences, Croatia

<sup>3</sup>University of Zadar, Croatia

### Abstract

The aim of this study was to determine which variables of situational efficiency have the greatest impact on the final outcome of the game (win-defeat) of men handball teams at the 2019 World Handball Championship. The sample of entities consists of 91 games played (draws excluded). For the purposes of the research, a sample of 17 variables of standard indicators of situational efficiency were used.

Regression analysis was used to determine the relationship between the indicators of the situational efficiency variables of handball teams in the final result of matches and the criterion variable wins - loses. Out of a total of seventeen (17) variables, nine (9) variables of the situational efficiency variable of handball teams contribute statistically significant to the explanation of the criterion variable win - lose at the level of significance ( $p = 0.95$ ). From the obtained results, it is possible to conclude that the winning teams play according to the model of as few as possible turnovers, as many as possible successfully executed shots from 6 m, stolen balls in the defensive phase and successful shots from the wing. In addition to the above, the game of the winning teams is characterized by greater number of successfully realized counterattacks as well as a smaller number of unsuccessful shots from 6 and 9 meters, at the same time having a high realization from 9 meters, while having greater amounts of blocked shots in the defensive phase.

**Key words:** *situational efficiency, handball, men, 2019 World Cup*

### Introduction

In modern sports, the structure of the parameters of competitive activity is the basis for comparative analyses of athletes and the entire team and, which is especially important, for the rational programming of sports preparation. Therefore, it is necessary to precisely shape the profile of the individual structure of the situational efficiency indicators of each player. By registering situational efficiency, the required values of team efficiency can be reached, as well as the model of individual performance of an individual player in all phases of the game. The system of criteria for assessing the actual quality of handball players must provide an assessment of the situational performance or playing performance of an individual player in relation to the positions in the game and the stages of the game. In this way, objective indicators of the condition, ie efficiency of players and teams are obtained, and there is no more subjective assessment, and based on the indicators, the coach can assess the contribution of each player to the successful and unsuccessful operation of the team in attack or defence. A number of studies are aimed at determining the contribution and various standard performance indicators and differently defined criteria of performance in the games of world and European championships and Olympic tournaments (Srhoj et al., 2001, Vuleta et al., 2003, Rogulj et al., 2004, Vuleta et al., 2005; Gruić et al., 2006; Rogulj et al., 2011, Vuleta et al., 2012). The aim of this research is to determine which predictor variables of situational action of handball players in the game have the greatest impact on the positive outcome of handball teams at the World Championships in the World Handball Championship for men in Denmark and Germany in 2019.

H - There is a statistically significant correlation between certain standard indicators of situational efficiency and the final outcome and there is a different contribution of some standard indicators of situational efficiency to the final outcome of men's handball teams at the Men's World Handball Championship in 2019.



## Methods

### Entity sample

The sample of entities in this study consists of 91 matches played by 24 men's handball teams that were divided into 4 groups A, B, C and D with 6 teams each at the 2019 World Men's Handball Championship in Denmark and Germany.

Group A featured: France, Norway, Russia, Brazil, Poland and Japan. In Group B: Spain, Slovenia, Macedonia, Iceland, Tunisia and Angola. In Group C: Germany, Croatia, Belarus, Hungary, Saudi Arabia and Chile and in Group D: Denmark, Sweden, Egypt, Qatar, Argentina and Bahrain.

### Sample variables

The sample of 17 predictor variables consists of the frequencies of successfully and unsuccessfully performed elements of technical and tactical action of players during a handball match in the phases of attack and defence. All these data were collected by The Swiss Timing Games Information System, which is a worldwide famous system for a variety of specific needs of multiple sports. For the present study the game Match Time Report files were selected and downloaded from the official IHF statistics published on their official website ([www.ihf.com](http://www.ihf.com)). Several other authors have used similar methods in their research (Gruić et al., 2006; Ohnjec et al., 2008; Vuleta et al., 2005). Most of the analysed variables (14) are indicators of situational efficiency in the attack phase while three (3) indicators of situational efficiency of technical-tactical action relate to the phase of defence (table 2).

The criterion variable is a binary defined variable based on the final results of handball matches according to the criterion of victories or defeats in men's handball teams at 91 matches of the 2019 World Cup in Denmark and Germany.

### Data processing methods

Data processing was performed in Microsoft Excel and Statistica (TIBCO Statistica® 13.5.0.17, TIBCO Software Inc., Palo Alto, CA, USA). Within the descriptive statistics, the central and dispersive parameters of the observed variables were calculated. Regression analysis was used to determine the relationship between the indicators of the situational efficiency variables of handball teams in the final result of matches and the criterion variable wins - loses at the level of inference with error  $p = 0.05$ .

## Results and discussion

Table 1 shows the results of a regression analysis of the correlation between the predictor set of variables in 91 matches played by men's handball teams at the 2019 World Men's Handball Championship in Denmark and Germany.

Table 1. Multiple indicators of regression analysis of situational efficiency variables and the final result of matches according to the criterion of won-lose at the 2019 World Handball Championship for men

CRITERIA win - lose	Multiple R	Multiple R2	Adjusted R2	F (17,164)	p	Std.Err. of Estimate
	0,73	0,53	0,48	10,08	<b>0,00</b>	3.62

LEGEND: Criterion variable (win-lose), multiple correlation coefficient (Multiple R), coefficient of determination (Multiple R2), adjusted coefficient of determination (Adjusted R2), F-values statistical significance of prediction of the criterion variable, level of statistical significance (p), standard error of estimate (Std.Err. of Estimate)

The coefficient of multiple correlation R is statistically significant and amounts to (.73), and there is no doubt that success or victory based on the criteria win-lose can be predicted based on the variables of shooting on goal but also on the basis of some defensive variables. Namely, these variables explained 53% of the common variance ( $R^2 = 0.53$ ) of various successful and unsuccessful ways of shooting on goal, assists, but also defensive activities in the handball game. In accordance with previous research (Srhoj et al., 2001; Rogulj et al., 2004, 2011; Gruić et al., 2006), a different contribution of predictor variables in defining the criterion variable was determined.

Table 2 shows the basic statistical indicators of the variables of competitive efficiency of winning and defeated handball teams as well as partial regression coefficients. High average frequencies in winning teams have variables: assists - ASSIST (15.45), lost balls - IZGULOP (8.85), shot from six meters successfully - SHOT6MUS (7.36), shot from nine meters unsuccessfully - SHOT9MNE (7.20) and a shot from nine meters successfully - SHOT9MUS (6.86). The variables that have the highest average frequency in defeated teams: lost balls - IZGULOP (11.68), assists - ASSIST (11.24), shot from nine meters unsuccessfully - SHOT9MNE (10.74), shot from six meters successfully - SHOT6MUS (6.16) and a shot from nine meters successfully - SHOT9MUS (5.97).

Based on the partial regression coefficients and the corresponding t-values of the test, it can be concluded that a total of nine (9) variables contribute statistically significantly to the explanation of the criterion variable - victory - defeat at the level of significance ( $p = 0.91$  and  $p = 0.95$ ).

Table 2. Partial indicators of regression analysis of the variables of situational efficiency and final outcome of matches at the 2019 World Handball Championship.

	Winning teams			Defeated teams		b*	Std. Err.- $\beta$	b	t (164)	p
	N	Mean	SD	Mean	SD					
Intercept								0,21		
SHOT6MUS	91	7,36	3,20	6,16	2,76	<b>0,24</b>	0,06	<b>0,039</b>	<b>3,09</b>	<b>0,00**</b>
SHOT6MNE	91	3,40	2,09	4,23	2,68	<b>-0,17</b>	0,07	<b>-0,03</b>	<b>-2,56</b>	<b>0,01**</b>
SHOTKRUS	91	4,48	2,23	2,95	1,79	<b>0,22</b>	0,06	<b>0,05</b>	<b>2,96</b>	<b>0,00**</b>
SHOTKRNE	91	2,21	1,61	2,23	1,48	0,00	0,07	-0,00	-0,08	0,94
SHOTT9MUS	91	6,86	2,80	5,97	2,85	<b>0,14</b>	0,08	<b>0,02</b>	<b>2,03</b>	<b>0,04*</b>
SHOT9MNE	91	7,20	3,07	10,74	4,45	<b>-0,19</b>	0,07	<b>-0,02</b>	<b>-2,32</b>	<b>0,02*</b>
SHOT7MUS	91	2,67	1,57	2,67	1,64	0,05	0,06	0,01	0,69	0,49
SHOT7MNE	91	0,74	0,89	0,99	1,04	-0,07	0,08	0,04	-1,18	0,24
SHOTKOUS	91	5,82	2,98	3,43	1,98	<b>0,19</b>	0,06	<b>0,03</b>	<b>2,50</b>	<b>0,01**</b>
SHOTKONE	91	1,36	1,31	0,96	0,86	0,05	0,06	0,02	0,95	0,34
SHOTPRUS	91	3,32	1,88	2,98	2,15	0,03	0,06	0,01	0,53	0,59
SHOTPRNE	91	1,08	1,30	1,26	1,24	-0,04	0,06	-0,02	-0,73	0,47
ASSIST	91	15,45	4,55	11,24	3,88	-0,07	0,09	-0,01	-0,70	0,48
IZGULOP	91	8,85	3,33	11,68	3,45	<b>-0,21</b>	0,06	<b>-0,03</b>	<b>-3,44</b>	<b>0,00**</b>
OSVOLOP	91	4,37	2,41	2,89	1,60	<b>0,19</b>	0,06	<b>0,04</b>	<b>2,99</b>	<b>0,00**</b>
BLOKLOP	91	2,78	2,06	1,49	1,45	<b>0,14</b>	0,07	<b>0,04</b>	<b>2,17</b>	<b>0,03*</b>
2MINISK	91	3,90	1,74	4,09	1,79	-0,02	0,06	-0,01	1,89	0,66

LEGEND: Arithmetic mean - Mean, standard deviation - SD, number of games played - N, standardized regression coefficient -  $b^*$ , b-unstandardized regression coefficient, value of t-test (t), level of statistical significance (p). Successful shots from six meters - SHOT6MUS, unsuccessful shots from six meter - SHOT6MNE, successful shots from the wing - SHOTKRUS, unsuccessful shots from the wing - SHOTKRNE, successful shots from nine meters - SHOT9MUS, unsuccessful shots from nine meters - SHOT9MNE, successful shots from the wing - SHOTKRUS, successful shots from 7 meters - SHOT7MUS, unsuccessful shots from seven meters - SHOT7MNE, successful shots from the counterattack - SHOTKOUS, unsuccessful shots from the counterattack - SHOTKONE, successful shots during breakthrough - SHOTPRUS, unsuccessful shots during breakthrough - SHOTPRNE, assists - ASSIST, lost balls - IZGULOP, won balls - OSVOLOP, blocked balls - BLOKLOP, 2 minute suspension - 2 MINISK.

Winning teams perform more successful shots on goal from a distance of 6m (SHOT6MUS) (7.16) (BETA=0.24) compared to losing teams (6.16) Shooting from the position of a pivot, has significant prognostic power at the level of significance ( $p = 0.00$ ). Considering the obtained results of the arithmetic means of the winning teams at the World Cup in France in 2017 in the group stage of the competition, Vuleta (2019), the number of average successful shots on goal from a distance of 6m is (8.53) while the defeated teams shot on average (7.26) successful attempts per game. A large number of teams end up in a situation with a shot from 6m, ie from the pivot position when their opponent plays a deep zone or combined defence to stop outside attackers, thus opening a lot of space and chances for realization from the "line" (Vuleta et al., 2003, 2005, 2012)

Also, winning teams perform more successful shots from the wing positions - SHOTKRUS (0.22), has prognostic power at the level of significance ( $p = 0.00$ ). In this research, the average values of winning teams (4.48) and defeated teams (2.95) were obtained, while Gruić et al. (2006) at the World Cup in Portugal obtained 5.56 successful realizations on average per game. The winning teams perform more successful shots on goal from the wing positions and the accuracy of shooting from the wing positions is an extremely important variable on which the overall situational efficiency of the team generally depends, ie the success in the game.

Additionally, winning teams have more won balls - OSVOLOP. A positive sign is logical and very important because in defining the final result of a handball match, the number of balls won can be crucial to the final outcome of the matches. This is in line with other research showing that winning and losing teams differ in the number of stolen balls (Milanović et al., 2018; Vuleta et al., 2017). The basic task of any defence is to achieve as many successful defences and thus receive as few goals as possible, but if possible to win as many balls by cutting, subtracting, blocking, which certainly contributes to achieving a better result and ultimately achieving a better goal difference and thus victory.

Furthermore, winning teams have more successful counterattacks - SHOTKOUS (BETA = 0.19) at the level of significance ( $p = 0.01$ ). The correlation of the variable shot from the counterattack successfully - SHOTKOUS with the criterion variable win - lose means that teams play more counterattacks during the game have a better chance of winning matches. In this study, the average values are (5.82) of winning teams and (3.43) of defeated teams. Similar results were obtained by Milanović et al (2018) at the Women's Olympic Tournament in London, where the winning teams had (5.11)

and the defeated (3.00) successful counterattacks. The counterattack is the result of an efficient game in the defensive phase, and is reflected in the goalkeeper's defences, blocked and won balls.

Moreover, winning teams have more blocked balls - BLOCKLOP (BETA = 0.14) at the level of significance ( $p = 0.03$ ). The importance of blocked balls has been proven in previous research: Šibila (2011) obtained 3.81 blocks per game. In this research, a relatively smaller number, compared to previous research, of blocked balls in winning teams (2.78) and in defeated teams (1.49) was obtained, which definitely indicates the fact that top handball in the defensive phase is increasingly based on deep defenders coming out on outside shooters and less on attempts to block outside shooters shots.

The situational efficiency variable shot from nine meters successfully - SHOT9MUS has a surprisingly lower statistical significance at the level ( $p = 0.04$ ) with a positive impact (BETA = 0.14), because in most previous studies the results obtained (Srhoj et al., 2001) indicate, that for the final success of the team, a high degree of realization of shooting from outside positions is necessary. It is obvious that to succeed in a handball match you need to perform as many successful shots from a distance of 9m, ie from the free throw line and further.

The variable that differentiates winning and losing teams the most is the variable lost balls - IZGULOP which has statistical significance at the level ( $p = 0.00$ ) with a negative impact (BETA = -0.21), The goal of a well-organized game in the attack phase is to have as few lost balls which means making as few technical errors and bad passes as possible that end up either out of bounds or by cutting the ball by the opponent. Of course, the opposing teams also have a certain number of lost balls which is less in winning teams because handball has been gaining momentum lately which results in fast and risky passes that often end up with more balls lost. In this study were obtained, the average values of lost balls in winning teams (8.85) and losing teams (11.68). This is in line with other research that shows that winning teams have significantly more assists than losing teams (Lalić, 2017; Milanović et al., 2018).

Also, losing teams perform more unsuccessful shots from six meters - SHOT6MNE (BETA = -0.17), although relatively low, has a significant correlation at the level of significance ( $p = 0.05$ ). A large number of teams end up in a situation with a shot from 6m, ie from the pivot position when their opponent plays a deep zone or combined defence to stop outside attackers, thus opening a lot of space and chances for realization from the "line" (Vuleta et al., 2012;).

Furthermore, losing teams perform more unsuccessful shots from 9m - SHOT9MNE. In this study, the average number of unsuccessfully executed shots from 9m in winning teams is (7.20) and losing (10.74) teams. This is in line with other research showing that an unsuccessful shot from 9 meters significantly distinguishes the winning from the defeated teams (Vuleta et al., 2017; Lalić, 2017) A large number of unsuccessful shots on goal from a distance of 9 m due to the action of defensive players (block, goalkeeper defence, interruption of the game, etc.) has a double negative effect - first, it is a ruined opportunity to score, and secondly, an unsuccessful shot opens space to perform a counterattack, from which it is easiest to score.

## Conclusion

Out of a total of seventeen 17 variables, nine 9 variables of the situational efficiency variable of handball teams statistically significantly contribute to the explanation of the criterion variable win - lose at the level of significance ( $p = 0.95$ ). The highest statistical significance on the criterion variable win - lose have variables: shot from the wing position successfully, won balls, shot from the counterattack successfully, blocked balls, shot from nine meters successfully and with a negative sign the variables lost ball, shot from six meters unsuccessfully and shot from nine meters unsuccessfully. Based on the obtained results, it can be concluded that the first hypothesis, the relationship between individual indicators of situational efficiency and final performance of men's handball teams at the World Cup in Denmark and Germany in 2019 and the final result as well as the second hypothesis that individual variables of situational efficiency have different contributions in forecasting of the final result with respect to the win-lose criterion variable can be confirmed.

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## DIFFERENCES IN PASSING BETWEEN QUALIFIED AND NON-QUALIFIED TEAMS FOR THE KNOCKOUT STAGE IN WORLD CUP 2018

Ivan Mikulić<sup>1</sup>, Mihael Mindek<sup>2</sup>, Valentin Barišić<sup>1</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>GNK Dinamo Zagreb, Croatia

### Abstract

Based on all matches played in the group phase of the World Cup in Russia 2018 we determined the importance of ball passing regarding the qualifying outcome to the knockout phase of the competition. Using T-test for independent samples and descriptive statistics, we collected and analyzed data proving that passing, as a key performance indicator, posed significant difference to the qualifying teams as opposed to the non-qualifying teams. Moreover, when analyzing passes by type and length, we can get a clearer picture of which pass type is more crucial to the final outcome. Statistically significant difference between teams was found in variables: total passes ( $p=0.015$ ), inaccurate long passes ( $p=0.012$ ), accurate short passes ( $p=0.012$ ), key passes: both long ( $p=0.006$ ) and short ( $p=0.000$ ) and assists divided into through balls ( $p=0.003$ ), corners ( $p=0.018$ ) and crosses ( $p=0.000$ ). There were no statistically significant differences found in variables regarding accurate long passes ( $p=0.421$ ), inaccurate short passes ( $p=0.123$ ) and freekick assists ( $p=0.363$ ). Finally, these results suggest that passing presents an extremely important role in modern international football teams, especially when qualifying to the knockout phase of the World Cup Championship.

**Key words:** *international championship, situational indicators, group phase, notational analysis, ball possession, passing*

### Introduction

A large number of football experts think that the World Cup (WC) is not only the biggest football, but also the biggest sports event in the world. The best teams, coaches and players from the world's strongest leagues compete and try to outwit each other to achieve a better score and present their own country in the best light to the entire world. National teams employ different gameplay strategies at World Cup. Kempe et al. (2014) found that during the World Cup 2010 in South Africa more successful teams had higher ball possession and more vertical passes. Almost the same result were founded by Yi et al. (2019), where the authors suggested that teams qualified for the knockout stage had more possession play and less direct play than non-qualified teams. It is almost impossible to give the formula of success on such large competitive football event. However, considering that the last few world cups were won by teams who played „technical football“, i.e. teams that neutralized opponents by keeping high ball possession (Kempe et al., 2014), we can conclude that „technical football“ leads to success (2014. Germany, 2010. Spain, 2006. Italy, 2002. Brazil, 1998. France, 1994. Brazil, etc.). Furthermore, the same pattern of situational performance indicators, i.e. high ball possession, can be applied in the younger age categories of the national team as a predictor of success (Mikulić, Barišić and Bašić, 2016). Analyzing the World Cups and European Championships from 1990 to 2006, many authors concluded that more successful teams made more long passes while keeping the ball possession and finished significantly more attacking actions by making long passes (Hughes and Franks, 2005; Yiannakos and Armatas, 2006; Armatas and Yiannakos, 2010). On the other hand, recent research (Castellano, Casamichana and Lago, 2012; Clemente, 2012; Liu et al., 2015) emphasize the importance of short and medium passes in achieving the positive final outcome of the match. Also, analyses of the development of football tactics, over the years in the club competition, showed that the ball possession, assists and the total number of passes have been linearly increasing. (Lago – Penas et al., 2010; Vigne et al., 2013; Bradley et al., 2014; Yue, Broich and Mester, 2014; Mindek, Sporiš and Mikulić, 2018). Technical and tactical evolution have led to implementation of complex operating systems that help in preparation for the game, also in planning and programming the training sessions. All professional clubs and national teams have experts in charge of scouting the opponents. Nowadays, not many tactical solutions can be hidden from the opponent, but the fact remains that football is a game in which three things are the most important: receiving the ball, short time decision making and passing (Jozak and Kepčija, 2017).



We hypothesized there were differences in passing between qualified and non-qualified teams in the knockout stage of competition. Therefore, the aim of the current study was to determine differences between teams, in the group tactical mean “passes”, primarily related to the group phase of the competition at the WC in 2018 in Russia since the style of game and requirements differ from the knockout stage of the competition.

## Methods

### Sample

Match statistics of all 48 group phase games from the 2018 Russia FIFA WC were retrieved from the website of “Whoscored” (www.whoscored.com). The sample consists of 32 teams divided into qualifiers (A) (N=16) and non-qualifiers (B) (N=16) for the knockout phase. Each team played three (3) games in total in the group phase.

### Data analysis

Eleven variables were selected as predictor variables in the analysis and they were divided into two groups (attacking phase) according to the available literature (Castellano et al., 2012; Lago–Ballesteros, Lago–Peñas, & Rey, 2012; Lago–Peñas & Lago–Ballesteros, 2011; Lago–Peñas et al., 2010; Liu et al., 2013; Tenga et al., 2010):

1. 7 variables related to passing (total passes, accurate long passes, inaccurate long passes, accurate short passes, inaccurate short passes, key pass long, key pass short)
2. 4 variables related to the type of assists (crosses, corner kicks, through balls, freekicks)

For data analysis was used SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Mac, Version 21.0. Armonk, NY: IBM Corp). Data were collected in 48 matches from the group stage and were analyzed through the T-test for independent samples. Descriptive statistics provided basic statistical parameters for every variable: arithmetic mean (Mean) and standard deviation (SD). The level of statistical significance was set to  $p < 0.05$ .

## Results

Data shows the differences in passing (table 1) and assist (table 2) variables between qualified and non – qualified teams for the knockout stage at the WC in Russia in 2018. There are 5 passing variables (total number of passes, inaccurate long passes, accurate short passes, key passes long, key passes short) that showed significant difference between qualified and non – qualified teams. Also, there are 3 assist type variables (crosses, corner kicks, through balls that showed significant difference between qualified and non – qualified teams for the knockout stage.

Table 1. Passing variables in group phase

Variable	Group	N	Mean ± SD	t	p
Total passes	A	16	1494.31 ± 330.56	2.273	0.015*
	B	16	1227.25 ± 334.21		
Accurate long passes	A	16	85 ± 18.36	-0.200	0.421
	B	16	86.31 ± 18.74		
Inaccurate long passes	A	16	78.69 ± 19.28	-2.374	0.012*
	B	16	95.06 ± 19.73		
Accurate short passes	A	16	1169.88 ± 340.22	2.365	0.012*
	B	16	894.69 ± 317.58		
Inaccurate short passes	A	16	160.75 ± 22.47	1.182	0.123
	B	16	151.19 ± 23.29		
Key passes long	A	16	137 ± 4.77	2.675	0.006*
	B	16	81 ± 2.14		
Key passes short	A	16	617 ± 15.64	4.117	0.000*
	B	16	318 ± 9.23		

A - qualifiers for the knockout phase, B - non-qualifiers for the knockout phase, N – number of teams, \* - significant difference

Table 2. Assist types in group phase

Variable	Group	N	Mean $\pm$ SD	t	p
Crosses	A	16	1.50 $\pm$ 1.03	3.922	0.000*
	B	16	0.38 $\pm$ 0.50		
Corner kicks	A	16	0.56 $\pm$ 0.73	2.178	0.018*
	B	16	0.13 $\pm$ 0.34		
Through balls	A	16	0.69 $\pm$ 0.95	2.905	0.003*
	B	16	0.00 $\pm$ 0.00		
Freekicks	A	16	0.19 $\pm$ 0.40	-0.355	0.363
	B	16	0.25 $\pm$ 0.58		

## Discussion

The aim of this study was to determine differences in passing and assist types between teams which qualified for the knockout stage at the WC in Russia in 2018. and non-qualified teams. The results of T-test for independent samples identified five variables of passing that differed between teams which qualified for the knockout stage and those that couldn't qualify (table 1). The results also show difference with statistically significant in 3 variables of assist types (table 2). There are significant differences in the total passes between the teams that advanced ( $1494.31 \pm 330.56$ ) to the further round of competition and those who were not ( $1227.25 \pm 334.21$ ) with the statistical significance of  $p < 0.05$ . Many authors (Lago-Penas et al., 2010; Vigne et al., 2013; Bradley et al., 2014; Yue et al., 2014; Kempe et al., 2014; Mindek et al., 2018) also determined the importance of passing the ball and concluded that successful teams differ from less successful teams in this particular indicator of situational efficiency. Castellano et al. (2012) found that winning teams had statistically more ball possession than losing teams in WC 2002, 2006 and 2010. However, WC winner in 2006 didn't have higher ball possession than the other opponents (Balyan et al., 2007). Furthermore, the authors found that seven teams which qualified for the quarter-final stage combined both possession and more direct play tactical approach (Yi et al., 2019). Nowadays, combining possession and direct play, which is determined by the opponent, could lead to the better performance and results.

During the ball possession, the teams used different types of passes with respect to the passing distance, so the table 1 shows the variables *accurate and inaccurate long* (>23 meters) and *short passes* (<23 meters), as well as *key pass long and short*. It is evident that qualified teams for the knockout stage of the competition ( $78.69 \pm 19.28$ ), in contrast to non-qualified teams ( $95.06 \pm 19.73$ ), had a significantly smaller number of *inaccurate long passes* ( $p = 0.012$ ), while there were no significant differences in *accurate long passes* ( $p = 0.421$ ). Results showed that more successful teams do not make so many mistakes in passing long balls, which means they do not give the opportunity to the opponent to take back ball possession and make some chances for scoring a goal. This demonstrates that more successful teams have a higher individual technical quality and thus use it for making the advantage over the opponents because of the greater effectiveness of ball possession and winning empty space of the field very quickly. There was also a significant difference ( $p = 0.012$ ) in *accurate short passes*, where the teams that passed in the further round of the competition had significantly more precise passes ( $1169.88 \pm 340.22$ ) and demonstrated a higher degree of technical-tactical preparedness. Taking the ball possession, it is possible to make the opponent more physically and mentally tired, which leads to making more mistakes in defense. Also, making more accurate short passes, gave the opportunity to the more successful teams to control the rhythm of the game. Making a lot of short passes, and after that doing some long pass enabled surprising the opponent and made the opportunities to score a goal. It is interesting that successful teams do not differ significantly from less successful in the *inaccurate short passes*. This indicator can be linked to a spot on the field where *inaccurate short passes* are generally occurring. Namely, it is possible that both teams had the highest number of *inaccurate short passes* far away from their own goals, in the middle of the field or in front of the opponent's penalty area. In those, players quickly returned the ball back into their possession, in case it has been previously lost, or succeeded in running back and helping in the defensive phase of the game. In both categories, *long and short key passes*, the differences between the teams are significant ( $p = 0.000$  and  $p = 0.006$ ). These indicators confirmed similar previous results of the research by Barišić, Dizdār & Bašić (2016), where the authors concluded that the winning teams, in the league system of competitions, significantly differ in the number of key passes from the defeated teams. Through multiple football matches it enables more scored goals. Based on the total number of key passes it is possible to conclude that the teams that passed the knockout stage of the competition were in the constant possession of the ball. Teams managed to connect all phases of the game to reach the finishing phase of the attack, create scoring opportunities and demonstrate a high level of technical and tactical preparedness. Table 1 shows successful teams had significantly more ( $p = 0.006$ ) *long key passes* ( $137 \pm 4.77$ ) compared to less successful teams ( $81 \pm 2.14$ ), as opposed to *accurate long passes* where this difference was not significant ( $p = 0.421$ ). This data indicates that a high number of long passes is needed for winning a match, but in terms of vertically concurring the empty space on the field, creating shooting opportunities and not skipping the game with long balls. All these results of the current study,

according to passing variables, are matched with previous study where authors concluded that European teams had more ball possession, short passes, medium passes, total passes, and accurate passes than African teams in FIFA WC 2018 (Kubayi and Toriola, 2019). Also, African teams showed more direct play than European teams with less ball possession, but without higher success (Yi et al., 2019). It is known that there was no African team which qualified for the knockout stage in FIFA WC 2018. When it comes to quality of passes, assists are also one of the key variables, which may differ successful and non-successful teams (Lago Penas et al., 2010). The authors of this scientific paper showed four types of assists (table 4), where three types significantly differ the teams which qualified for the knockout stage of the competition from non-qualified teams: assists through crosses ( $p=0.000$ ), through balls ( $p=0.003$ ) and corner kicks ( $p=0.018$ ). These results demonstrate how important it is to strike over side positions (wings or back) and run into free space behind the opponent's defenders. The results of the current study (freekick assists) are contrary to the results by Kubayi and Toriola (2019). The authors found that African teams conceded more goals from freekicks than European teams. The difference in the results may be explained by including all qualified teams for the knockout stage. Current study includes European teams as well as South American teams in a variable *assist through freekick*.

## Conclusion

In summary, the results in current study showed that number of passes and the type of passing and assists are crucial in winning. Also, study showed how important it is for the teams to make more key passes to qualify for the knockout stage in WC. For further research, it is advised to investigate how many passes have been made before scoring goals by qualified and non-qualified teams for the knockout stage in WC 2018, as well as number of passes selected by direction. Also, it would be interested to search how many goals were scored, followed by diagonal back pass inside the box, from the qualified and non-qualified teams. With respect to obtained data and results of the analysis, we conclude that passing is a crucial segment in the process of planning and programming training sessions and matches, creating quality teams and getting best results on the biggest football scene in the world such as FIFA WC.

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# DIFFERENCES BETWEEN WINNING AND LOSING TEAMS AT THE 2018 FIFA WORLD CUP IN RUSSIA IN SITUATIONAL PARAMETERS OF A FOOTBALL MATCH

**Luka Milanović, Kristijan Mitrečić, Marin Dadić**

*University of Zagreb Faculty of Kinesiology, Croatia*

## Abstract

The goal of this study was to examine the differences in situational parameters between winning and losing teams at the 2018 FIFA World Cup in Russia. From a total of 64 games played, 50 games were analyzed which satisfied the criteria for analysis. It was found that winning teams statistically score significantly more goals per match, take more shots at the goal and hit more shots on target, while also scoring more goals by bouncing the ball off the goal frame. Defeated teams have a significantly higher number of yellow cards per match.

*Key words: football, situational parameters, football world cup*

## Introduction

The systematic observation of a football match reveals many characteristic events which are repeated throughout the match, are noticeable and can be recorded. These events and their outcomes show the degree of situational effectiveness of the players and teams and respectively the level of their performance. The parameters of success are defined as a choice and combination of variables which define some aspects of the performance and assist in achieving sports success (Hughes and Bartlett, 2002). The recognition of significance between parameters of success and results of the game is a challenging, but important task in the analysis of the performance of football matches (Sarmiento, 2014). Empirical studies which concern the analysis of football matches were mainly focused on scoring goals and play patterns in the attack phase which led to scoring a goal (Ensum et al., 2002; Hook and Hughes, 2001; Hughes and Churchill, 2005; Hughes and Franks, 2005; Jones et al., 2004; Konstadinidou and Tsigilis, 2005; Scoulding et al., 2004; Stanhope, 2001). Some of these studies link these aspects with the result of the match (victory or defeat). Hughes and Franks (2005) compared the success of successful and unsuccessful teams at the World Cup of 1990. They found differences between them in converting ball possession into shots at the goal, with successful teams having better ratios. Hook and Hughes (2001) found that successful teams had longer ball possession at the Euro 2000, although significant differences in the number of passes which led to a goal weren't found. Taylor and Williams (2002) stated the significance of keeping ball possession for the winners of the 2002 World Cup finals and proposed that acquisition of ball possession in the defense area resulted with more shots at the goal. The analysis of parameters of a football match, with regard to individual and collective skills, is one of the tools which can be utilized to describe and follow behavior in competition (Ortega et al., 2009). Despite the limitations which can occur from using different variables in these investigations (Hughes et al., 2002), this type of data is useful for better understanding of the game of football. Although these kinds of studies have examined the indicators of success in football, some limitations and/or methodological issues can be observed in the study of these aspects.

**H<sub>1</sub>** – there is statistically significant difference between winning and losing teams at the 2018 World Cup in Russia in situational parameters of a football match

**H<sub>2</sub>** – there is statistically significant differences in specific situational parameters of a football match between winning and losing teams at the 2018 World Cup in Russia

## Methods

### Entities

Consist of 50 matches from a total of 64 played at the 2018 World Cup in Russia. Only games which had a winner after the regular match time (90+ minutes), those which didn't end with a tie after 90 minutes, entered the sample. Some of the analyzed teams are Croatia, France, Belgium, England, Russia, Sweden, Brazil, Argentina, Uruguay and Switzerland.



## Variables

Unprocessed data was downloaded from the official website. <https://www.fifa.com/worldcup/matches/>. It consists of 21 variables which showed the values which teams achieved in specific situational parameters through their numerical values. Eight variables concern attack: goals, shots, shots on target, shots off target, blocked shots, goals off the goal frame, corners and offsides. Six variables concern team performance: ball possession, pass precision, total passes, passes on target, passes off target and distance covered by the team in kilometers. Four variables concern defense: quick repossession after losing the ball, rebounds, blocked shots and clearances. Three variables concern disciplinary actions: yellow cards, red cards and fouls.

Table 1. List of indicators and their definitions

	TECHNICAL/TACTICAL INDICATOR
Goals	Number of scored goals
Shots	Number of all shots at the goal
Shots on target	Shots at the goal which would a) enter the net b) enter the net, but get blocked by the goalkeeper c) enter the net, but get blocked by the last player
Shots off target	Shots which go outside the goal, miss or hit the goal frame
Blocked shots	Number of shots blocked by defense players
Goals off the frame	Shots which hit the goal frame and enter the net
Corners	Number of shots from corners
Offsides	Number for which the player is considered to be in offside
Ball possession	Percentage of time for which the team keeps the ball
Pass precision	Number of passes on target divided by number of total passes
Total passes	Number of all passes
Passes on target	Number of purposely directed balls which reached a teammate
Passes off target	Number of purposely directed balls which didn't reach a teammate
Team distance covered	Total distance covered by all players including the goalkeeper
Repossession	Number of rebounds after the player has lost the ball or where the ball was played directly to him
Crosses	Number of passes from side positions to a specific area in front of the goal
Blocked shots	Number of shots blocked by defense players
Clearances	Number of defense actions in which the player hits the ball from his goal
Yellow cards	Number of yellow cards shown to the players
Red cards	Number of red cards shown to the players
Fouls	Number of fouls on the opponent

## Statistical analysis

Data from the study was processed with the computer software Statistica, ver. 13.3. The normality of distribution and homogeneity of the variance was assessed with the help of Shapiro-Wilk W and Levene's test. For variables which have a normal distribution and homogenous variance, differences between winning and losing teams were calculated using the univariant analysis of variance for independent samples (ANOVA), and with Fischer LSD correction ('post hoc' test), at a level of significance of  $p < 0,05$ . For variables which don't have a normal distribution and homogenous variance between winning and losing teams, the Kruskal-Wallis test was used to calculate them.

## Results

Table 2. Differences between winning and losing teams at the 2018 World Cup in Russia in situational parameters of a football match

Outcome	N	SUM of ranges	AVG of ranges	p-value
Victory	50	3541,50	70,83	0,000
Defeat	50	1508,50	30,17	

Legend: AVG – average, p-value – significance of differences

Using the Kruskal-Wallis test (Table 2.), statistically significant global differences were found in situational parameters between winning and losing teams at the 2018 World Cup.

Table 3. Differences between winning and losing teams at the 2018 World Cup in Russia in situational parameters of a football match

Variables	Winners (N=50)	Losers (N=50)	p-value
	AVG±SD	AVG±SD	
<b>Goals**</b>	<b>2,12±1,13</b>	<b>0,48±0,70</b>	<b>0,000</b>
<b>Shots**</b>	<b>13,22±4,61</b>	<b>11,56±5,47</b>	<b>0,036</b>
<b>Shots on target**</b>	<b>4,60±2,24</b>	<b>3,12±2,06</b>	<b>0,000</b>
Shots off target*	5,26±2,12	4,94±2,44	0,486
Blocked shots**	3,46±1,95	3,46±2,71	0,680
<b>Goals off goal frame**</b>	<b>0,28±0,49</b>	<b>0,12±0,38</b>	<b>0,042</b>
Corners**	4,94±2,29	4,50±2,71	0,298
Offsides**	1,34±1,28	1,46±1,21	0,509
Ball possession*	51,06±9,63	48,94±9,63	0,273
Passing precision**	83,14±6,14	81,84±5,33	0,135
Total passes*	460,72±137,24	435,26±122,73	0,330
Passes on target*	389,78±135,45	361,12±118,65	0,263
Passes off target**	70,94±13,93	74,14±15,62	0,569
Distance covered by team*	104,38±5,20	103,96±5,98	0,708
Repossessions*	41,96±6,90	41,02±8,32	0,540
Rebounds*	9,68±5,12	11,34±4,41	0,085
Blocked shots**	3,48±2,71	3,36±1,94	0,706
Clearances**	25,08±10,21	23,50±10,26	0,400
<b>Yellow cards**</b>	<b>1,40±1,08</b>	<b>1,94±1,25</b>	<b>0,036</b>
Red cards**	0,02±0,14	0,06±0,23	0,309
Fouls*	13,12±4,39	14,20±4,15	0,209

Legend: AVG - average, SD - standard deviation, p-value – significance of difference, ANOVA\*, Kruskal-Wallis\*\*

Variables which statistically significantly vary winning from losing teams are goals, shots, shots on target, goals off the goal frame and yellow cards. Winning teams score more goals  $p < 0,000$ , direct more shots at the opponent's goal  $p < 0,036$ , direct more shots on target  $p < 0,000$  and score more goals by bouncing the ball off the goal frame  $p < 0,042$ . Losing teams receive more yellow cards  $p < 0,036$ .

## Discussion

The entire essence of the competitive game is to score more goals than the opponent team, so it is not surprising that winning teams scored more goals than losing teams. Castellano et al. (2012) determined that winning and losing teams scored 2,2 and 0,4 goals per match during the World Cups of 2002, 2006 and 2010, while the result of this study was 2,12 and 0,48. These results are higher than those found by Delgado-Bordonau et al. (2013) at the 2010 World Cup with 1,7 and 0,7 scored goals. At the 2018 World Cup, a total of 64 teams participated and 169 goals were scored, which is 2,64 goals per match. The total number of shots at the opponent's goal also statistically significantly differs between winning (13,22) and losing teams (11,56). This is in accordance to the results previously found by Castellano et al. (2012) at the

World Cups of 2002 and 2006, but in contrast to the findings of Delgado-Bordonau et al. (2013) comparing successful and unsuccessful teams during the 2010 World Cup. Data from the Spanish La Liga (Lago-Ballesteros and Lago-Peñas, 2010), the Italian Serie A (Rampinini et al., 2007) and the English Premier League (Araya and Larkin, 2014) also revealed that the total number of shots was a deciding factor for success. Quality plays an important role. Winning teams have more attempts at the goal (13,22) which is in accordance with the previous results because I haven't found studies which point at success not being linked to the number of attempts at scoring a goal. Shots on target also discern winning from losing teams. While teams don't significantly differ in shots off target, although winning teams achieve higher values in this variable as well. Winning teams needed a lower number of shots to score (6,23) and losing teams needed 24,08 shots which is in accordance with previous studies (Lago-Ballesteros and Lago-Peñas, 2010; Lago-Peñas et al., 2010; Delgado-Bordonau et al., 2013). Winning teams scored goals from a lower number of shots on target (2,17) than losing teams (6,5). In this regard, Lago-Ballesteros and Lago-Peñas (2010) found in the Spanish La Liga that the rate of all shots was linked with the teams' success, while the rate of shots on target wasn't linked. Altogether, success relies on precision. The number of shots isn't so important, but the quality of these shots is what makes the difference. As was said by Papahristodoulou (2007), "more is better" does not apply to shots at the goal, taking into account unprocessed data, shots which didn't score can reflect the incompetence of a player at scoring a goal. It is also worth noting that the efficiency of shots on target at the 2018 World Cup was 46% for winning teams, and for losing teams only 15%. For the remaining technical/tactical indicators, yellow cards were the only indicator in which losing teams achieved higher values, which was not noticed during the 2002, 2006 and 2010 World Cups (Castellano et al., 2012). Less successful teams committed more fouls which confirmed the results from the previous study (Castellano et al., 2012). And these results are in contrast to the study Lago-Peñas et al. 2010. High ball possession is a strong characteristic of the Barcelona play style under Guardiola. It is proposed for it to be linked with success, but the result of this study is that successful teams didn't have a higher rate of ball possession, which is unlike what was recorded during the 2002, 2006 and 2010 World Cups (Castellano et al., 2012). Collet (2012) pointed out how the answer to the question of whether football is a game of possession or not, should be distinguished from the competition. While some domestic leagues showed a relationship between ball possession and team success (Premier League, Ligue 1 and Bundesliga), this didn't show up for the tournaments of the World Cup. While the percentage of ball possession is probably the most common data published during football games, its relationship to the performance is complex. It is under the influence of situational variables. Many studies (Lago-Peñas and Martin, 2007; Lago-Peñas et al., 2010 and Paixao et al., 2012) examined the causal mechanism which stands behind ball possession and emphasized that it depends on the status of the game, whereby the rate of ball possession is, for instance, higher when the team loses. Ball possession is highly related to the number of passes during the match (Collet, 2012). Unlike the 2010 World Cup (Saito et al., 2013), there weren't any differences found in the total number of passes and passes on target between winning and losing teams. A surprising fact is that pass precision isn't a sign of success. Passes on target do not discern winning from losing teams at the 2018 World Cup, but Collet (2012) and Arava and Larkin (2014) signified that passes on target are a sign of success. Bad performance of highly ranked FIFA teams like Germany, Brazil and Spain (teams with above-average on target passes) could explain the observations collected during the 2018 World Cup. Regarding corners, except the 2006 World Cup (Castellano et al., 2012), studies haven't found any relationship between the number of corners and success (Lago-Ballesteros et al., 2010; Castellano et al., 2012). The results of this study also haven't found any connection. The total distance covered by the team wasn't a discriminating indicator of success during the 2010 World Cup (Clemente et al., 2013). During the 2018 World Cup, no difference was found between teams in total distance covered which is identical to the Dufour et al. (2016) study on teams of the Bundesliga.

## Conclusion

This study revealed that the efficiency of shots at the goal was a factor which made a difference between winning and losing teams during the 2018 FIFA World Cup. The quality of shots was more important than the number of shots, and it is linked with success. Winning teams were superior in the following 3 variables: number of shots, number of shots on target and goals scored off the goal frame. The second main finding of this study was the absence of connection between many technical and conditional indicators with success. Ball possession, amount and quality of passes didn't make a difference. Data from the 2018 World Cup collected by FIFA were not sufficient to explain what made the difference between winning and losing teams. Football, thanks to its exceptional nature, still makes it very problematic to accurately determine factors which result in victory or defeat. The results of this study show that some parameters were linked to success but didn't add new real knowledge. Further studies are definitely needed in order to determine relevant situational parameters which influence success in a football match.

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## ABSOLUTE AND RELATIVE RELIABILITY OF SPECIFIC VERTICAL JUMPING TESTS IN SENIOR FEMALE VOLLEYBALL PLAYERS

Mirjana Milić, Zoran Grgantov

Faculty of Kinesiology University of Split, Croatia

### Abstract

Absolute and relative reliability of 6 tests assessing vertical jumping ability were analyzed on a sample of 17 senior female volleyball players. Tests standing vertical jump, vertical jump after a volleyball approach with two-feet take-off and vertical jump after a volleyball approach with one-foot take-off were performed first on a wall scale and then on vertec apparatus. Wall scale (WSCMJ) and vertec countermovement jump (VECMJ), and vertec approach jump – 2 leg takeoff (VEAJ-2L) have excellent relative reliability (ICC 95%CI >.90) and good sensitivity (SEM < SWC). Relative reliability of other tests: wall scale approach jump – 2 leg takeoff (WSAJ-2L) and wall scale approach jump – 1 leg takeoff (WSAJ-1L) and vertec approach jump – 1 leg takeoff (VEAJ-1L) ranges from good to excellent (ICC 95%CI = 0.845 – 0.980), whereas their sensitivity is not satisfactory (SEM > SWC). In all tests no systematic bias was found between test items by applying the repeated measures ANOVA. The obtained results indicate that the countermovement jump can be measured on both wall scale and vertec, the approach jump – 2 leg takeoff is recommended for measuring only on vertec, whereas the results in tests wall scale approach jump – 2 leg takeoff and approach jump – 1 leg takeoff on both wall scale and vertec should be taken with caution.

**Key words:** wall scale, vertec, intraclass correlation coefficient, standard error of measurement (SEM), small worthwhile change (SWC), ANOVA

### Introduction

Technical-tactical skills, proper morphological characteristics, speed, agility and jumping ability are key elements of success in volleyball (Amasay, 2008; Lidor & Ziv, 2010). Athletes and coaches should pay special attention to testing and development of vertical jumping ability (Lidor & Ziv, 2010).

High jump reach allows for a greater number of tactical solutions during spikes and serves in volleyball, whereas during blocks, players with higher jump reach can “cover” a larger portion of their field as compared to the players with lower reach (Jurko et al., 2008). There are different measuring instruments for measuring vertical jumping ability. Video technique, i.e., motion analysis equipment (Leard et al., 2007), and force plate (Attia et al., 2017) are considered the gold standard, but different photocell and contact mat devices (Borràs et al., 2011; Sattler et al., 2012; Grgantov et al., 2013; Sattler et al., 2015) are also used often. Even though all the mentioned instruments have good reliability and validity in assessing vertical jumping ability, most volleyball clubs do not possess such devices, so they use other methods to measure vertical jumping ability.

Two most frequently used methods for measuring specific jumping ability in volleyball clubs are the Sargent test (vertical jump), standing or after a volleyball approach, measuring the reach height on a wall scale (Katić et al., 2006; Jurko et al., 2008; Marelić et al., 2008), or on a stand-alone measuring instrument (“vertec”) (Melrose et al., 2007; Nuzzo et al., 2008). Both methods can be used for assessing specific jumping ability in volleyball, i.e., different movement structures used by volleyball players in training and competition during spiking, blocking or jump serving can be imitated. This is important because studies in which vertical jumping ability in volleyball is analyzed by specific volleyball tests are lacking (Lidor & Ziv, 2010). It should also be kept in mind that most points in volleyball are won by spiking (Šuker et al., 2015), thus, it is most important to analyze vertical jumping ability in spike performance with standing two-leg takeoff, and one-leg and two-leg takeoff after a volleyball approach.

In order for the obtained results to be usable, metric characteristics of the applied tests must be tested first. Therefore, the aim of this study was to determine absolute and relative reliability of specific tests for assessing vertical jumping ability in senior female volleyball players (countermovement jump, approach jump with two-leg takeoff and approach jump with one-leg takeoff), using a wall scale and a vertec device.



## Methods

The study included 17 senior female volleyball players, members of clubs in the town of Kaštela, competing in Superliga, the highest level of competition in Croatia. Of the 17 players, 3 were setters, 3 were libero players, 3 were opposite hitters, 4 were outside hitters, and 4 were middle blockers. Volleyball players' mean body height was 181.97 cm, mean body weight was 70.61 kg, and mean body mass index was 21.55. A warm-up was conducted before the testing, which included 10 minutes of jogging and mobility exercises, followed by several preparatory jumps. After the warm-up, three tests were conducted to assess vertical jumping ability (countermovement jump, approach jump with two-leg takeoff and approach jump with one-leg takeoff), first on a wall measuring scale and then on a custom-made vertec apparatus. Vertec comprises plastic swivel vanes attached to a telescopic metal pole that can be adjusted to the subjects' standing reach. All vertical jumping tests conducted on vertec require the subject to use their hand to displace the vanes with an overhead swinging motion at the peak of their vertical jump. The highest displaced horizontal swivel vane determines the maximum jump height. To calculate vertical jump height, the difference between standing reach measurement and the highest displaced horizontal swivel vane is measured. When measuring the maximum countermovement jump, the subjects were not allowed to move their feet, but attempted to jump as high as possible swinging their arms from a half-squat to reach the highest possible point on the wall measuring scale/vertec with their hitting arm. In the approach jump – 2 leg takeoff, a two-leg takeoff following a four-step volleyball approach is performed (right-left-right-left for the right-handed), in order to achieve maximum vertical jump on the wall measuring scale/vertec. In the test approach jump – 1 leg takeoff all subjects perform a one-leg takeoff after a three-step volleyball approach (left-right-left for the right-handed) and, as in the previous test, reach the highest possible point on the wall measuring scale/vertec with their hitting arm.

All tests were conducted on an indoor floor surface during one training session which took place between 5 and 7 p.m. Each test was repeated 3 times with a 45-second pause between items of each test and a 3-minute pause between different test.

All the data were analyzed using the SPSS version 24 for Windows statistical program. Descriptive statistics including the mean, standard deviation, minimum and maximum values were calculated. To determine relative reliability, ICC estimates and their 95% confident intervals were calculated based on a single rater, absolute-agreement, 2-way mixed-effects model. To test the absolute reliability of vertical jumping tests, the standard error of measurement (SEM) was also calculated to give an indication of the precision of individual scores over repeated administrations ( $SEM = SD \times \sqrt{1 - ICC}$ ). To establish the usefulness of the vertical jumping tests, the smallest worthwhile change (SWC) was determined (Atkinson & Nevill, 1998). The sensitivity of the test was assessed by comparing the SWC and SEM, using the thresholds (Liow & Hopkins, 2003). If the SEM is smaller than the SWC, the ability of the test to detect a change is "good"; if the SEM equals SWC, then the test is "satisfactory", but if the SEM is greater than the SWC, then the test is rated as "marginal". A repeated measure ANOVA was used to assess systematic bias between test items.

## Results

The results of metric characteristics of absolute and relative reliability and sensitivity of 6 tests assessing vertical jumping ability in female volleyball players are presented in Table 1.

Table 1. Reliability and sensitivity of tests assessing vertical jumping ability in female volleyball players

	AM±SD	ICC	95%ICC	SEM(cm)	SWC(cm)
WSCMJ	42.7±6.6	0.98	0.896-0.981	2.17	3.08
WSAJ-2L	46.7±6.54	0.95	0.888-0.980	3.46	3.1
WSAJ-1L	41.3±5.92	0.93	0.849-0.975	3.57	2.92
VECMJ	47.2±5.8	0.98	0.954-0.992	2.05	2.9
VEAJ-2L	53.6±5.96	0.98	0.964-0.994	1.52	2.9
VEAJ-1L	48.47±6.45	0.93	0.832-0.971	3.54	2.68

Legend: WSCMJ – wall scale countermovement jump, WSAJ-2L – wall scale approach jump – 2 leg takeoff, WSAJ-1L – wall scale approach jump – 1 leg takeoff, VECMJ – vertec countermovement jump, VEAJ-2L – vertec approach jump – 2 leg takeoff, VEAJ-1L – vertec approach jump – 1 leg takeoff, ICC – intraclass correlation coefficient, 95%ICC – 95% intraclass correlation coefficient, SEM – standard error of measurement, SWC – smallest worthwhile change.

By comparing the mean values in tests measured by the wall scale and the vertec apparatus, it can be seen that female volleyball players had 5-7 cm higher results in tests assessing vertical jumping ability on the vertec in relation to the wall scale. Relative reliability of tests was assessed by intraclass correlation coefficient (ICC). Wall scale (WSCMJ) and vertec countermovement jump (VECMJ), and vertec approach jump – 2 leg takeoff (VEAJ-2L) have excellent relative reliability (ICC 95%CI >.90). Relative reliability of other tests: wall scale approach jump – 2 leg takeoff (WSAJ-2L) and

wall scale approach jump – 1 leg takeoff (WSAJ-1L) and vertec approach jump – 1 leg takeoff (VEAJ-1L) ranges from good to excellent (ICC 95%CI = 0.845 – 0.980).

To assess absolute reliability of the tests, standard error of measurement (SEM) was calculated. Standard error of measurement is somewhat smaller in wall scale and vertec countermovement jump tests and in the vertec approach jump – 2 leg takeoff, whereas the error is somewhat larger in tests wall scale approach jump – 2 leg takeoff and approach jump – 1 leg takeoff on both wall scale and vertec. For assessing sensitivity SEM was compared with smallest worth-while change (SWC), which was calculated in a way that the smallest worthwhile effect (0.2) was multiplied by the between subject SD (Batterham et.al., 2006). By comparing the values of SEM and SWC in Table 1, it can be seen that the wall scale and vertec countermovement jump tests, and the vertec approach jump – 2 leg takeoff have good sensitivity (SEM < SWC), whereas sensitivity of the other 3 tests is not satisfactory (SEM > SWC).

In Table 2, by applying the repeated measures ANOVA, the significance of differences between the items of tests assessing vertical jumping ability in female volleyball players was analyzed.

Table 2. Homogeneity of tests assessing vertical jumping ability in female volleyball players

	AM <sub>12</sub> SD <sub>1</sub>	AM <sub>22</sub> SD <sub>2</sub>	AM <sub>32</sub> SD <sub>3</sub>	F	p
WSCMJ	42.1±6.67	42.9±6.41	43.2±7.04	2.69	0.1
WSAJ-2L	46.5±6.52	46.5±7.48	47.1±6.58	0.26	0.76
WSAJ-1L	40.1±6.37	41.8±6.45	41.9±5.79	3.46	0.06
VECMJ	46.6±5.54	47.6±6.28	47.5±5.91	2.46	0.1
VEAJ-2L	53.3±6.67	54±5.87	53.5±5.53	1.26	0.29
VEAJ-1L	48.6±5.6	48.1±6.13	48.7±7.63	0.22	0.69

Legend: WSCMJ – wall scale countermovement jump, WSAJ-2L – wall scale approach jump – 2 leg takeoff, WSAJ-1L – wall scale approach jump – 1 leg takeoff, VECMJ – vertec countermovement jump, VEAJ-2L – vertec approach jump – 2 leg takeoff, VEAJ-1L – vertec approach jump – 1 leg takeoff, F-test – test value in testing significance of inter-item differences. p – significant difference at the level p≤0.05.

The lack of significant differences between test items indicates that there is no systematic bias of measurement. Good homogeneity of the tests is caused by the characteristics of the sample, which includes senior female volleyball players who have been using countermovement jumps and approach jumps from 2-leg takeoff for years during training and competition.

The analysis of variance between test items indicates that there is no fatigue effect either.

## Discussion

The comparison of mean values in tests measured by the wall scale and the vertec apparatus shows that female volleyball players had higher results in tests assessing vertical jumping ability on the vertec in relation to the wall scale, which indicates that the performance of jumping tests is more difficult on the wall scale.

Somewhat lower values of relative reliability (ICC = 0.89) in the vertec countermovement jump were obtained by Nuzzo et al. (2011) on a sample of university female volleyball players. Sattler et al. (2012), on a sample of senior male volleyball players, as well as Rodriguez-Rosell et al. (2017), on a sample of male soccer and basketball players of different age groups, found similar values of relative reliability in vertical jumping tests performed on an optojump device.

Similar values (SEM = 2.1 cm) were found by Nuzzo et al. (2012) in the countermovement jump test, whereas Rodriguez-Rosell et al. (2017) recorded somewhat lower values in test assessing countermovement jump, approach jump with 2 leg takeoff and approach jump with 1 leg takeoff, in relation to the values obtained in this study.

The comparison of values of SEM and SWC shows that three tests have good sensitivity (SEM < SWC), whereas sensitivity of the other 3 tests is not satisfactory (SEM > SWC).

Significant differences were not determined between test items, which indicates that there is no systematic bias of measurement which could be caused by, for example, learning or fatigue. Good homogeneity of the tests is probably partly caused by the characteristics of the sample, which includes senior female volleyball players who have been using countermovement jumps and approach jumps from 2-leg takeoff for years during training and competition. Nevertheless, the performance of jumping tests is somewhat different than the performance of those movement structures during volleyball training sessions and competitions. This primarily refers to the performance of the wall scale approach jump in which the approach angle is parallel to the wall, which is very different that the approach angle for spike in relation to the net, which is much more vertical. Moreover, jumps after a 1-leg takeoff are not often used and are usually only used by the players in middle hitter position. Considering all the above mentioned, good homogeneity of the tests is probably partly caused by the performance of several maximum trials of each test before the testing itself, which reduced the motor learning effect. The analysis of variance between test items indicates that there is no fatigue effect either, which is

probably due to good preparedness of the volleyball players who are used to performing a large number of jumps during training and competition, and partly due to the fact they were allowed to rest for a sufficient amount of time between different test items and between different tests.

Similar results were found by Nuzzo et al. (2011), Nuzzo et al. (2012), Sattler et al. (2012) and Rodriguez-Rosell et al. (2017).

## Conclusion

Absolute and relative reliability, along with sensitivity and homogeneity, of the most commonly used tests for assessing vertical jumping ability in volleyball were analyzed in this study. Relative reliability of all test ranges from good to excellent. Homogeneity of all tests is good, which confirms the lack of the systematic bias. However, somewhat lower values of relative and absolute reliability and unsatisfactory sensitivity of the tests assessing wall scale and vertec approach jump – 1 leg takeoff, and wall scale approach jump – 2 leg takeoff indicate that the results of these tests should be interpreted with caution. Female volleyball players achieved 5-7 cm higher results in vertec tests, as compared to the wall scale tests, thus, the results obtained by these different methods of testing should not be compared.

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## DIFFERENCES IN THE TREND LINE OF TOP 100-M DASH RESULTS IN ATHLETES WITH DIFFERENT DEGREES OF VISION IMPAIRMENT

Saša Milovuković<sup>1</sup>, Vedran Budetić<sup>2</sup>, Branimir Budetić<sup>3</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>School of Applied Arts and Design Osijek, Croatia

<sup>3</sup>City of Zagreb, City office for sport and youth, Croatia

### Abstract

A characteristic of Paralympic sport is that athletes compete in categories determined on the basis of physical impairment. The aim of this research was to analyze the eight best 100-m run results in the world during 17 years of competition, to determine the differences in the trend of development of results between sprinters with different degree of vision impairment. The sample of entities consisted of the competition years from 2003 to 2019, represented by eight variables representing the eight fastest times in the world rankings. The variables were reduced and condensed into four variables: first and eighth place, and the average and standard deviation of the first eight places. Analysis of graphs with trend lines of competition results on these four variables revealed the expected lower consistency of results during 17 years of competition, as well as lower consistency between first to eighth place results within each year in visually impaired sprinters, compared to non-disabled sprinters. However, the consistency of the results is significantly higher in visually impaired sprinters of category T12 (greater visual impairment) than in T13 (minor visual impairment). The reason could lie in the fact that T12 sprinters (as opposed to T13 sprinters) are entitled to an assistant who guides them to the track, gives them additional instructions, and optionally, they even run alongside them.

**Key words:** Paralympics, visual impairment, sprint, 100-m race

### Introduction

Sport provides people with disabilities with numerous opportunities to achieve physical, social, and mental well-being (Blauwet & Willick, 2014; McVeigh et al., 2019; Groff et al., 2019). The Paralympic Games are the most elite sporting event for athletes with disabilities within which athletics is the most massive sport. Comparable to the Olympic Games, in Paralympic competitions, the sprint races (i.e., 100- and 200-m dash) attract much attention, being considered the most prestigious events across all track and field modalities (Pereira et al., 2016). Visually impaired athletes, apart from visual impairment, do not have any physical defects, but the times achieved are not in line with the Olympic results of the same disciplines (Budetić, 2017). The athletic rules system is the same for athletes with and without disabilities, with a few exceptions. One of them is that highly visually impaired athletes of the T12 category use an escort that allows them to move and position themselves on the arena, and guides them verbally during sports performance, and run along with them, if athletes with disabilities require that (IPC, 2015). Sprinters with visual impairment compete in 3 categories: T11 (a person who does not have a sense of sight in the better eye to a weak sense of light (palm recognition up to 25 cm)), T12 (ability to recognize the shape of the palm and visual acuity of 2/602 with or without visual fields less than 5 degrees in the better eye) and T13 (range of visual acuity is between 2/60 - 6/60 with or without field of view in the range of 5 - 20 degrees in the better eye) In this research, the results of athletes with visual impairments of categories T12 and T13 in the discipline of running at 100 meters will be processed, and the results of top sprinters without disabilities will be taken as reference results. The aim of the research is to analyze the eight best results of top visually impaired sprinter runners during 17 years of competition to determine the differences in the development trend of the achieved times in the 100m race.

### Methods

The entities in this study were the competition years from 2003 to 2019, ie 17 years of competition in the 100 m running for visually impaired and non-disabled athletes. A total of 51 years were analyzed, i.e. the same 17 years of competition analyzed for each category of athletes. The variables make the first eight places on the world ranking list in the 100 m running for visually impaired athletes of categories T13 and T12, and athletes without disabilities. There are a total of eight variables (one place won = one variable), and the results in the variables are displayed in seconds. The

results in the first variable represent the fastest time in the world in certain years, while the results in the eighth variable represent the eighth best time in the world in those same years. The variables are inversely scaled; hence lower scores represent better scores. In order to reduce the amount of less useful information of this battery of variables, and keep the more useful ones, the variables have been reduced and condensed to half a smaller number:

- 1<sup>th</sup>-PLACE - the maximum value of the battery of variables, which in this study is identical to the first variable, which represents the fastest time in the world during the observed series of years;
- 8<sup>th</sup>-PLACE - the minimum value of the battery of variables, which in this study is identical to the eighth variable, which represents the eighth fastest time in the world over the observed series of years;
- 1-8 MEAN - arithmetic mean of the eight best results in the world; 1-8 SD - the standard deviation of the eight best results in the world.
- 1-8 SD - standard deviation of the eight best results in the world.

For each condensed and reduced variable and separately for each category, the basic statistical parameters (arithmetic mean, standard deviation, minimum, maximum) were calculated, and the variables were graphically represented by the trend line of the results development. The results were processed by Microsoft Excel 2017.

## Results

Table 1 shows the basic statistical parameters of the condensed variables 1st - 8th place and the test of normality of distributions for each category separately. The column indicating the minimum result (Min) represents the best result in the 100 m run during 17 years of competition. For the variable 1<sup>th</sup>-PLACE, the parameter Min indicates the best seasonal record during 17 years of competition (hence the world record), while for the variable 8<sup>th</sup>-PLACE it represents the best running eighth time in the world in the observed years of competition. For the 1<sup>th</sup>-PLACE variable, the Max parameter indicates the worst seasonal record during the observed 17 years of competition. The table is similarly read for other variables and other parameters.

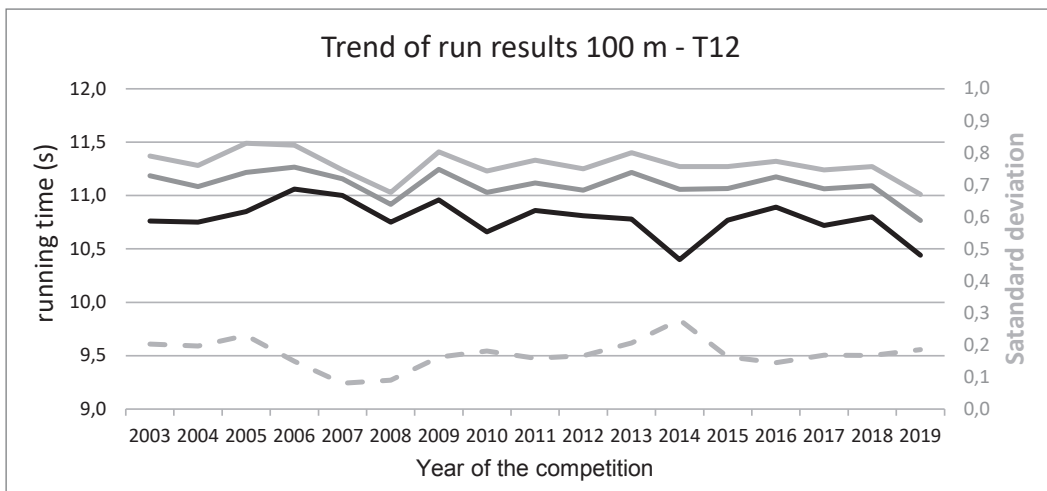
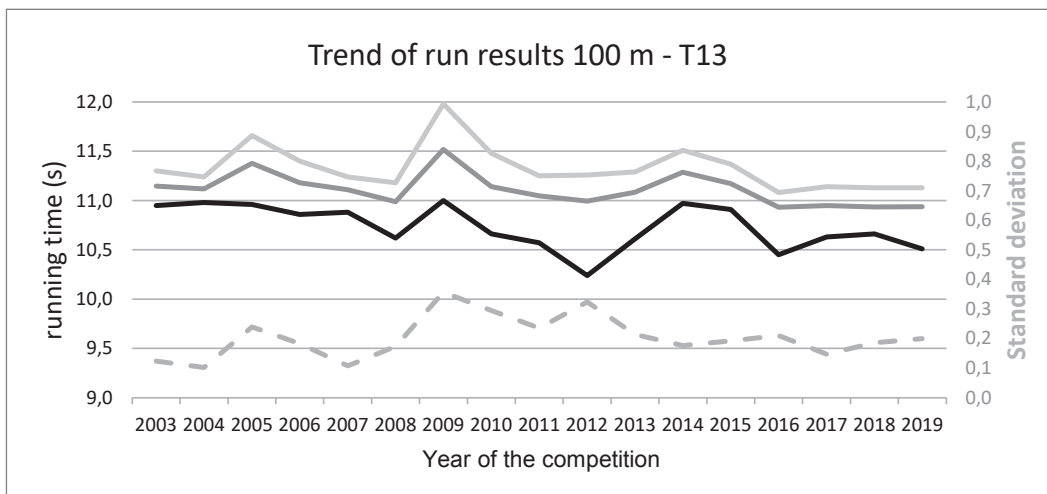
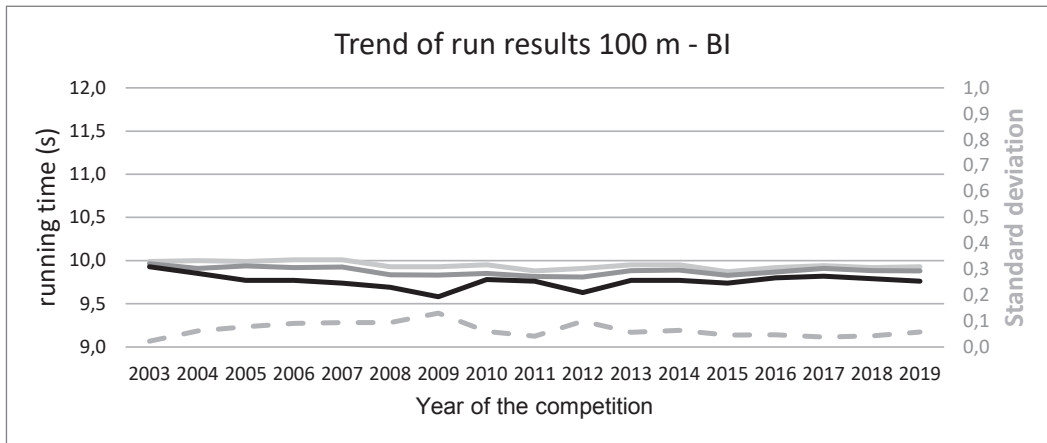
Table 1

Athlete category	Condensed and reduced variables	Min	Max	AS	SD	S-W
<b>BI</b>	1 <sup>th</sup> -PLACE	9,58	9,93	9,76	0,08	p = 0,14
	8 <sup>th</sup> -PLACE	9,87	10,01	9,95	0,04	p = 0,31
	1-8 MEAN	9,81	9,96	9,88	0,04	p = 0,64
	1-8 SD	0,02	0,13	0,07	0,03	p = 0,34
<b>T13</b>	1 <sup>th</sup> -PLACE	10,24	11,00	10,73	0,22	p = 0,09
	8 <sup>th</sup> -PLACE	11,08	11,98	11,33	0,22	p = 0,01*
	1-8 MEAN	10,93	11,52	11,11	0,17	p = 0,08
	1-8 SD	0,1	0,36	0,20	0,07	p = 0,40
<b>T12</b>	1 <sup>th</sup> -PLACE	10,40	11,06	10,78	0,17	p = 0,15
	8 <sup>th</sup> -PLACE	11,01	11,49	11,29	0,13	p = 0,12
	1-8 MEAN	10,77	11,27	11,10	0,12	p = 0,10
	1-8 SD	0,08	0,28	0,17	0,05	p = 0,31

Basic statistical parameters and Shapiro-Wilk distribution normality test of reduced and condensed variables of the first to eighth place from 2003 to 2019 for sprinters without disability (BI), and sprinters with impaired vision of categories T13 and T12.

Graphs 1, 2 and 3 show the trend lines of the results in the 100 m run from 2003 to 20019, the reduced and condensed eight best results in the world for athletes without disabilities (Graph 1), and visually impaired athletes with less visual impairment. (graph 2) and greater visual impairment (graph 3).





Graph 1, 2 and 3: trend of development of results in 100 m running in top sprinters without disabilities (BI) and visually impaired sprinters of category T13 and T12; [upper, solid, lighter graph line = 8th-PLACE]; [medium, solid graph line = 1-8 MEAN]; [bottom, solid, black graph line = 1th-PLACE]; [lower dashed graph line = 1-8 SD]

## Discussion

Although the trend lines of the top eight results of visually impaired sprinters in the world have a downward trajectory (inversely scaled variables) like the trend line of sprinters without disabilities, the latter show (Graph 1) very high consistency in results during all observed 17 years of competition and within all eight best positions. in the world. The range of all results is within two to three tenths of a second, with two local lows, in 2009 when the world record was set (9.58 s) and in 2012, which deviated significantly from the average of all eight positions and thus created two local highs on the dashed trend line of the standard deviation of the same group of athletes. In visually impaired sprinters, the ripple

of sports form in the Paralympic cycles is more noticeable (Graphs 2 and 3), and is characterized by a slight progression of results in the pre-Paralympic years and the Paralympic year, followed by a sudden regression in the post-Paralympic year. In 2009, when Usain Bolt broke the world record, all top Paralympians followed the standard ripple curve of sports form (post-Olympic year), emphasizing that all top T13 sprinters that year recorded the worst results in the observed 17 years of competition. It can be seen from Table 1 that T12 sprinters are better than T13 sprinters in six of the nine running time parameters, although this difference is minimal. However, the variation of results (standard deviation) within a position during 17 years of competition, as well as within the first to eighth place within a year is less in athletes with greater visual impairment (T12), which means that their results are more consistent.

Athletes of category T13 have a slightly higher visual perception of the environment around them. The Paralympic Federation believes that T13 athletes have so much better eyesight than T12 athletes that according to the rules, they are not entitled to an assistant who will bring them to the track, and give them additional guidance and instructions on the track. From the above, it was to be expected that the trend lines of the first eight best results in the world in the 100-meter run will be more stable and consistent in visually impaired T13 athletes than in T12 athletes, however, Table 1 and the presented graphs show that the thesis is not confirmed.

What factors influence that T13 athletes who have less visual impairment have such inconsistency in results, as opposed to T12 athletes who see worse, is a big question that arises from the presented results. Potential answers could be found in the fact that the assistant who helps the T12 sprinter get to the track, where he gives him additional guidance and guidance potentially perhaps means a lot more than the slightly better eyesight that T13 sprinters have. On the other hand, it is known that adverse weather conditions during competition such as heat also significantly affect the competitive result in athletic disciplines of running on medium and long distances (Suping et al., 1992). So it would be interesting to investigate whether, for example, extreme heat, rain or cold affect the results in visually impaired athletes, and further research should certainly be aimed in this direction.

## Conclusion

An analysis of the results of the world rankings of sprinters without disabilities and visually impaired sprinters in categories T13 and T12 showed that the best results followed the trend of major international competitions, world championships and Paralympic Games, which shows that international competitions are a great motivation for athletes with disabilities. When we compare the results of sprinters of varying degrees of visual impairment, we notice that sprinters with greater visual impairment (T12) achieve better, more stable and consistent top results in the world in 100 m running, as opposed to visually impaired sprinters with less visual impairment (T13). The reason could lie in the fact that T12 sprinters (as opposed to T13 sprinters) are entitled to an assistant who guides them to the track, gives them additional instructions, and optionally, they even run alongside them.

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## DIFFICULTY VALUES IN MEN'S ARTISTIC GYMNASTICS AT 2019 EUROPEAN AND WORLD CHAMPIONSHIPS

**Marijo Možnik, Tomislav Krističević, Lucija Milčić**

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

The aim of this study was to find the differences in D-score values between European and World Championships. The research was conducted on a sample of 48 gymnasts, best eight D-scores from qualifications for the men's event final competition. D-scores were observed from the official results of 49<sup>th</sup> FIG Artistic Gymnastics World Championships – Stuttgart, 2019 and the 8<sup>th</sup> European Championships – Szczecin, 2019. Statistica 12 was used for data analysis. Basic descriptive parameters, normality of distribution – KS test was calculated for all variables. The differences in D-score between European and World Championship individual finals on all apparatus was determined by T-test. The vault and horizontal bar are the statistical significance apparatus in World and European Championships in favor on the World Championship. On these apparatuses to qualify for the World Championships finals gymnasts should have significantly stronger D-score than at Europeans Championships.

*Key words: judging, top-level gymnastics, D-score, European Championships, World Championships, start value*

### Introduction

Men's artistic gymnastics consisted of six apparatus: floor exercises, pommel horse, rings, vault, parallel bars, and horizontal bar. Each exercise is composed of Difficulty value (D-score) and Execution score (E-score). D-score included elements which have values, and they are added in the exercises by rules and gymnast choose the best elements that can perform at the competition. Different levels of competitions differ gymnast by its quality of execution. There is a small investigation based on differences between competition, start value which is important in periodization of training and concentration on difference between apparatus in European and World level. The main problem in artistic gymnastics is changing the rules every four years, which effect on composing the exercises were in the last period the D-score is growing rapidly, and gymnast tends to perform the highest value elements from the FIG Code of Points. Accordingly, it is important to track and investigated where is the difference (championships and apparatus). As the rules have been changed through history, the calculation of the final score passed many changes. Proportions of D-score and E-score on some apparatus are above 70% (pommel horse, horizontal bar), although in the FIG Code of Points (2009-2013) state that exercises presentation is much more important than the difficulty (Čuk, Fink, Leskošek, 2012). As the rules are changing every Olympic Cycle the D-score for the qualification at competition start to be in the first place when coaches and gymnasts preparing an exercise. Leskošek, Čuk, & Pajek (2013) investigated trends in E-score and D-score of exercises on all apparatus in qualifications and finals of male European Championships before and during a 5-year period after the introduction of new "open-ended" Code of Points in 2006. Čuk and Atiković (2009) tested the equality between disciplines at the Olympic Games 2008. Equality in apparatus in all-around has not been equal in D-score. Čuk & Forbes (2014) tested difficulty scores in relation to the success in all-around competition at the 2009 European Championships.

Floor exercise and horizontal bar are the riskiest apparatus (Čuk, Fink & Leskošek, 2012), which means that small mistake in the exercise can change D but also E-score dramatically. If the gymnast does not perform any element by rules, judges will not take into D-score, so the start value will be lowered. The similar thing will be happening when gymnast makes mistakes or fall from the apparatus, E-score will be low, and at the end the final score will be lower. Román, et al., (2010) investigated the difficulty of floor exercises and influence on the final score at the Olympic Games in Beijing (2008) and conducted that D-score does not predict final score, except E-score. As the rules are changing every Olympic Cycle, depended on competition and trends on apparatus there will be differences in D and E-score.

The aim of this study was to find the differences in D-score values between European and World Championships.

## Methods

The research was conducted on a sample of 48 gymnasts, best eight D-scores from qualifications for the men's event final competition. D-scores were observed from the official results of 49<sup>th</sup> FIG Artistic Gymnastics World Championships – Stuttgart, 2019 and the 8<sup>th</sup> European Championships – Szczecin, 2019. D-score or start value of the exercise of each apparatus was taken into analyses. A sample of variables which have been used in this study are: European Championships floor exercises (ECF), World Championships floor exercises (WCF), European Championships pommel horse (ECPH), World Championships pommel horse (WCPH), European Championships rings (ECR), World Championships rings (WCR), European Championships vault (ECV), World Championships vault (WCV), European Championships parallel bars (ECPB), World Championships parallel bars (WCPB), European Championships horizontal bar (ECHB), World Championships horizontal bar (WCHB). Statistica 12 was used for data analysis. Basic descriptive parameters, normality of distribution – KS test was calculated for all variables. The differences in D-score between European and World championship on individual finals on all apparatus was determined by T-test.

## Results

Basic descriptive statistics results are shown in the Table 1.

Table 1. Descriptive Statistics

Variable	Valid N	Mean	Minimum	Maximum	Std.Dev.
ECF	8	6,15	5,90	6,5	0,23
WCF	8	6,30	6,10	6,5	0,17
ECPH	8	6,08	5,60	6,8	0,35
WCPH	8	6,26	6,00	6,9	0,30
ECR	8	6,13	6,00	6,4	0,15
WCR	8	6,16	6,00	6,3	0,11
ECV	8	5,43	5,00	5,6	0,23
WCV	8	5,65	5,40	6,0	0,19
ECPB	8	6,24	5,90	6,5	0,18
WCPB	8	6,35	6,20	6,6	0,16
ECHB	8	5,83	5,60	6,2	0,20
WCHB	8	6,18	6,00	6,5	0,17

Note: Valid N – number of gymnasts on each apparatus, Mean– average values; Minimum – minimum values; Maximum – maximum values; Std.Dev.- Standard Deviation.

Results of T-test are shown in the Table 2.

Table 2. T-test for Independent Samples

Group 1 vs. Group 2	Mean Group 1	Mean Group 2	t-value	df	p	Valid N Group 1	Valid N Group 2	Std.Dev. Group 1	Std.Dev. Group 2	F-ratio Variances	p Variances
ECF vs. WCF	6,15	6,30	-1,50	14	0,16	8	8	0,23	0,17	1,80	0,46
ECPH vs. WCPH	6,08	6,26	-1,14	14	0,27	8	8	0,35	0,30	1,37	0,69
ECR vs. WCR	6,13	6,16	-0,58	14	0,57	8	8	0,15	0,11	1,97	0,39
ECV vs. WCV	5,43	5,65	-2,18	14	0,05	8	8	0,23	0,19	1,48	0,62*
ECPB vs. WCPB	6,24	6,35	-1,30	14	0,21	8	8	0,18	0,16	1,33	0,72
ECHB vs. WCHB	5,83	6,18	-3,82	14	0,00	8	8	0,20	0,17	1,41	0,66*

Note: \*= statistically significant value,  $p < 0,05$

## Discussion

EG<sup>1</sup> in their memberships gathers 50 countries from Europe. Considering that FIG<sup>2</sup> has a total of 152 member countries, with 1/3 countries Europe is the biggest continent represented in global gymnastics. It is also the continent with the most countries that has highly developed artistic gymnastics on the top-level, comparing to the other continents. Therefore, European Championships is the most important gymnastics championships in Europe, where all countries send their best national gymnasts to compete, very often the same gymnasts as they send to the World Championships. For the gymnasts from Europe, European Championships finals and medals are more valuable comparing to the same results achieved at the World Cup or World Challenge Cup competition in gymnastics. This research was conducted on results from 2019 European Championships in Szczecin (Poland) held in April and 2019 World Championships in Stuttgart (Germany) held in October.

The final score of the gymnasts is a sum of D-score and E-score. D-score (Difficulty score) is very important to achieve top-level results such as qualifying for the finals at European and World Championships. For example, proportions of D-score and E-score on some apparatus are above 70% (pommel horse, horizontal bar) (Čuk, Fink, Leskošek, 2012). E-score (execution score) needs to be as high as possible, and the highest possible E-score is 10,000. The D-score doesn't have a limit, so for the elite gymnasts it is important to achieve D-score high enough to be competitive for the finals and medals, individual and all-around. Importance of D-scores in all-around finals were presented in research of 2009 European Championships, where it is concluded that with D-score only we can predict 84% of all-around final score (Čuk & Forbes, 2014).

The results showed there is a difference on each apparatus between D-score comparing 2019 European and 2019 World Championships. Logically, on each apparatus D-score on World Championships was slightly higher than on the European Championships. After introducing new open-ended rules in 2006 it is indicated the increase in D-scores itself, while the E-scores were generally decreased (Leskošek, Čuk, & Pajek, 2013). Although, Čuk and Atiković (2009) concluded that in all-around competition the results from the 2008 Olympic Games shows that the vault has the highest D-score, and the pommel horse has the smallest D-score. Obviously, the size of the difference between D-scores are not the same at each apparatus. Thus, the quality of gymnastics is not the same and with the results of these researches we can consider which apparatus is more "European" than others, compared to Worlds. If we compare the size of the difference, rings seem to be mostly "European" apparatus, where the D-score was almost the same on both competitions. The difference was larger, in turn, on pommel horse, parallel bars and floor, while the D-scores on vault and horizontal bar had the biggest and statistically significant difference between European and World Championships. Obviously, the vault and the horizontal bar are apparatus that is, in accordance with D-scores, "stronger" on other continents than Europe, compared to the other apparatus. Or we could say, gymnasts with D-scores which was enough to qualify for the finals at the European Championships on pommel horse, parallel bars and floor, had a greater chance to get to the finals at the World Championships than gymnast on the vault and horizontal bar, if they performed the same D-score on both competitions. Gymnasts on vault and horizontal bar should perform a routine with the higher D-score because there is a lot of gymnast with higher D-score on a global level, which pretended to the World Championships finals. At European Championship 2009 the highest prediction of the all-around score has the parallel bar D-score (Čuk & Forbes, 2014).

There are other factors at the competition that also can change D and E-score. Variability in the D and E-score are existed in judging and depend on quality of judging, competition season, seat position of judges, angle of view and other subjective and objective factors (Leskošek, et al., 2010). Anyway, the bigger variability we could find in the E-score because the D-score in men's artistic gymnastics is more objective than E-score and there is less possibility to make a judge's mistake.

## Conclusion

We can conclude that horizontal bar and vault are the apparatus which statistically significantly differ European Championships form World Championships in D-score. Those are two apparatus where if gymnasts want to compete at the World Championships finals must have higher start value than for the European Championships. It means that World gymnasts are better than gymnasts compete at the European Championships. Also, it says that competitors at World Championships have more difficult exercises at that two apparatus. This could be reason in specialization, training methods and conditions of training.

<sup>1</sup> European Gymnastics

<sup>2</sup> Federation Internationale de Gymnastique



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## GOALKEEPER ACTIVITY AND EFFICIENCY IN FUTSAL

Tihana Nemčić

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

*Introduction/purpose:* the purpose of this paper is to determine goalkeepers' activity structure and efficiency, based on the observations of Croatian first division futsal matches in the 2015/16 season. The *methods* used in this study for data collection were: notational analysis to source the data and later on descriptive statistics to evaluate the data; the spearman correlation coefficient was applied in order to determine the correlation of goalkeepers' saves with their teams' final competition standing. The entities were goalkeepers, while the variables tracked were goalkeepers' saves and their efficiency, as well as types of saves and ball distribution. *Results* showed that goalkeepers perform on average  $13.13 \pm 5.8$  saves during a futsal match, and their efficiency is on average 79.6%. Number of goalkeepers' saves is not a variable that impacts teams regarding their competition standing. Goalkeepers perform most saves inside their penalty area (63%), and they distribute the ball most often to their team players (85%). *Conclusion:* due to the majority of events occurring in close proximity to the goals, teams simultaneously have chances of scoring and are in danger of having goals scored against them, which makes the position of a goalkeeper highly important. Further study is needed to evaluate goalkeepers' actions, by determining the behavior of entire teams which greatly impacts goalkeepers' actions, saves and their efficiency.

*Key words:* futsal, efficiency, goalkeepers

### Introduction

The game of futsal is characterized with constant turnovers and proximity of the opponent provoked by the pitch size (Vaeyens et al., 2007). The progress in results in futsal championships over the years indicates an increase in demands and dynamics of the game, which can be easily explained with offensive and defensive tactical development, using „four in line“ tactical system more while attacking and pressuring in all parts of the court while defending. As a result, greater distances are covered. Distance covered and performance intensity in futsal are affected by the tactical plan and the system of the game (Castagna et al., 2009). Due to the high dynamics of the game, provoked by the court size and constant turnovers and proximity of the opponent, great number of actions towards both goals occur. Since there are constant shifts from the defensive to the offensive phase, and vice versa, performance indicators that are taken into consideration when describing the structure of the activity in futsal refers to the number of shots on the goal and their efficiency, as well as the most common ways of attacking. Regardless of the difference in quality between the teams, both sides will inevitably produce chances. One of the most important indicators that differentiate winning teams from losing teams is the number of scored/received goals. However, winning teams score more goals in general (Neyah et al., 2016), and they need less shots on goal to win, which makes them more efficient. The average number of goals scored in futsal is 4.5 (Neyah et al., 2016; Souares Leite, 2012; Irokawa et al., 2010; Silva et al., 2004). Abdel- Hakim (2014) showed that winning teams have more shots, they score more goals and they are more efficient ( $p < 0.05$ ) than the losing teams. Regarding the efficiency measurements, the study of Souares Leite (2012) showed that of total number of shots on goal, 33.53% were blocked or taken by the opponent, 23.35% were off target, 2.20% were stopped by the goal frame and 32.94% were saved by the goalkeepers. Futsal is an absolutely unpredictable game and we cannot always determine which team will win, or even claim that the team with more positive performance indicators will win. The final score in a futsal match very often depends on efficiency of attack, or defence, and the quality of attacking plays (Souares Leite, 2012). With that in mind, the goalkeeper in futsal plays an extremely important role. While in the defensive phase of the game the goalkeeper tries to prevent the opponent from scoring, in the offensive phase he is the first attacker, providing precise throws and constructive passes in the build-up. In both cases, the goalkeeper should provide his team with security and confidence. Oszmanlec and Szwarc (2016) showed in their research that in the attacking phase, futsal goalkeepers mostly perform actions by passing with their feet. In defence, most of their actions prevent the opponent from scoring by pushing the ball away with their hands. The purpose of this research is to determine the actions and efficiency of futsal goalkeepers.

## Methods

### Materials

This research has been made from a sample of fifty (50) Croatian first division futsal matches in the 2015/16 season. 12 teams competing in a double-round format competition: FC Nacional, MNK Split Tommy, MNK Futsal Dinamo, MNK Vrgorac, MNK Uspinjača, MNK Square, MNK Potpićan '98, MNK Solin, MNK Osijek Kelme, MNK Novo Vrijeme, MNK Alumnus i MNK Murter. Each team has been analysed between a minimum of seven and maximum ten times.

### Entities

In keeping commensurate with the aim of this research, the entities were goalkeepers and their activities and efficiency in the technical/tactical elements during the futsal match.

### Variables

For monitoring, analysis and evaluation of goalkeepers' performance, the following variables have been noted: goalkeepers' saves (a moment during the match in which a goalkeeper performs an action like catching, boxing or transferring the ball); goalkeepers' efficiency (the ratio of the goalkeeper's saves to the number of shots on target by the opposition); the structure of goalkeepers' saves and the outcome of goalkeepers' ball distribution.

### Data collection

Data has been collected from the sample of Croatian first division futsal matches (50) in the 2015/16 season. Matches have been recorded on HDD/DVD.

### Statistics

Descriptive statistics have been used to describe goalkeepers' actions and their efficiency during the match. Arithmetic means, standard deviations, minimum and maximum results have been calculated for goalkeepers' saves, while the Spearman correlation coefficient has been applied in order to determine the correlation of goalkeepers' saves to teams' final competition standings.

## Results

In table 1 descriptive parameters for goalkeepers' saves are shown.

Table 1. Descriptive parameters for goalkeepers' saves: minimum (MIN), maximum (MAX), arithmetic mean (MEAN), standard deviation (SD)

Variable measured	MIN	MAX	MEAN	SD
GK	2	29	13,13	5,80

Legend: GK – goalkeepers' saves

Final positions of the teams on the league table at the end of the regular part of the season (without play-offs), with number of points allocated per team (12 points- first team, 1 point- last team), values of average goalkeepers' saves per team, and the correlation of goalkeepers' saves to teams' final competition standings have been shown in table 2. Shown in table 3 are the efficiency coefficients expressed in percentages as goalkeepers' saves ratio to shots on goal by the opposition. In figure 1 the patterns of goalkeepers' saves with regards to their positioning and performed actions are presented, as well as the structure of goalkeepers' ball distribution (figure 2).

Table 2. Final positions of the teams on the league table at the end of the regular part of the season (without play-offs); with number of points (P) allocated, values of average goalkeepers' saves per team (meanGS), and correlation coefficient (r) of goalkeepers' saves to teams' final competition standings.

P	Team	E (%)
12	Nacional	75,6
11	Split Tommy	88,4
10	Dinamo Futsal	89,2
9	Vrgorac	83,3
8	Uspinjača	76
7	Square	82,9
6	Potpican '98	75,6
5	Solin	84,3
4	Osijek Kelme	72,7
3	Novo Vrijeme	70,8
2	Alumnus	81,7
1	Murter	74,7

Table 3. Final positions of the teams on the league table at the end of the regular part of the season (without play-offs); with number of points (P) allocated, and efficiency coefficients (E%) expressed in percentages.

P	Team	meanGS
12	Nacional	15,8
11	Split Tommy	17,5
10	Futsal Dinamo	13,0
9	Vrgorac	15,8
8	Uspinjača	12,3
7	Square	11,0
6	Potpican '98	14,3
5	Solin	9,0
4	Osijek Kelme	11,8
3	Novo Vrijeme	17,3
2	Alumnus	6,5
1	Murter	13,3
R		0,430

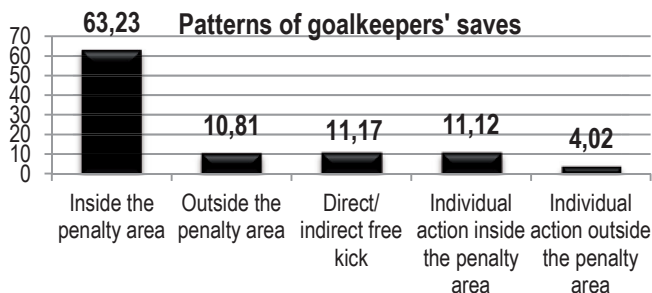


Figure 1. Patterns of goalkeepers' saves with regards to their positioning and performed actions showed in percentages (%)

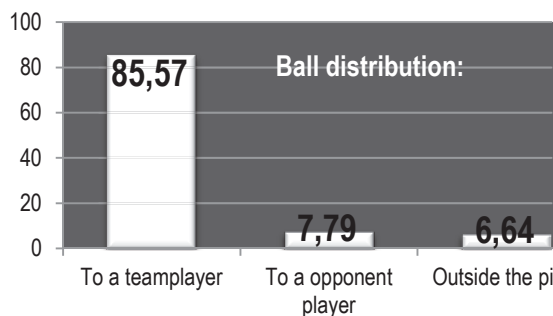


Figure 2. Structure of goalkeepers' ball distribution regarding the outcome, showed in percentages (%)

Results showed that goalkeepers perform on average  $13.13 \pm 5.8$  saves during a futsal match, with a minimum of 2 saves and a maximum of 29 saves per goalkeeper during a match. Most saves per match have been found for 2<sup>nd</sup> placed team Split Tommy (17.5 saves on average) and for 10<sup>th</sup> placed team Novo Vrijeme (17.3). 1<sup>st</sup> placed team Nacional had an average of 15.8 saves per game, the same as 4<sup>th</sup> placed team Vrgorac. The second from bottom team Alumnus had the least saves (6.5), but according to the correlation coefficient for goalkeepers' saves with final competition standing ( $r = 0,430$ ), it has been shown that the number of goalkeepers' saves is not a variable that influences teams' standings on the competition table.

## Discussion

The most successful teams regarding goalkeepers' efficiency are the 2<sup>nd</sup> and 3<sup>rd</sup> placed teams, Split Tommy and Futsal Dinamo which indicates the goalkeeper's quality as well as the quality of the entire team, since team's behaviour influences and potentially makes it easier for a goalkeeper to react better. Futsal Dinamo shows the highest goalkeepers' saves efficiency. This indicates a high level of the team's performance in the defensive phase. Novo Vrijeme as the 10<sup>th</sup> placed team, has the highest number of average goalkeepers' saves, but the lowest efficiency coefficient. This data indicates a great number of shots taken by the opponent, between 40 and 67 shots per game shown in the studies of Souares Leite (2012); Irokawa et al. (2010); Silva et al. (2004), and potentially a low level of team performance in the defensive phase. Alumnus, the team with the smallest number of saves, shows above average goalkeepers' efficiency, which indicates a potentially good defensive performance. Goalkeepers perform most saves inside their penalty area, which is expected since it is the space where they can use their hands. Furthermore, most attacks finish in that space, most often after counterattacks and set pieces (Souares Leite, 2012). The same percentage of goalkeepers' saves were calculated for: direct and indirect free kicks; individual actions inside the penalty area and shots from outside the penalty area. The outcomes of the direct and indirect free kicks are often blocked by defensive players. Due to the small space

and the constant proximity of the opponent, there is a smaller number of situations where the attacking player is alone in a 1vs1 situation with the goalkeeper in the penalty area. An even rarer situation is an attacking player in a 1vs1 situation with the goalkeeper outside the penalty area, which can be seen from the smallest percentage of these type of saves. A goalkeeper leaves his area when his team players transition to defence too slowly and the goalkeeper estimates the situation as dangerous. In that situation his best solution is intercepting the ball, kicking the ball away, or going out to block and/or to minimise the angle for the player with the ball. In possession, goalkeepers' high pass completion of 85% enables build-up play and further possession. A goalkeepers' technique is very important in futsal because many times he represents the fifth player on the field, despite being permitted one action with the ball per team possession. A smaller number of passes are directed *to the opponent* and *out of play*. Instead, goalkeepers mostly perform actions with aim to keep the ball possession passing it to a teammate with a foot from the ground (Ozmanlec and Szwarc, 2016) and keeping the possession after receiving the ball from a teammate. The importance of goalkeepers having good technique with their feet can be crucial in: overcoming a high pressing opposition, counterattack development or finishing with a long pass to the pivot. Despite the rule that a goalkeeper is permitted one action with the ball per team possession, the quality of goalkeepers' passing and receiving is important to continue the actions started by teammates.

## Conclusion

The number of goalkeepers' saves is not a variable that differentiates teams regarding their standing in the competition table. Further investigation on teams' behaviour in the defensive and offensive phases is needed, in order to give a more precise evaluation on team standings in the competition table. Goalkeepers' saves most often occur inside their penalty area, while saves in 1vs1 situations with the goalkeeper outside the penalty area are negligible. In possession, goalkeepers have a high pass completion, enabling development of the attacking phase.

## Acknowledgement

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## BODY COMPOSITON EVOLUTION OF ROMANIAN PROFESSIONAL RUGBY PLAYERS – FORWARDS

Alexandru Oprean, Marin Chirazi, Rares-Alexandru Puni

Alexandru Ioan Cuza University of Iasi, Romania

### Abstract

The evolution of the rugby game in recent years in Romania, has brought with it the need for updating to the morphological and functional specificity of the players. Knowledge of the somatic profile and adapting it to the game requirements, will surely determine a performance improvement. The purpose of this study is to highlight the evolution of some morphological particularities of the players from the forwards compartment, within a four yare range. The hypothesis in this study is that the average body composition improves in the direction of a higher lean mass amount related to the progression of speed and power in the rugby game. The study was conducted in preseason of 2015-2016 Romanian first league and again in preseason of 2019-2020. The study was conducted on 12 forwards activating in the first Romanian rugby league. The body composition of forwards ranges within the standards generated by similar studies. The tested props present the poorest results on body composition, although they improve the results within four years.

**Key words:** *body fat, lean mass, sport*

### Introduction

In the recent period, rugby has evolved considerably worldwide and nationwide. The restructuring of the first Romanian rugby league and the flow of foreign players have generated a rapid increase in the training level of professional players. In order to maintain a high level of the rugby game, the players of the first Romanian league have to meet the technical, tactical and functional somatic requirements. By the nature of its complexity, rugby requires intensely multiple energetic resources from athletes. In this respect, optimizing the level of these resources conditions their performance level.

In scientific literature, there are several studies (*Drăgan, 2002; Duthie et al, 2006; Gabbett, 2005; Gabbett, 2002; Hind et. al. 2015; Oprean, 2014*) regarding the physical training level and the somatic profile of rugby players, mostly in the countries with tradition in this respect. In Romania, this topic has been approached increasingly in the recent years, considering the increased of the first rugby league players.

The topic of this study concerns the relationships between the power manifested by the rugby players and their body composition particularities. This study regards only the rugby forwards, a category presented per positions, as follows:

- The forwards category, which comprises 8 players:
  - *front row* – made of two props and a hooker;
  - *second row* – made of two locks;
  - *back row* – made of two flankers and a number-8.

We have chosen to study each category because the very different tasks and loads generate highly distinct somatic and functional profiles. This phenomenon also emerges for positions within the same category, but on a different scale.

**The purpose** of this study is to highlight the evolution of some morphological particularities of the players from the forwards compartment, within a four yare range. This study is meant to complete previous studies conducted by the authors. In the period 2008-2020, the authors analysed the morphological and functional characteristics of first-league rugby players. (*Oprean, 2014; Oprean 2020*)

**Hypothesis** – in this study, we have started from the following premises:

The body fat index decreased within the four year range, as the players developed speed and power capacities, ranging within the standards generated by similar studies.

## Material and methods

The study was conducted during the 2015-2016 pre-season and again in 2019-2020 on the same players. The athletes within our research are part of different teams in the first Romanian league. The first and second tests were conducted on more than 20 forwards in both occasions, but only 12 participated in both tests.

The morphological tests were performed using bioelectrical impedance analysis, namely "Omron BF 511" (<http://www.omron-healthcare.com/en/products/weightmanagement>) and they consisted in the following:

- total body mass
- body mass index
- body fat percentage
- lean mass percentage

Paired-Samples T-Test, for the four tests between the two sets of tests. Concerning the comparison between groups, in each particular test, the results are presented as follows.

The significance level for all analyses was set at  $p < 0.05$ .

The data in the Tables below are expressed as mean  $\pm$  STDEV (standard deviation).

## Results and discussions

The research results were included in tables; we calculated arithmetic mean and standard deviation for all forwards positions.

Figure 1 features the results of morphological measurements of the athletes studied in 2015. The average total body mass of players fits the profile of forwards (110.9kg 10.6.) (Duthie et al., 2006) Body mass index is large for non-athlete population, but it does not exceed the normal limit for the players tested (Hind et al., 2015). The main motor skill of these players is power. (Drăgan, 2002) Concerning body fat percentage, it exceeds the limit for front row and second row (30%, 28.9%), but it ranges within normal limits in the case of back row (24%). Lean mass percentages vary in an inversely proportional manner from body fat percentage, but this variable does not exceed the normal limits in the players we tested (35,4% 2.4). (Gabbett, 2002)

POSITION	BODY MASS (kg)	BMI (kg/m <sup>2</sup> )	FAT TISSUE (%)	LEAN MASS (%)
PROP	115,3 $\pm$ 6,3	35,3 $\pm$ 4,3	30 $\pm$ 2,8	33,7 $\pm$ 6,1
HOOKER	108,7 $\pm$ 4,2	33,2 $\pm$ 5,3	26,8 $\pm$ 4,9	36 $\pm$ 3,4
LOCK	118,4 $\pm$ 6,1	32 $\pm$ 1,1	28,9 $\pm$ 4,3	34,7 $\pm$ 2,2
BACK ROW	101,2 $\pm$ 9,3	29,6 $\pm$ 4,9	24 $\pm$ 2,4	37,1 $\pm$ 6,6
<b>MEAN</b>	<b>110,9 <math>\pm</math>10,6</b>	<b>32,5 <math>\pm</math>2,8</b>	<b>27,4 <math>\pm</math>4,3</b>	<b>35,4 <math>\pm</math>2,4</b>

Figure 1. Results of morphological tests on forwards in 2015

Figure 2 presents the results of tests of 2019 forwards. The average total body mass of players fits the profile of forwards (110.7kg  $\pm$ 5.6.) (Duthie et al., 2006) Body mass index is large for non-athlete population, but it does not exceed the normal limit for the players tested (31.9 kg/m<sup>2</sup>  $\pm$ 2.4) (Hind et al., 2015) Concerning body fat percentage, it exceeds the limit for front row and second row (28.9%, 28.7%), but it varies better than the results in the previous tests. The hookers and the back row presents better results (24.8%, 24.2%). Lean mass percentages vary in an inversely proportional manner from body fat percentage, but this variable does not exceed the normal limits in the players we tested (35.8%  $\pm$ 1.9). (Gabbett, 2002)

POSITION	BODY MASS (kg)	BMI (kg/m <sup>2</sup> )	FAT TISSUE (%)	LEAN MASS (%)
PROP	113,1 $\pm$ 5,3	34,3 $\pm$ 1,1	28,9 $\pm$ 4,6	34,3 $\pm$ 4,3
HOOKER	106,8 $\pm$ 6,7	32,6 $\pm$ 6,6	24,8 $\pm$ 2,9	36,9 $\pm$ 7,3
LOCK	117,3 $\pm$ 2,1	31,9 $\pm$ 5,3	28,7 $\pm$ 6,3	34,2 $\pm$ 4,6
BACK ROW	105,4 $\pm$ 3,3	28,6 $\pm$ 4,3	24,2 $\pm$ 5,7	37,9 $\pm$ 5,5
<b>MEAN</b>	<b>110,7 <math>\pm</math>5,6</b>	<b>31,9 <math>\pm</math>2,4</b>	<b>26,7 <math>\pm</math>2,5</b>	<b>35,8 <math>\pm</math>1,9</b>

Figure 2. Results of morphological tests on forwards in 2019

The results presented by props are within the range of morphological adaptations for this position, related to other studies on professional rugby players. (Gabbett, 2002; Gabbett, 2005)

The specific effort for this position requires a high body mass, although the evolution of this sport in speed and power developed a special need of a higher percentage in lean mass and lower in fat tissue.

The evolution of the tested morphological adaptation varies within the four years in a positive manner. Therefore, even if the total body mass decreases (115,3 kg  $\pm$ 6,3 to 113,1 kg  $\pm$ 5,3) the body composition improves. The lean mass improves from 33,7%  $\pm$ 6,1 to 34,3%  $\pm$ 4,3 as an adaptation on long term on the specific effort of the front row.

Statistically, the differences are not significant ( $p > 0.05$ ) between the initial and the second test.

POSITION	BODY MASS (kg)	BMI (kg/m <sup>2</sup> )	FAT TISSUE (%)	LEAN MASS (%)
PROP - 2015	115,3 $\pm$ 6,3	35,3 $\pm$ 4,3	30 $\pm$ 2,8	33,7 $\pm$ 6,1
PROP - 2019	113,1 $\pm$ 5,3	34,3 $\pm$ 1,1	28,9 $\pm$ 4,6	34,3 $\pm$ 4,3
BETWEEN THE TWO GROUPS	p=0.2			

Figure 3. Results of morphological adaptations on props in both tests

The results presented by hookers are within the range of morphological adaptations for this position, related to other studies on professional rugby players. (Gabbett, 2002; Gabbett, 2005)

The specific effort for this position requires a smaller body mass that that of props. Even if they are all in the front row, the game tasks of his two positions are very different. The same pattern appears in other contact sports as well (Muntianu et al. 2020)

The evolution of the tested morphological adaptation varies within the four years in a positive manner, for hookers as well. Therefore, the total body mass decreases from 108,7 kg  $\pm$ 4,2 to 106,8 kg  $\pm$ 6,7. The lean mass improves from 36%  $\pm$ 3,4 to 36,9%  $\pm$ 3 proving a long term adaptation on, the specific effort of the front row.

Statistically, the differences are not significant ( $p > 0.05$ ) between the initial and the second test.

POSITION	BODY MASS (kg)	BMI (kg/m <sup>2</sup> )	FAT TISSUE (%)	LEAN MASS (%)
HOOKER - 2015	108,7 $\pm$ 4,2	33,2 $\pm$ 5,3	26,8 $\pm$ 4,9	36 $\pm$ 3,4
HOOKER - 2019	106,8 $\pm$ 6,7	32,6 $\pm$ 6,6	24,8 $\pm$ 2,9	36,9 $\pm$ 7,3
BETWEEN THE TWO GROUPS	p=0.27			

Figure 4. Results of morphological adaptations on hookers in both tests

For locks the differences between the two testes are the lowest from all forwards. The total body mass decreases only 1 kg (118,4 kg  $\pm$ 6,2 to 117,8 kg  $\pm$ 2,1). Is the only group of forwards where the lean mass decreases (34,7%  $\pm$ 2,2 to 34,2%  $\pm$ 4,6), this result may be due to the fact that locks are the oldest from all the forwards.

Statistically, the differences are not significant ( $p > 0.05$ ) between the initial and the second test.

POSITION	BODY MASS (kg)	BMI (kg/m <sup>2</sup> )	FAT TISSUE (%)	LEAN MASS (%)
LOCK - 2015	118,4 $\pm$ 6,1	32 $\pm$ 1,1	28,9 $\pm$ 4,3	34,7 $\pm$ 2,2
LOCK - 2019	117,3 $\pm$ 2,1	31,9 $\pm$ 5,3	28,7 $\pm$ 6,3	34,2 $\pm$ 4,6
BETWEEN THE TWO GROUPS	p=0.18			

Figure 5. Results of morphological adaptations on locks in both tests

The back row are the only forwards where the total body mass increases (101,2kg  $\pm$ 9,3 to 105,4kg  $\pm$ 3,3), the second results being more in the range of body mass for this position. Although there is a slight increase in the body fat for this position (24%  $\pm$ 2,4 to 24,2%  $\pm$ 5,7), the lean mass increases as well, proving a good adaptation (37,1%  $\pm$ 6,6 to 37,9%  $\pm$ 5,5).

Statistically, the differences are not significant ( $p > 0.05$ ) between the initial and the second test.

POSITION	BODY MASS (kg)	BMI (kg/m <sup>2</sup> )	FAT TISSUE (%)	LEAN MASS (%)
BACK ROW - 2015	101,2 ±9,3	29,6 ±4,9	24 ±2,4	37,1 ±6,6
BACK ROW - 2019	105,4 ±3,3	28,6 ±4,3	24,2 ±5,7	37,9 ±5,5
BETWEEN THE TWO GROUPS	p=0.41			

Figure 6. Results of morphological adaptations on back row in both tests

## Conclusions

It can be concluded that results vary depending on both the positions occupied by players and their morphological particularities, as follows:

- The body composition of forwards ranges within the standards generated by similar studies. The tested props present the poorest results on body composition, although they improve the results within four years.
- The body fat index decreased within the four year range except for the back row, due to a high evolution in body mass. Overall, the fat tissue decreases as a result of the long term adaptation even if the decrease is not statistically significant.
- The lean mass evolution is higher especially for the back row and for hookers, these players having higher aerobic and power needs during a rugby game.

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## DIFFERENCES IN PARAMETERS OF SERVICE SITUATIONAL EFFICIENCY BETWEEN MAN PLAYERS WHO WON AND LOST MATCHES AT WIMBLEDON 2017

Tomislav Paripović<sup>1</sup>, Petar Barbaros<sup>2</sup>, Mario Oršolić<sup>3</sup>

<sup>1</sup>Croatian School Sport Federation, Croatia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>3</sup>Faculty of Food Technology Osijek, Croatia

### Abstract

The successful performance of first and second service is considered as a very important factor and one that can have quite a considerable influence on the match outcome. The above stated particularly relates to playing on grass surfaces where the tennis ball has a somewhat lower and faster bounce due to the lower friction of the grass surface. The afore-said fact often places the opponent who returns the service in a somewhat unfavourable position with regard to other playing surfaces, and this is precisely the specificity of grass courts of Wimbledon. For this reason, the aim of this research is to determine the differences in parameters of service situational efficiency between tennis players who won and lost matches at Wimbledon 2017. For the purpose of this research, analysis was conducted by using statistical indicators of all singles matches played between ATP ranked players participating in the main part of Wimbledon 2017. Service variables were observed during the first three sets for tennis players who won and lost in all played matches. The research sample for this study is composed of the statistics of played matches for a total of 127 players, whereas the sample of variables includes 16 statistical parameters that were officially recorded by the International Tennis Federation at Wimbledon 2017. Basic parameters of descriptive statistics were calculated for all the variables, while the differences in parameters of service situational efficiency between players who won and lost were determined by using the t-test for independent samples. The results of this research regarding the parameters of service situational efficiency indicate that players who won the matches show a statistically significant difference in their performance of faster services, winning more aces and playing fewer points on their service, especially in the second and third set.

**Key words:** tennis, service situational efficiency, fast surface

### Introduction

Tennis certainly belongs to the group of most widely spread sports and it can be classified at the very top of kinesiological activities that individuals engage in, both professionally and recreationally. Therefore, tennis also records a growing increase in the number of competitors at the highest, as well as a recreational level, while the game itself is developing and improving with exceptional dynamics that can be observed in the noticeable high performance level of both male and female tennis players at the top competition level. According to its movement structures, tennis belongs to the group of polystructural acyclic movement activities, as each point is different and requires the player to adjust to every new situation with the aim to optimally overcome space, time and, ultimately, the opponent. There is a great number of factors that can affect the game, such as the following: tennis ball characteristics, type of playing surface, weather conditions in which the match is played, etc. However, despite numerous factors that affect players, winning points largely depends on a player's tactical plan, the ability to implement it and the manner of applying optimal strokes in specific situations during the match. It is precisely such various parameters that can determine a player's efficiency that need to be monitored during each point, game, set and the overall match. As the playing surface can be faster or slower, depending on the fact if a tennis match is played on a grass, clay or hard court, the tactics for the beginning, middle or final part of a point can also often differ. Klaassen and Magnus (2011) thereby determined that a grass court significantly alters the manner and tactics for the initial part of a point in comparison to other playing surfaces, particularly in matches played at Wimbledon, the oldest and most prestigious tennis tournament in the world. Since the goal of the service point is to put the opposing player in an unfavourable position for returning the ball, Klaassen and Magnus underline the fact that the service must include a high level of strength, high precision percentage, as well as it must be versatile in relation to rotation application, and which should particularly be evident in the difference between the first and second service. Another research conducted with data from the Wimbledon tournament, also implemented by Magnus and Klaassen (1999), yielded results that suggest that the first player who is serving always has an advantage over the opposing player on



a grass court. The mentioned authors further report that service efficiency is significantly higher in the men's competition in comparison to female competitions, while favourite players at the Wimbledon tournament differed according to the quality of their first service, and not so much in their second service.

Considering the various mentioned parameters that can determine the overall winner, this research presents an analysis of service efficiency parameters at Wimbledon 2017. The main goal of this study was to research the differences between players who won and lost in the variables that are considered to have an effect on the final match outcome.

## Research methods

For the purpose of this research, available statistical indicators were used for all singles matches played between ATP ranked players participating in the main part of Wimbledon 2017. Service variables were observed during the first three sets in tennis players who won and lost in all played matches. All data was downloaded from the official website of Wimbledon 2017.

## Research sample

The research sample for this study is composed of statistical data from played matches of 127 players, which was the number of players that qualified for the main draw of the tournament. Statistical analysis was conducted on the first three sets played by the players who won and lost in each played match throughout the entire tournament, i.e. in all matches of the first, second, third and fourth round, as well as in quarterfinals, semi-finals and finals matches.

## Sample of variables

The sample of variables measured in this study includes 16 statistical parameters that were officially recorded by the International Tennis Federation at Wimbledon 2017.

## Data processing methods

In this research, statistical methods for descriptive statistical indicators were used. For each variable, the following parameters of descriptive statistics were calculated: arithmetic mean (AM), minimum value (Min), maximum value (Max) and standard deviation (SD). The differences in parameters of service situational efficiency between players who won and lost at Wimbledon 2017 were determined by using the t-test for independent samples.

## Results

The results obtained in this research represent statistical indicators for the above-mentioned variables and based on which differences between parameters of service situational efficiency between players who won and lost at Wimbledon 2017 can be determined. The results are presented in Table 1. The variables referring to speed are expressed in kilometres per hour (km/h).

In the first set, statistically significant differences can be observed in the variable "Aces" in favour of the players who won, as well as it can be observed that the winning players score more "Service Winners". The players who lost show a higher number of "2<sup>nd</sup> Serve Total Points", whereas when it comes to variables of "Total Points Won" and "1<sup>st</sup> Serve Total Points Won" a significant difference can be observed in favour of the winning players. There were no differences in the variable "2<sup>nd</sup> Serve Total Points Won", as well as in the "1<sup>st</sup> Serve Average Speed" and "2<sup>nd</sup> Serve Average Speed", even though the "Average Serve Speed" of winning players was higher than that of players who lost.

In the second set, a significant difference between players who won and lost occurred in the variable "Aces" in favour of the winners, while it can also be observed that the players who lost have a higher number of "Double Faults". "2<sup>nd</sup> Serve Total Points" are higher in players who lost, whereas the players who won achieved significantly better results in variables of "Average Serve Speed", "1<sup>st</sup> Serve Average Speed" and "2<sup>nd</sup> Serve Average Speed".

From the data obtained for the third set, it can be observed that the players who won maintained a higher number of "Aces" and fewer "Double Faults". Significant differences also appeared in the variable of "Total Points Won" in favour of the winners. "Average Serve Speed", "1<sup>st</sup> Serve Average Speed" and "2<sup>nd</sup> Serve Average Speed" proved to be significantly higher in winning players, as well as it was also manifested that the winners had a significantly higher number of "1<sup>st</sup> Serve Total Points Won" and "2<sup>nd</sup> Serve Total Points Won" in the third set.

Table 1. Descriptive statistics and indicators of statistical significance in parameters of service situational efficiency in the first, second and third set between players who won and lost matches at Wimbledon 2017.

VARIABLE	N1 AM±SD 1 <sup>st</sup> set	N2 AM±SD 1 <sup>st</sup> set	N1 AM±SD 2 <sup>nd</sup> set	N2 AM±SD 2 <sup>nd</sup> set	N1 AM±SD 3 <sup>rd</sup> set	N2 AM±SD 3 <sup>rd</sup> set
Aces	3,26 ±2,44	2,28++ ±2,00	3,39 ±2,73	2,41** ±2,29	3,28 ±2,44	2,26** ±2,20
Service Winners	0,79 ±1,21	0,51* ±0,83	0,53 ±0,78	0,50 ±0,83	0,61 ±0,76	0,46 ±0,66
Double Faults	0,94 ±1,05	1,14 ±1,21	0,87 ±1,09	1,27** ±1,23	0,81 ±0,90	1,10* ±1,06
Total Points	29,76 ±8,47	31,18 ±8,92	29,01 ±8,97	31,59* ±8,99	29,76 ±8,56	30,63 ±9,23
1 <sup>st</sup> Serve Total Points	18,91 ±5,33	18,94 ±5,99	18,78 ±6,53	19,91 ±6,80	18,85 ±6,21	19,00 ±6,69
2 <sup>nd</sup> Serve Total Points	10,85 ±4,45	12,31** ±4,98	10,23 ±4,23	11,68** ±4,33	10,91 ±4,24	11,63 ±4,32
Total Points Won	21,24 ±5,50	19,27** ±6,77	20,68 ±6,13	19,46 ±6,80	21,11 ±5,55	19,06** ±6,99
1 <sup>st</sup> Serve Total Points Won	14,92 ±4,22	13,13** ±4,99	14,87 ±5,17	13,77 ±5,29	14,67 ±4,61	13,39* ±5,31
2 <sup>nd</sup> Serve Total Points Won	6,31 ±2,63	6,13 ±3,10	5,81 ±2,60	5,69 ±2,80	6,36 ±2,68	5,67* ±2,74
Service Games	5,08 ±1,10	4,93 ±1,11	4,96 ±1,21	4,86 ±1,14	5,01 ±1,12	4,87 ±1,00
Average Serve Speed	178,54 ±9,39	175,34* ±10,06	177,92 ±9,46	174,71* ±9,86	176,97 ±9,21	173,73* ±9,66
1 <sup>st</sup> Serve Average Speed	189,07 ±9,72	186,55 ±10,41	188,35 ±9,51	184,95* ±10,81	188,56 ±9,52	184,58* ±10,27
2 <sup>nd</sup> Serve Average Speed	157,79 ±9,42	156,28 ±10,62	158,09 ±10,32	154,61* ±10,25	157,08 ±9,45	153,80* ±10,02
Fastest Serve Speed	204,93 ±9,40	201,58* ±10,85	204,34 ±9,82	200,51* ±12,46	204,35 ±10,32	200,00* ±10,85
Fastest 1 <sup>st</sup> Serve	204,42 ±10,20	201,43 ±10,74	204,34 ±9,82	200,41* ±12,43	204,30 ±10,23	200,00* ±10,85
Fastest 2 <sup>nd</sup> Serve	172,12 ±12,58	170,35 ±14,08	172,55 ±12,46	168,63 ±13,91	172,13 ±13,52	165,58** ±11,27

N1 - winners, N2 - players who lost, AM - arithmetic mean, SD - standard deviation

\*\*Statistical difference (p≤0,01)

\*Statistical difference (p≤0,05)

## Discussion

Efficiency in tennis is largely defined by the fact to what extent a player is able to win his service game and at the same time take away the opponent's service game. The afore-said points out the critical importance of the service point, as it represents the only stroke in tennis where the player does not act reactively considering the situation in which the opposing player places him by his actions. It can thus be determined that the service presents an exceptional opportunity for gaining an advantage at the very beginning of a point. It is precisely the choice of force, direction and type of rotation in the service that can have a significant impact on directly winning a point, i.e. on the desired beginning of a point in terms of gaining an advantage and controlling the remaining part of the point. Upon observing the differences between the players who won and lost matches at Wimbledon 2017, it can be detected that the winning players recorded the highest values in both "Fastest 1<sup>st</sup> and 2<sup>nd</sup> Serve" in all three sets. In addition to the fastest service speed, the players who won scored a higher number of "Aces" in all three sets, while the players who lost had more "Double Faults" in the second and third set. A similar setting was also determined in a research by Cross and Pollard (2009) that studied the service point in Grand Slam competitions. The mentioned authors concluded that the service point showed an ever-increasing speed within the period between 1991 and 2009, which thus favoured scoring an even higher number of aces and service winners at Wimbledon due to the faster playing surface. In addition to the above-stated, they determined that during the above-mentioned period there was also a decrease in the number of double faults, which probably points to fact that the players, besides increasing the speed, also improved their service precision abilities. In some way, it can in fact be argued that over the years the technology of player preparation was more and more modified towards generating stronger and more precise services, which indicates the exceptional awareness of the importance of the service on a fast playing surface.

Tennis players who are more efficient have a higher number of “Total Points Won” in both the first and second set, which is most probably precisely a result of the higher number of “1<sup>st</sup> Serve Total Points Won” in the first and second set. The above stated points to the importance of the first service, which is also confirmed by the results obtained in the research conducted by Magnus and Klaassen (1999), in which they determined that favourite players in tennis matches have a significantly higher number of “1<sup>st</sup> Serve Total Points Won”, as opposed to the players who are not considered as the match favourite. It is also interesting to note the significant difference in the variable “2<sup>nd</sup> Serve Total Points Won” in the third set, which is in favour of the winning player and which could indicate that players who win can maintain a somewhat higher level of quality in their second service throughout the entire match. Upon noting the above stated, it is important to mention that the quality of the second service is manifested in its speed, rotation, variability and unpredictability, and when combined with a well-planned initial part of a point, it can provide any player a safer winning of the point and service game. It would be equally interesting to determine the correlation between the quality of the first and second service in some newer studies, as it can often be noted that tennis players with a better second service demonstrate more initiative and risk while performing the first service, while as the match goes on and fatigue appears, the quality of certain segments in the performance becomes even more prominent.

## Conclusion

As a result of this research, it has been determined that the average serve speed presents one of the most significant factors for gaining advantage at the beginning of a point, as well as that greater service speed results in a higher number of aces, service winners and total points won after a serve. The players who won matches demonstrated more aggressive and high-level serves in each set, which, combined with the specific type of grass court, resulted in a considerable advantage for winning the match.

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## SEASONAL CHANGES IN LABORATORY CYCLING PERFORMANCE, METABOLIC ECONOMY AND PEDALLING EFFICACY IN COMPETITIVE ROAD CYCLISTS

Karmen Reinpõld, Indrek Rannama

*School of Natural Sciences and Health, Tallinn University, Estonia*

### Abstract

The purpose of this study was to characterise seasonal changes in aerobic and anaerobic laboratory cycling performance and pedalling technique efficacy and to examine the relationships between seasonal dynamics of Gross Efficiency and pedalling efficacy during intensive aerobic cycling. The laboratory based measurements of cycling specific aerobic, anaerobic performance and metabolic economy and pedalling efficacy were performed in the beginning of the Preparatory period, during Pre-Competition and the Competition period. The seasonal changes in measured parameters were compared and also correlations between seasonal dynamics of GE and pedalling efficacy were evaluated. The results of the current study demonstrate that cyclist's aerobic potential measured as VO<sub>2</sub>max increase during the Preparation period and declines in competition period, in the same time the GE and Power values at intensive aerobic workload improving along the season, but cyclist's anaerobic abilities and pedalling efficacy characteristics do not change systematically along the cycling season. The intra individual seasonal dynamics of GE and pedalling efficacy were not related.

**Key words:** *Cyclus2, Aerobic Performance, Anaerobic Performance, Garmin Vector pedals*

### Introduction

Road cycling competitions vary largely in the duration and intensity levels, that sets excellent demands on athlete's aerobic performance (Mujika & Padilla, 2001), but winning of the race ensures from cyclists' also a high anaerobic power and capacity (Jeukendrup et al., 2000). The riders maximal ability to consume oxygen (VO<sub>2</sub>max) and peak power at that level, as well absolute (W) and relative (W/kg) power values at aerobic and anaerobic level intensities are good laboratories measured predictors of cyclists aerobic performance (Faria et al., 2005). The cyclists' anaerobic power and capacity are often expressed as average mechanical power values of up to 30s all out sprint tests. According to performance model of Joiner and Coyle (2008) in addition to aerobic and anaerobic power and capacity the ability to transfer metabolic energy to mechanical work, measured as Gross Efficiency (GE), is an additional important component of endurance performance. The level of GE is related to cyclists muscle morphological properties (Joiner & Coyle, 2008) as well with pedalling technique characteristics like cadence and bicycle set-up (Jobson et al., 2012). At the same time the associations between GE and mechanical pedalling force efficacy are controversial (Bini et al., 2013).

To achieve the necessary adaptations changes on performance related biological systems, the top level cyclists' need to tolerate extremely high training and competition loads (Mujika & Padilla, 2001), that should be properly distributed and structured along with the training carrier and cycling seasons (Jeukendrup et al., 2000). The insight to cyclists performance related measures during different time points of cycling season or cyclists carrier offers valuable information about the dynamics of adaption processes. Several studies have reported seasonal dynamics on cyclist's aerobic performance (Lucía et al., 2000; Sassi et al., 2008) and GE measures (Hopker et al., 2009; Sassi et al., 2008), but little is presented seasonal changes in laboratory measured anaerobic characteristics and even less is known the seasonal dynamics of pedalling efficacy. Also, remaining question is: is the seasonal dynamics of GE also related to changes in pedalling efficacy? The purpose of this study was to characterise seasonal changes in aerobic and anaerobic laboratory cycling performance and pedalling technique efficacy and to examine the relationships between seasonal dynamics of Gross Efficiency and pedalling efficacy during intensive aerobic cycling.

### Methods

**Participants** of the current study were 9 competitive trained U23 class male road cyclists (20.8±1.6 years, 1.84±0.06 m, 74.8±10.1 kg at the start of the study) who had at least seven years of cycling training experience and seasonal cycling distance above 15000 km. The local ethical committee approved the study design.

**The study design** included one cycling season and consisted of three testing sessions – in the beginning of Preparatory period (after annual time-off period at the end of November), Pre-Competition (February) and during the Competition period (May). Average weekly training load of studied athletes between 1<sup>st</sup> and 2<sup>nd</sup> test was 16.1±2.4 h and 482±65 km, and between 2<sup>nd</sup> and 3<sup>rd</sup> test: 16.7±3.1 h and 533±115 km. All athletes were tested three times in a season with same testing procedures performed on a Cyclus 2 cycling ergometer (Avantronic, Cyclus 2, Leipzig, Germany), the testing session started with Incremental exercise and followed by 30s sprint test after 20 minutes. Maximal incremental exercise with target cadence of 90±5 rpm started with a load of 100 W and was increased by 30 W after every 3 minutes until exhaustion. Respiratory gas exchange variables (Oxygen uptake (VO<sub>2</sub>), carbon dioxide output (VCO<sub>2</sub>), minute ventilation (VE)) continuously measured with Cosmed Quark CPET metabolic analyser (Rome, Italy) using a breath-by-breath mode. The first (VT1) and the second ventilatory threshold (VT2) assessed using Cosmed Omnia 1.6 software by methods described and validated by Weston and Gabbett (2001). The maximal aerobic oxygen uptake (VO<sub>2</sub>max [ml/min/kg]) determined as the highest 30 s average value during the exercise test. The corresponding values of heart rate (HR), relative power (P) and VO<sub>2</sub> which were normalized with body mass at VT1, VT2 and VO<sub>2</sub>max levels, were determined. For the last minute of every step between VT1 and VT2, the Gross Efficiency (GE (%)) value computed as the precentral ratio between cycling power and metabolic energy expenditure rate ( $E_{met} = [(3.869 * VO_2) + (1.195 * VCO_2)] * 69.77$ ) (Moseley & Jeukendrup, 2001). The average value of GE of all loads between VT1 and VT2 incorporated to future analyse.

The 30 second maximal sprint test with maximum power application at the start was performed in isokinetic mode with the target cadence of 110 rpm in seated cycling position hands on the drops. The average 30 second sprint power was measured as an indicator of anaerobic capacity and best 5 second average power as an anaerobic power. The power was normalised with cyclists' body mass and was included in the future analyses as a performance measure. Immediately after the maximal incremental and 30s sprint test lactate values (LA) was collected from capillary blood after every minute until the last measured value was lower than the previous value to determine the maximum LA values (Mujika & Padilla, 2001).

The biomechanical effectiveness of force application during pedalling was described by Torque Effectiveness ( $TE = 100 * (\text{Positive Torque in pedalling cycle}) / (\text{Positive} + \text{Negative Torque in pedalling cycle})$  [%]) and Pedalling Smoothness ( $PS = 100 * \text{Average Torque in pedalling cycle} / \text{Maximal Torque in pedalling cycle}$  [%]), that were registered with Garmin Vector™ power meter pedals. Similarly, with GE characteristic, the TE and PS values were recorded at the third minute of every step between VT1 and VT2. Data were collected with 1 second intervals, independently from the left and right side of the pedals. The measurements were averaged and the average values of the right and left pedal in VT1 and VT2 levels were taken into further analysis. Similarly with GE computation average values of all loads between VT1 and VT2 were computed for TE and PS to associate the seasonal dynamics of pedalling efficacy to GE.

**Data analysis** performed with IBM SPSS Statistics software version 23.0 for Windows. The descriptive statistics were computed for all variables and expressed as a mean±SD. The between training periods differences in performance characteristics were tested by one-way ANOVA for repeated measures with Bonferroni post-hoc test. The significance level for differences was set when  $p < 0.05$  and *Cohen d* > 0.2. The Pearson correlations were performed to control the associations between seasonal dynamics of the metabolic economy ( $\Delta GE$ ) and pedalling efficacy ( $\Delta TE$  and  $\Delta PS$ ).

## Results

The descriptive statistics of cyclist's aerobic and anaerobic performance and pedalling technique characteristics are presented in Table 1. The cyclists GE, LA level after incremental test, VO<sub>2</sub>max value and power at that level increased significantly from the start of the Preparatory period to the Pre-Competition period, as well lowered the HR at VT1 level. During the Competition-period the rise of GE was noted and power at VT2 level, but maximal LA, VE, HR and VO<sub>2</sub>max values had a tendency for decrease. No significant seasonal changes were detected on VT1 level power, HR and VO<sub>2</sub> characteristics and also none of anaerobic sprint test power values. There were some between the period's differences in some single pedalling efficacy measures, but no systematic seasonal changes at different intensity levels in those characteristics which were evaluated. Also there was no detected significant correlations between seasonal dynamics of GE and Pedalling Efficacy parameters ( $r = -0.09$ ;  $r = -0.06$ , for TE and PS respectively) as shown in Figure 1.



Table 1. The descriptive statistics of 30-second sprint cycling performance and pedalling technique parameters

N=9	Preparatory		Pre-Competition		Competition	
	Mean	± SD	Mean	± SD	Mean	± SD
<b>Maximal Incremental test</b>						
HR at VT1 (rpm)	158	± 8	153	± 11	153	± 10
HR at VT2 (rpm)	180	± 5	174	± 9	173	± 7 *
HR at PP (rpm)	193	± 7	192	± 6	186	± 5 * #
P at VT1 (W/kg)	3.56	± 0.39	3.57	± 0.37	3.76	± 0.44
P at VT2 (W/kg)	4.55	± 0.32	4.58	± 0.43	4.77	± 0.37 * #
P at VO2max (W/kg)	5.37	± 0.46	5.56	± 0.42 *	5.59	± 0.37 *
VO2 at VT1 (ml/kg/min)	50.3	± 6.6	49.0	± 5.7	50.6	± 5.5
VO2 at VT2 (ml/kg/min)	63.5	± 6.2	61.7	± 5.2	63.5	± 3.8
VO2max (ml/kg/min)	71.0	± 5.3	73.3	± 5.7 *	69.9	± 3.4 #
GE (%)	20.9	± 1.1	21.7	± 0.7 *	22.3	± 0.6 * #
VEmax (l/min)	200	± 30	210	± 28	192	± 24 #
LACmax after incremental test (mmol/l)	12.6	± 2.2	14.5	± 1.6 *	11.1	± 2.7 #
<b>30s sprint test</b>						
Pmax 5s (W/kg)	16.9	± 2.0	16.7	± 2.3	16.8	± 1.9
Pmax 30s (W/kg)	12.2	± 1.2	12.2	± 1.6	12.3	± 1.3
LACmax after 30s sprint test (mmol/l)	15.6	± 2.6	14.1	± 2.4	13.5	± 1.0 *
<b>Pedalling Effectiveness and Smoothness during incremental test</b>						
TE at VT1 (%)	84.2	± 5.9	85.2	± 5.6	86.4	± 6.0
TE at VT2 (%)	91.5	± 4.4	92.5	± 4.4 *	93.4	± 3.3
TE at VO2max (%)	93.5	± 3.9	94.5	± 2.9	95.2	± 2.7
PS at VT1 (%)	24.6	± 1.8	24.7	± 1.8	25.3	± 2.1
PS at VT2 (%)	27.4	± 2.1	27.6	± 1.9	28.3	± 1.6
PS at VO2max (%)	28.0	± 1.7	28.1	± 1.6	29.3	± 1.9 #

\*-Significantly different from Preparatory period; # - Significantly different from Pre-Competition period ( $p < 0.05$ ,  $d > 0.2$ )

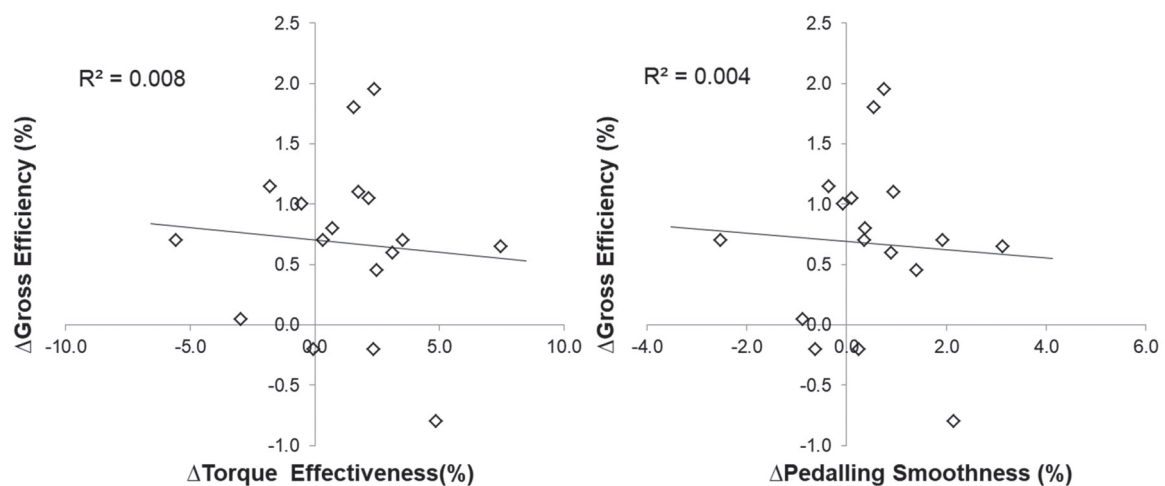


Figure 1. Associations between seasonal dynamics of GE and Pedalling Efficacy characteristics

## Discussion

Previous research with professional cyclists have demonstrated HR values at different intensity levels did not change along the cycling season (Lucía et al., 2000) but results of the present study did not found differences in VT1 level while VT2 and maximum HR values decreased significantly after preparation period. Professional cyclists also improve VO<sub>2</sub> and power values at all intensity levels as the season progresses (Sassi et al., 2008) but U23 cyclists' from our study had better power values in competition period only in VT1 and VO<sub>2</sub>max level, but no improvement was registered in VO<sub>2</sub> measures at VT1 and VT2 level and VO<sub>2</sub>max value even declined during competition period. Differently from aerobic power and capacity measures no significant seasonal changes in GE are presented in professional cyclist's population (Sassi et al., 2008), but lower level cyclists of present study demonstrated significant improvement of GE along the season and this is in line with the findings of Hopker and colleagues (2009), who noted similar tendency for seasonal improvement of GE in nonprofessional cyclists group. In cross sectional studies have demonstrated that professional cyclists have better GE and also pedalling efficacy (García-López et al., 2016) and it is hypothesised that pedalling force application effectiveness may be one possible mechanism for improvement of the metabolic economy. But in studies were cyclists have been forced to pedal mechanically more effectively the metabolic cost is decreased (Korff et al., 2007). The present study also demonstrated that the seasonal changes in cyclists GE did not associate with changes in pedalling efficacy and probably those two cycling efficiency measures are not directly related. It can be hypothesised that professional cyclists have stronger endurance base and they do not lose aerobic potential during competitions as fast as less trained U23 cyclists, but lower level cyclists may have larger adaption potential to improve muscle morphological properties that lay under the improvement of GE (Joiner & Coyle, 2008), but seasonal improvement in GE is probably not related with improved pedalling force delivery effectiveness.

## Conclusion

The results of the current study demonstrate that cyclists' aerobic potential measured as VO<sub>2</sub>max increase during the preparation period and declines in competition period, in the same time the GE and Power values at intensive aerobic workload are improving along the season but cyclists' anaerobic abilities and pedalling efficacy characteristics do not change systematically along the cycling season. The intra individual seasonal dynamics of GE and pedalling efficacy were not related.

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## PERFORMANCE INDICATORS OF SERVE RECEPTION FOR DIFFERENT PLAYER ROLES IN FEMALE VOLLEYBALL HIGH-LEVEL COMPETITIONS

Tomica Rešetar, Anja Toplek, Nenad Marelić

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The aim of this research is an analysis of performance indicators in the serve reception phase of top-level female volleyball players. The primary goal of this paper was to determine the differences in performance indicators of serve reception within and between individual player roles that participate in the performance of serve reception. The analysis included a total of 5745 actions on a sample of 40 volleyball matches in the 2019 CEV Women's Volleyball European Golden League. The performance of the serve reception was evaluated according to a five-point scale, based on which the performance coefficient was thus calculated, as a general indicator of quality performance indicators of serve reception. Upon comparison between player roles of the libero in relation to other receivers, a statistically significant difference was determined in the results of the performance quality indicator by means of the performance coefficient for serve reception. On the other hand, when taking into consideration the higher or lower team ranking, there was no statistically significant difference determined between the two groups of libero players, whereas the analysis of differences between serve receiving player roles within the league identified a statistically significant difference in indicators of performance quality by means of the performance coefficient for serve reception.

**Key words:** performance indicators, female volleyball players, serve reception, playing roles, Mann-Whitney U test

### Introduction

The main goal of serve reception in volleyball is to precisely direct the ball towards the net into the primary setting zone. The dominant technique which is used for the performance of serve reception is the forearm pass, as well as numerous variations of it, however, also the technique of the overhead pass. Choosing between the two afore-mentioned techniques primarily depends on the height and speed of the oncoming serve by the opponent. On the other hand, the tactics of serve reception also includes individual and team actions (Janković, Đurković & Rešetar, 2009) which are thus modified and adjusted in relation to the opposing teams' serve performance. In high-level senior female volleyball, the most represented serve reception system is with three (less often two) players in charge of receiving jump float serve, as well as with the obligatory three players for receiving jump spin serve. Each of the players must understand her zones of responsibility, as well as have a good assessment of the opponent's serve and, in accordance with all the afore mentioned, select the adequate serve reception technique. When considering different player roles, in the 5-1 system, serve reception is performed by a relatively new player role (*Éloi*, Langlois & Jarrett, 2015), the libero, as well as by one or both receivers. Likewise, less frequently opposites also participate in serve reception, while sometimes also centres when receiving shorter serves.

Furthermore, to obtain insight into the efficiency of the serve reception phase of an individual player, it is necessary to objectively and reliably assess and register both the quantity and quality of performance. Upon completing the mentioned performance registration, it is thus possible to determine the overall final performance indicators of an individual player in the serve reception phase, as well as establish various relations for reaching generalized conclusions.

Upon review of previous research (João et al., 2006; Rentero, Joã & Moreno, 2015; Sánchez et al., 2017), there is a substantial number of research that was completed on a sample of male volleyball senior teams. The results of such research cannot be implemented for a population of female volleyball senior players due to the specificities in the performance of serve reception. Namely, the mentioned specificities are a result of differences in rules, that is the net height (male players=243 cm, female players=224 cm), as well as of differences in physical and motor skills between male and female players that affect the selection of serve technique (in male volleyball players the dominant choice is jump spin serve, whereas in female volleyball players it is jump float serve), which ultimately also affects the efficiency of serve reception performance in female players. Precisely as a result of all the afore mentioned, the aim of this research is to perform an analysis of performance indicators of serve reception on a sample of top-level senior female volleyball players, i.e., to determine the quality of serve reception for different player roles that participate in the serve reception phase. In this regard, we can single out three different goals of this research: 1. to determine the differences in serve reception efficiency between "the libero" and "other receivers"; 2. to determine the differences in serve reception efficiency among "the libero"

of teams ranked in the top four positions and those from other teams; 3. to determine the differences in serve reception efficiency among “other receivers” of teams ranked in the top four positions and those from other teams.

## Methods

For the purpose of conducting this research, matches played during the 2019 Women’s Volleyball European Golden League for seniors were chosen. All matches were played in the organization of CEV (Confédération Européenne de Volleyball). A total of 12 national teams competed in the play-off phase in groups, after which the final tournament took place that determined the final placement of the teams (1. Czech Republic, 2. Croatia, 3. Belarus, 4. Spain, 5. Hungary, 6. Ukraine, 7. Austria, 8. Finland, 9. Slovakia, 10. Azerbaijan, 11. France and 12. Sweden). The analysed entity in this research were game sets, and their overall number was 145 (i.e., 290 when considering both teams) as part of 40 played matches. Regarding the difference in duration and the number of points required to win in the fifth set, only the first four sets were used for the purpose of data processing and analysis. As the determined goal of this research was performance indicators of the serve reception phase for different player roles in volleyball, the overall sample was divided into subsamples for the player roles of the libero and the receivers, as well as for each of the mentioned player roles of teams ranked from 1<sup>st</sup> to 4<sup>th</sup> place (higher ranking) and those from teams ranked between the 5<sup>th</sup> and 12<sup>th</sup> place (lower ranking). The numeric quantification of the serve reception phase in this research was implemented through appointing each performance with a grade between 1 and 5, so that the grade 1 represented the lowest possible assessment, whereas the grade 5 represented the highest possible assessment (Table 1). Thus, recorded and ranked frequencies were inserted into a formula by means of which the performance coefficient for the serve reception phase was then registered:  $K = (\text{number of performances } 1) * 1 + (\text{number of performances } 2) * 2 + (\text{number of performances } 3) * 3 + (\text{number of performances } 4) * 4 + (\text{number of performances } 5) * 5 / \text{overall number of performances (performance } 1 + \text{performance } 2 + \text{performance } 3 + \text{performance } 4 + \text{performance } 5)$ . The calculated coefficient can be considered as an overall performance indicator, as it simultaneously includes and ponders various performances of serve reception.

Table 1. Grade, evaluation and description of assessments for serve reception performance

Grade	Evaluation	Description
1	Error	the ball was not played at all or it was played in such a way that after performing the serve reception the team failed sending the ball into the opponent’s court
2	Poor	the ball goes over the net into the opponent’s court and does not allow any opportunity for organizing the play
3	Negative	it only allows to set a high ball or just sending the volleyball into the opponent’s court without a spike
4	Positive	the ball is directed towards the secondary setting zone, where it is more difficult to set quick balls in the middle, however, it still allows for a quick set towards the ends of the net
5	Ideal	the ball is directed towards the primary setting zone with an ideal ball trajectory, after which all options for setting are possible

Data collection was conducted by using a laptop computer based on live played matches and by means of a specialized statistical programme Data Volley (Data Project S.r.l., Salerno, Italy). The data was collected by experts in registering performance indicators in volleyball (statisticians-analysts) with years of experience and members of the professional staff in each national team. Furthermore, upon completing the registration, storage and editing of the data, everything was then entered in Microsoft Excel files and prepared for further analysis in the Statistica 13.5 programme (TIBCO Software Inc.). Percentages for the overall performance were calculated based on the assessments of all serve reception performances, while basic descriptive indicators were calculated for the performance coefficient of serve reception. The non-parametric Mann-Whitney U test was used for determining statistically significant differences. The test-retest method was utilized for establishing reliability of measurements in the research (Dizdar, 2006), which entails applying the measurement procedure on an identical group of entities, i.e., on a sample of 5 randomly chosen matches, that is, on 17 played sets, which amounts to more than 10% of the overall sample. After completing the repeated measurements, the Spearman correlation coefficient was calculated as the general reliability indicator, whose high values (0,99 - 1,00) refer to a high reliability of the measurements, as well as to a relevance for assessing performance indicators on the selected sample.

## Results

By comparison to other receivers, liberos demonstrate a lower percentage in grade 1 and grade 3, and a higher one in grade 4 and grade 5, whereas they are equal to other receivers in grade 2 (Illustration 1).

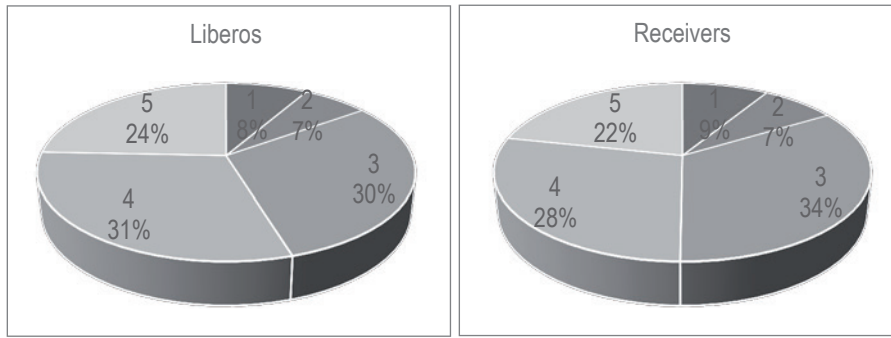


Illustration 1. Graphical representation of percentages of overall frequencies for individual assessments of serve reception performance for the player roles of “libero” and “receivers”

Liberos of higher ranked teams regarding to lower ranked teams attained a lower percentage in grade 1, grade 2 and grade 4, while they have a higher one in grade 3 and grade 5 (Illustration 2).

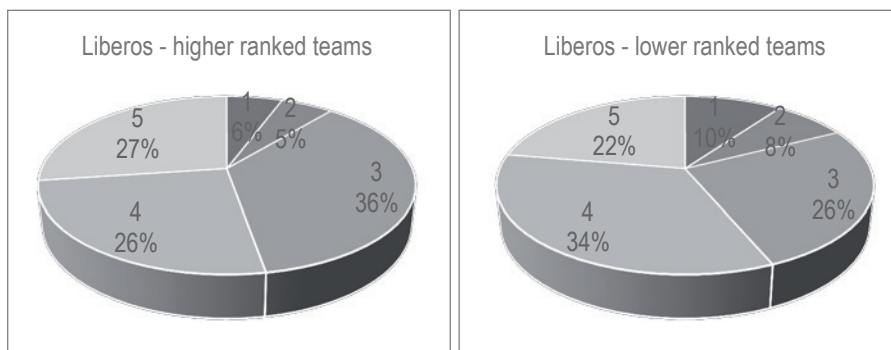


Illustration 2. Graphical representation of percentages of overall frequencies for individual assessments of serve reception performance for the player roles of “libero” in higher ranked teams and in lower ranked teams

Receivers of higher ranked teams regarding to lower ranked teams attained a lower percentage in grade 1, grade 2 and grade 4, while they have a higher one in grade 3 and grade 5 (Illustration 3).

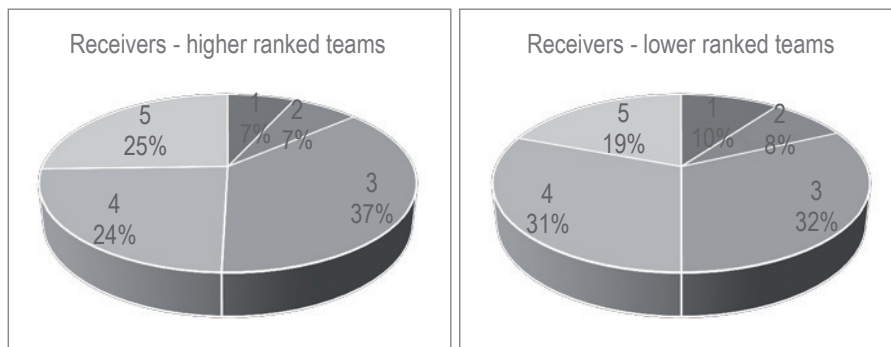


Illustration 3. Graphical representation of percentages of overall frequencies for individual assessments of serve reception performance for the player role of “receivers” in higher ranked teams and in lower ranked teams

Table 2 demonstrates results for basic indicators of descriptive statistics for the quality of serve reception performance by means of the performance coefficient, as well as results for the Mann-Whitney U test which was used for determining statistically significant differences in the performance coefficient between the groups of higher ranked teams (1st to 4<sup>th</sup> place) and lower ranked teams (5<sup>th</sup> to 12<sup>th</sup> place), separately for the playing roles of “libero” and “receivers”, as well as between the mentioned playing roles.



Table 2. Descriptive statistics and results of Mann-Whitney U test for performance coefficients of serve reception

	Groups	M±SD		p
Player role	Libero vs Receivers	3,55±0,75	3,48±0,38	0,00
Libero	1.-4. vs 5.-12.	3,56±0,77	vs 3,54±0,74	0,49
Receivers	1.-4. vs 5.-12.	3,55±0,35	3,43±0,40	0,02

Note: M – mean, SD – standard deviation, p – level of statistical significance

## Discussion and conclusion

Upon comparison of the percentages for individual assessments of performances in Illustration 1, it is determined that libero players showed higher efficiency than receivers did in the ideal (24%, 22%) and in the positive (31%, 28%) performance, while at the same time receivers demonstrated higher percentages in negative performance (34%, 30%). However, both player roles attained an equal number of errors and poor performances of serve reception. Ciemiński (2017), on a sample of female volleyball teams that participated in the 2015 Women's European Volleyball Championship, likewise determined that libero players were more efficient than receivers (38%, 32%) in the ideal performance of serve reception.

By analysis of the performance coefficient of serve reception between the groups of libero players and receivers, a statistically significant difference is reached ( $p=0.00$ ), in which libero players ( $3,55\pm 0,75$ ) attained higher values than receivers ( $3,48\pm 0,38$ ). Therefore, on the overall observed sample the conclusion can be made that libero players displayed a higher level of quality than receivers in the performance of serve reception.

Furthermore, in Illustration 2, which demonstrates the results of percentages for individual assessments of serve reception performance for the player role of libero in relation to the higher and lower ranking of the teams that took part in the competition, one can notice that libero players of higher ranked teams had less errors in serve reception than the libero players from lower ranked teams (6%, 10%). In addition, libero players from higher ranked teams were more successful in executing ideal performances when compared to libero players in lower ranked teams (27%, 22%). Libero players in lower ranked teams demonstrated more positive performances (34%, 26%), whereas libero players of higher ranked teams had more negative serve reception performances (36%, 26%). Upon comparing libero players from higher and lower ranked teams (Table 2), there was no statistically significant difference in performance coefficients of serve reception, which ultimately suggests about equal level of quality of libero players in examined teams regarding their ranking.

Analysis of the percentages of overall frequencies for individual assessments of serve reception performance in Illustration 3 determined that the receivers from higher ranked teams showed a higher percentage of ideal performances (25%) when compared to receivers from other teams (19%), as well as a lower percentage of errors (7%, 10%). However, receivers in lower ranked teams demonstrated more positive performances (31%, 24%), while receivers in higher ranked teams had more negative serve reception performances (37%, 32%). By comparing the receivers from the groups of higher and lower ranked teams (Table 2), a statistically significant difference was determined in the performance coefficient of serve reception ( $p=0.02$ ), as receivers of higher ranked teams ( $3,55\pm 0,35$ ) attained higher values than receivers of lower ranked teams ( $3,43\pm 0,40$ ). This allows for the conclusion that in the examined sample receivers in higher ranked teams are generally more efficient in serve reception performance.

In conclusion, this research was conducted on a sample of top-level female volleyball players in performance indicators of serve reception. In accordance with expectations of the authors, the obtained results indicate slight, however statistically significant differences in results between serve reception efficiency of libero players in relation to receivers. Likewise, the authors' expectations that receivers from top four ranked teams differ in efficiency of the serve reception phase when compared to teams with lower ranking (5th to 12th place) were also confirmed. The higher level of quality in serve reception enabled a better realization in the setting and spiking regarding teams with lower ranking. However, the results of this research also demonstrated an interesting data point, which was that all twelve national teams had players of equal quality on the libero position, as it was demonstrated that there is no statistically significant difference between libero players, regardless of the differences in their team's ranking. Both the highest and the lowest ranking team had libero players of equal quality. Thus, the most common serving tactics of attempting to avoid a serve directed towards the opponent's libero player would in this case be entirely justified.

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## THE PHYSICAL LOAD AND SPORTING ACHIEVEMENTS OF THE PROFESSIONAL ROAD CYCLIST R. N. DURING THE OLYMPIC CYCLE

Asta Sarkauskiene, Gabriele Navardauskiene

*Klaipeda University, Lithuania*

### Abstract

The aim of this study was to explore the athletic training and performance of the professional road cyclist R. N. during the four years of the Olympic cycle. The study participant was a Lithuanian professional road cyclist R. N. Document analysis and case study were applied in the research. The data descriptive statistics were compiled: the arithmetic averages, standard deviation, the highest and lowest values were calculated. The professional road cyclist R.N. attained his highest sporting achievements at the age of 25–27. R.N.'s most important achievement in international competitions is making 3rd place in the 2015 UCI Road World Championships in Richmond (Virginia, USA). R. N. has also won the 19<sup>th</sup> place at the most prestigious race of Tour de France in 2014. In 2013 R. N. won the 11<sup>th</sup> place at the Giro d'Italia, one of three highest level cycling competitions. The duration of the physical exertion that R. N. undertook during a single year averaged 931.25 hours. The average time spent on the road was 864.75 hours, which covered 30044.50 km by bicycle. This is less than is recommended for high-performance cyclists. Analysing the dynamics of perceived exertion during the period of the four years of the Olympic cycle, it was evident that the exertion was highest in the 4<sup>th</sup> year of the cycle. The scientists recommend to decrease the amount of physical load in the 4<sup>th</sup> Olympic year or to keep it the same as earlier in the period.

*Key words: Bicycle sport, physical load, physical exertion, preparation*

### Introduction

Cycling is one of the most sophisticated sports in its content because of the great variety of duration and intensity of physical load (Vaitkevičiūtė, & Milašius, 2011). The competitive activities and training of cyclists are a well-researched field of sports science, but as technology, training methodology and athletes' physical and functional capabilities increase, it is important to continue researching high-performance cyclists (Buivydas, & Milašius, 2011). Skernevičius, Milašius, Raslanas, and Dadelienė (2011) note that improvement in one's level of training depends on many factors that make up the content of the training. The major components of the athletic training of cyclists are the race system, the training system and factors, which affect the race and the training system. All of these components are related and affect each other. At the same time, they have defined tasks and methodological features that give them independent meaning (Захаров, 2005). Karbolis (2005) emphasizes that the training of high-performance athletes is based on the organization of sports exercises, based on the methodology of the most important didactic principles of education.

Skurvydas (2017) points out that one of the biggest problems in the management of the athletic training is related to planning how to enable the athlete achieve their best results. It is quite difficult to schedule training loads so that you get the best result on the race day. These ideas are echoed by the claims of Balyi, Way, and Higgs (2013) that very responsible planning and monitoring are essential.

A distinct structural unit in the athlete training is the four-year Olympic cycle (Skernevičius et al., 2011). It spans the time between the two Olympics and is under constant scientific examination. This structure of prospective sports training allows to properly plan the course of the training, to regulate physical loads, and to guarantee the increase of the athletes' mastery. The structure of the Olympic cycle in the preparation of high-performance athletes is repeated in preparation for the start of the next Olympic Games, however, the training tools and methods of each Olympic cycle must be different and correspond with the athlete's adaptability and other factors determining athlete training. Most of the results come from consistent planning regarding physical loads over a multi-year and annual training cycle. (Buivydas, & Milašius, 2011). Balyi et al. (2013) emphasize that the structure of their training program has the greatest influence on the success of high-performance athletes.

In order to have as many objective criteria as possible to optimize the training process and readiness data, it is important to study the didactic features specific to the preparation of high-performance cyclists for the Olympics, World Championships and World Cup events (Buivydas, & Milašius, 2011).

Analysis of the empirical research has revealed that physical and functional performance indicators of professional road cyclists are the most commonly studied and analyzed. Menaspà, Quod, Martin, Peiffer, and Abbiss (2015) studied the aerobic and anaerobic capacity of cyclists at the finish. Sassi, Impellizzeri, Morelli, Menaspà, and Rampinini (2008) analyzed the change in aerobic capacity during the annual macrocycle.

Analysis of the perennial training load of professional road cyclists is not a frequent subject of scientific research. Pinot and Grappe (2015) studied for two years the change in the physical load of a cyclist (18-23 years old) who finished in the top 10 twice in prestigious (Tour de France and Vuelta a España) multi-day races. Lithuanian scientists have not conducted longitudinal studies of the athletic training of professional road cyclists.

**The goal** is to study the athletic training and performance of a professional road cyclist R.N. over the four years of the Olympic cycle.

## Methods

**The research participant.** This paper analyzes the sports results achieved by the professional road cyclist R.N. and the annual macrocycle and four-year Olympic cycle loads. R.N. was born in 1988. R.N. started sports in 1999 at the age of 11. In 2005 he became the winner of the Lithuanian Junior Road Championship. R.N. first signed with the American professional team Garmin-Sharp in 2010.

R.N.'s most important achievement in the highest level international competition is winning the 3rd place in the UCI World Road Championships in Richmond (Virginia, USA). The athlete accomplished this at the age of 27. R.N. won the 19th place at the most prestigious Tour de France race in 2014, at the age of 26. The Giro d'Italia is ranked among the top three races. In 2013 R.N. won 11th place in this competition.

Case study and document analysis were applied in the research. The work analyzes the volume of physical load of one athlete, a professional road cyclist, R.N., during the four-year Olympic cycle (2013-2016). The document analysis method was used to determine the athletic performance results of the professional road cyclist, R.N., in official competitions.

The data descriptive statistics were compiled: the arithmetic averages, standard deviation, the highest and lowest values were calculated. All statistical analyzes were performed with the Statistical Package for Social Sciences (SPSS) (version 20.0 for Windows).

## Results

The average number of exercise days in a single year of the four-year Olympic cycle was  $313.50 \pm 10.66$  days (Table 1). The highest number of exercise days was in the third year of the Olympic cycle. The average number of training days was  $230.75 \pm 15.17$  days. The number of training days was also highest in the third year, i.e. in 2015. In a single year, R.N. had  $80.25 \pm 8.69$  race days. The highest number of race days was in the fourth year of the Olympic cycle - 92 race days. The average number of rest days was  $53.75 \pm 10.87$  days in a single year.

Table 1. Annual macrocycle load parameters of the professional road cyclist R.N.

Load parameters	Years				Average
	I (2013)	II (2014)	III (2015)	IV (2016)	
Number of exercise days	309	302	327	316	313.5
Number of training days	238	223	248	214	230.8
Number of race days	71	79	79	92	80.3
Number of rest days	55	61	38	61	53.8
Road (hours)	842	783	891	942	864.5
Road (km)	29957	27729	30088	32404	30044.5
Track (km)	11		2	0	3.3
Trainer stand (hours)	32	32	36	30	32.5
General physical preparedness/GPP (hours)	18	29	51	24	30.5
Running	6	4	5	0	3.8
Total load volume (hours)	898	848	983	996	931.3

In terms of cycling on the road, the fourth year of the Olympic cycle covered the most kilometers - 32404 kilometers (average being 30044.5 km) and the most hours were dedicated to achieving that - 942 hours (mean being 864.8 hours). The athlete cycled little in the track, averaging 3.25 hours within a single year. An average of  $30.50 \pm 14.39$  hours per year was spent on physical fitness training.

The total physical load volume in terms of hours in a single year was  $931.25 \pm 70.49$  hours (Table 2). The highest volume was in 2016 - 996 hours, the lowest - in 2014 - 848 hours. For three years, the highest load volume in terms of hours was in July and only during the Olympic year (2016) - in May.

Table 2. Total load volume (hours)

Month	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
2013 m.	45	80	98	68	11	92	99	72	100	83	35	24	807
2014 m.	54	61	68	82	90	71	69	80	97	76	73	27	848
2015 m.	74	94	93	84	88	88	91	85	101	89	62	34	983
2016 m.	52	94	95	84	91	91	101	77	98	85	85	43	996

## Discussion

This paper analyzes the athletic performance of a professional road cyclist R.N. and explores one of the components affecting performance - the volume of the training load. The analysis was conducted over the four-year Olympic cycle, 2013–2016. A variety of factors influence the athletic performance. Most results are determined by consistent physical load planning over a multi-year and annual training cycle. Training athletes in an annual cycle is a complex pedagogical process that involves various structural, physiological, mental, and adaptive processes (Kenney, Wilmore, & Cosill, 2012). The annual cycle training model should use physical exertion most effectively and athletes should be tested in various competitions (Faria, Parker, & Faria, 2005).

Allen and Hopkins (2015) point out that knowledge of the age at which elite athletes achieve the highest results can provide important information for long-term training programs, athlete selection, and resource allocation. In endurance sports, athletes' performance improves from 20 years (swimming 2–15 minutes) to 39 years (extreme long distance (27–29 hours) cycling races).

Buivydas and Milašius (2011) studied the preparation of the highly skilled road cyclist I. K. for the annual pre-Olympic cycle (2007-2008). Analyzing the athlete's last years of the four-year Olympic cycle shows that the athlete's total physical load volume was 1028 hours per year, and the athlete covered 32050 km. Of these, the intensity of the work on the road was 920 hours in various intensity zones, whereas the athlete spent 15 hours on the track. In the 2008 season cyclist I. K. participated in the ProTour A League, representing the French team Credit Agricole. The results of the Lithuanian cyclist I. K. were satisfactory in the Beijing Olympics (29th place) and the World Road Cycling Championship (34th place). After these games, the cyclist's performance progressed: at the World Cycling Championships in the individual start race he placed 8th in 2009 and 12th in 2010. The cyclist was ranked 4th in one of the most important stages of the professional cycling competition Tour de France in 2010.

Polichuk (Полищук, 1997) points out that the annual macrocycle load volume for high-performance cyclists should be 1400-1600 hours, 32000-40000 kilometers. The number of training days should be 320-340 days.

The physical load of athlete R.N. researched in this study during the fourth year of the Olympic cycle is in accordance with these recommendations and coincides with the annual load volume in kilometers of the professional road cyclist I.K., who participated in the study by Buivydas and Milašius (2011). Analyzing the load volume in hours, it was found to be less than recommended. The biggest difference was the time spent on the General physical preparedness (GPP) training. R.N. averaged 30.5 hours per year. Polishchuk (Полищук, 1997) recommends devoting almost ten times the amount for the General physical preparedness (GPP) training - around 300 hours per year. Rønnestad, Hansen, and Nygaard (2017) note that elite cyclists have a short time in the pre-training phase when they can focus on developing maximum strength. The researchers conducted an experiment and concluded that even a 10-week interval, when strength training is included, is very beneficial for increasing leg strength.

Platonov (2010) points out that the basic requirements of the theory of athletic training technology of high-performance athletes must be applied creatively, envisaging the possibility to participate in many competitions, taking into account the specifics of the sport, individual characteristics of the athlete, as well as material and technical conditions.

The following limitations of the research can be distinguished in the thesis: sports performance is determined by many factors: economic, social, psychological. The influence of the above mentioned factors on sports performance is not analyzed in this work. However, the results of this work benefit both the athlete himself and other elite athletes and their coaches. This analysis of the load volume will help to plan the training process for elite road cyclists.



## Conclusions

1. The professional road cyclist R.N. attained his greatest athletic achievements at the age of 25-27. R.N.'s most important achievement in international competitions is placing 3rd at the UCI World Road Championships in Richmond. The athlete achieved this at the age of 27. In 2014 at the age of 26, he won 19th place in the most prestigious Tour de France race. In 2013 R.N. won 11th place in the Giro d'Italia, ranked among the top three races. The age at which R.N. attained his highest athletic achievements corresponds to the age reported in the literature.

2. The duration of the physical exertion performed by R.N. reached 931.25 hours per year. The average time spent on the road was 864.75 hours, covering 30044.50 km by bicycle. This is less than recommended for high-performance cyclists. The analysis of the dynamics of perceived exertion during the four-year Olympic cycle showed that it was highest in the fourth year of the Olympic cycle. Scientists recommend reducing the amount of physical exertion during the Olympic year or maintaining the same level as in another year of this cycle.

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## THE RELATION IN QUANTITY OF BALL PASSES AND EFFECTIVENESS IN ELITE EUROPEAN BASKETBALL

Aleksandar Selmanović<sup>1</sup>, Tonći Jerak<sup>2</sup>, Vicko Mihaljević<sup>1</sup>

<sup>1</sup>University of Dubrovnik, Croatia

<sup>2</sup>University of Zadar, Croatia

### Abstract

The research evaluates the frequency of passes within the basic types of offenses we encounter in basketball: *set* offenses, *transition*, and *early* offenses. The results were drawn from the analysis of 2,604 offensive phases from 15 randomly selected games in the Euroleague playoffs. Contrary to expectations, the findings have shown that a greater number of passes in the *set* offense had the highest tendency of a negative offensive outcome - 45%, as opposed to a positive 37%. The quantity of passes within the *transition* and *early* offenses does not represent a discriminating factor in reference to the type of outcome ( $p < 0.05$ ). Passes, as an essential technical-tactical tool in the execution of offensive actions, demand a complete analysis as a precondition for explaining the influence of offensive characteristics. The authors agree that the influence of passes on offense effectiveness based only on quantitative indicators has various disadvantages since basketball is rich in passes that are not relative to tactical offense solutions. The analysis of passes in basketball must be fulfilled with the evaluation of the type of passes and, ultimately, the degree of their usefulness and connection with the final outcome of the offense.

**Key words:** *basketball, passing, set offense, transition offense, early offense, notational analysis*

### Introduction

Passing represents the fundamental element of basketball technique. As an elementary means of offensive performance, it shows the contours of the players' offensive approach, cooperation, and tactical inclination of the team, while in direct practical terms it presents an effective technique to keep the ball away from the defender, demonstrates the quickest way to advance the ball up the court, and creates more scoring opportunities than dribbling. Its successful execution can have a significant impact on the success of the offense. The harmony of the collective offense in basketball closes the inner space of the court, so the continuity of movement in the offense demands, among other, a certain frequency in proper and timely passing with potentially enhanced passes from the *help side* to the *weak side* in order to reach a surplus of free players who can receive the ball and have the opportunity to create an open shot. As a segment of the offensive tactical slant, its relevance is unquestionable - it shortens the transition phase period and helps set up an organized offense (Colbeck, 1985; Wissel, 2004). Timely and precise passes are an essential characteristic of extraordinary offense teams (Meyers, 2013). According to Miller (1994) and Dean (2001), almost 75% of successful realizations occur after passes, and they are the result of quality performance of offensive combinations (Wellenreiter, 1984). Due to this, pass analysis is considered as a very essential segment in the research of playing basketball.

The basic aim of the present research is to establish the frequency passes in relation to successful offenses in the Euroleague. Offense is set as the basic bearer of information so a more accurate interpretation on the result of the number of passes demands a categorical division of the basic forms of offense met in basketball.

### Methods

Notational analysis established the frequency of passes in 2,604 offenses acquired by complete analysis of 15 randomly selected matches of the Euroleague playoff competition in season 2010/11. It is important to note that the duration of offense phase is not determined by the total ball possession period but its limits are treated according to the shot-clock reset. The variable *Number of passes* within each entity is registered in number value and marks the total number of successful and unsuccessful passes during one offense, while the effectiveness is measured by three categories. *Successful* – offense where the minimum of one point is realized; *Unsuccessful* – offense where no point is realized; and *Neutral* – offense where the offense did not realize a point but the team retained the possession of the ball. The selection and interpretation of the result is carried out according to the basic type offense in basketball: *Set*, *Transition* offense, *Early* offense with

the note that the category of Other offenses (offenses that according to their structure cannot be classified in any of the aforesaid categories) is not classified in the interpretation due to unprecedented practical applicability.

The data processing method used involves the illustration and interpretation of the descriptive parameters of the number of passes within different offense types, including the relative parameters of the effectiveness coefficient and the mean duration of the perceived offense modalities. The differences in the types of offenses in the frequency of passes and their influence on the outcome is tested by Univariate Analysis Variance (ANOVA) supplemented with post-hoc Tukey HSD test with statistical significance level  $p > 0.05$ .

## Results and discussion

According to the method of modal division of offense in the present work, the *set* offenses make up about 68% of the total offenses in basketball; the *transition* are represented by 12%; *early* make up 8 % of the total number while the remaining belongs to *other* offenses. The high representation of *set* offense, as well as, its' susceptibility to tactical training provides an essential and suitable orientation of situational preparation. This offense is the longest type regarding time duration (lasts for 15 s) and consists of the highest number of passes (3.7), with an effectiveness ratio of 45% negative, 37% positive and 18% neutral outcome, while the offensive benefit value amounts to 0.79 points per offense (Table 1). Furthermore, the standard deviation value shows that two to three passes are mainly present whereby the central tendency measures - median and mode sum up to three passes. The range of results indicates a maximum of 12 passes in one offense, that there are set offenses without ball distribution respectively.

Table 1. Descriptive parameters of passes in relation to the overall number of analyzed offenses

	N offense	Overall off. ratio	N passes	Mean passes	Std.Dev. passes	Median passes	Mode passes	Min pass.	Max pass.	Skew. passes	Kurt. passes	OBV offense	t (s) offense
Set	1780	68%	6518	3.66	1.63	3	3	0	11	0.55	0.27	0.79	15.00
Transition	238	12%	345	1.45	0.97	1	1	0	6	0.78	1.35	0.97	5.25
Early	154	8%	322	2.16	1.42	2	2	0	5	0.51	-0.25	0.86	9.16
Other	432	12%											
Sum	2604												

*Transition* offenses in top basketball implicate with the share of 12% of total offenses. The present research has established that such offenses include the least amount of passes (1.45) and have the highest strength of effectiveness (0.97), whereby the effectiveness ratio registers 48% positive, 35% negative and 17% neutral outcome. This logically imposes an aspiration to create as many as possible fastbreaks. Generally, *early* offense is defined as an offense consisted of a transition state and a short set (position) state. Even though it regularly deals with the 5:5 players formation on frontcourt, it is characterized by an early finish due to incomplete control all offensive players at the moment of a shot. By reviewing the measures of the quantity of passes, offense duration and their effectiveness (Table 1), there is an obvious complete correlation among the offense modalities, and, therefore, according to those parameters *early* offenses can be placed between the established measures of *set* and *transition* offenses. The amount of passes among the viewed types of offenses are statistically significantly different (Table 2., Table 3.).

Table 2. ANOVA – Difference between

	SS	DF	MS	F	P
Passes	1272.916	2	636.458	268.783	0.0000
Error	5136.024	2169	2.368		

Table 3. Post-hoc Tukey HSD test types of offense in number of passes

	Type off.	1 (3.6618)	2 (1.4496)	3 (2.0909)
1	Set		0.000022*	0.000022*
2	Transition	0.000022*		0.000182*
3	Neutral	0.000022*	0.000182*	

Ball distribution in set offense represents the essential technical and tactical means in realizing an adequate opportunity during the realization of the offense. Stravropoulos and Foundilis, 2005. (according to Gomez, et. al. 2007.) concluded that the use of longer offenses with a greater number of passes reflects a better cooperation and has a positive influence on the realization of a position for a shot closer to the basket and greater effectiveness. The results of the present research, however, partly negate the stated claim. As can be seen in Table 4 and Figure 1, a higher number of passes in the offenses of the Euroleague system matches do not reflect the overall greater effectiveness.

Table 4. Relation of amount of passes and outcomes in Set offense (ANOVA)

Set off.	SS	DF	MS	F	P
Outcome	56.98	2	28.49	10.804	0.000022
Error	4685.43	1777	2.64		

Table 5. Post-hoc Tukey HSD test – Set offense

	Set off.	1 (3.5590)	2 (3.4709)	3 (3.8518)
1	Positive		0.351851	0.001853*
2	Negative	0.351851		0.000105*
3	Neutral	0.001853*	0.000105*	

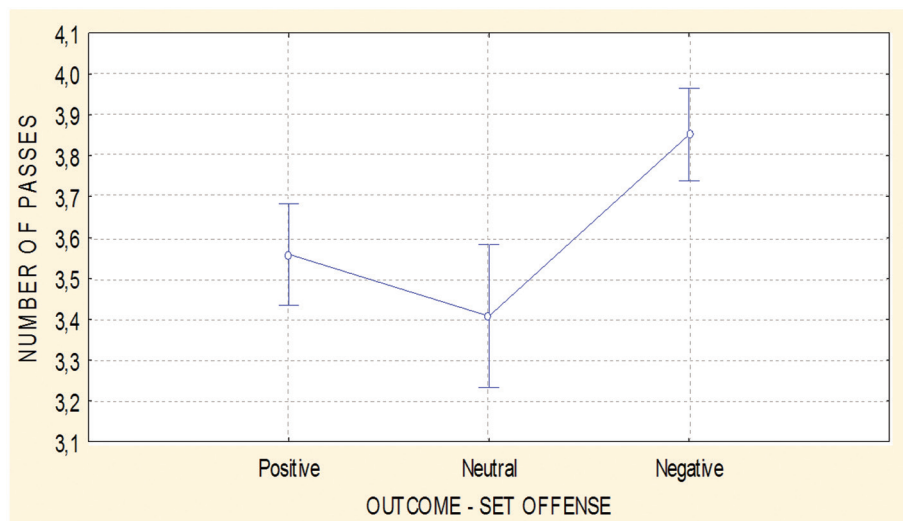


Figure 1. Relation of passes and outcomes in Set offense

Although such a condition encourages additional analysis of measures of pass functionality, it is not appropriate to connect a larger ball distribution with higher effectiveness in set offense. It is to be emphasized that general observation makes it evident that set offense regularly consists of passes that have no influence whatsoever on creating an advantage over defense. This is specially meant by passes in backcourt. In conclusion, it is extremely important to create a valid and reliable measure that would focus on the purposefulness of passes during offense actions. Such measure would establish whether the acquired results are a primary consequence of pass non-functionality or excessive tactical ball distribution. Looking in general, evaluation of passing suggests an integrative approach including biomechanics, performance analysis, physical conditioning, mental factors, and motor skills aspects (Quilez, et. al. 2019).

Unlike set offense where passes are dominantly tactically planned, and often partly patterned, passes in *transition* offense represent a spontaneous and almost reflexive action in the attempt of realizing a quick offense advantage. The mean frequency of passes within a fastbreak is significantly lower than the number of noted and set offences.

Table 6. Relation of amount of passes and outcomes in Transition offense (ANOVA)

Transition	SS	DF	MS	F	P
Outcome	5.1058	2	255.29	2.7802	0.064068
Error	215.7891	235	0.9183		

Table 7. Post-hoc Tukey HSD test – Transition off

	Transition	1 (1.4375)	2 (1.1957)	3 (1.6125)
1	Positive		0.319757	0.425152
2	Negative	0.319757		0.049101*
3	Neutral	0.425152	0.049101*	

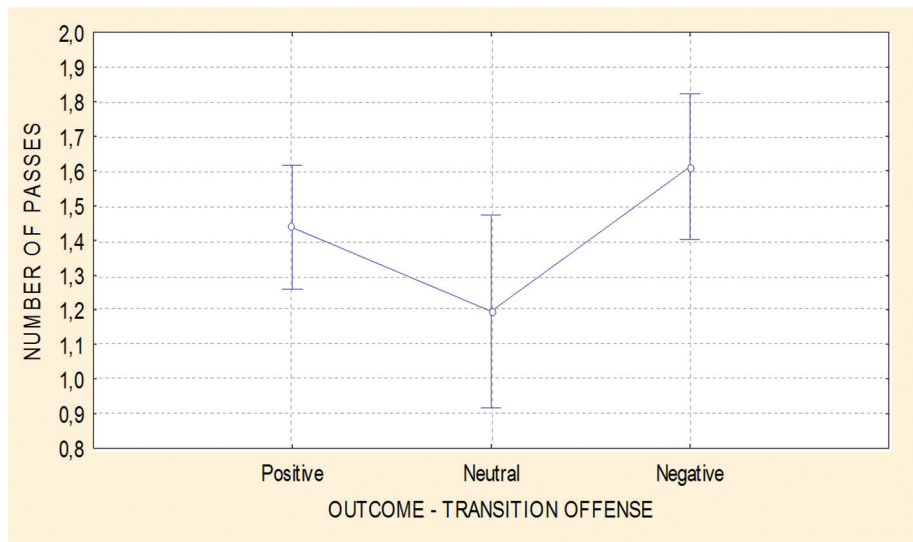


Figure 2. Relation of passes and outcomes in transition offense

By its essence, fastbreaks are regularly characterized by a quick ball transfer whereby the ratio of the offensive players are generally higher or equal to defensive players in the frontcourt with a favorable scoring opportunity. When focusing on passing frequency in relation to the success of offense, previous research mainly shows that a lower number of passes in transition have a favorable impact on a positive outcome. In Cardenas’ (2015) analysis of fast breaks it is stated that elite teams usually made maximum two passes. Similar finding was found in Swalgin’s analysis (2014), where there is no offense categorization but the number of passes is analyzed exclusively according to ball possession, it is concluded that offenses without passes or with one pass are the most effective type of offense (57% positive outcome in offenses without passes and 46% positive outcome in offenses with one pass). When the ball distribution quantity is viewed categorically – within the *transition* offense, as in the present case, it turns out, however, that the number of passes does not represent a factor that has an influence on the outcome. The Post-hoc test reveals a significant difference in the ball distribution between a negative and neutral outcome but it does not contain a practical implication.

A similar results appear in *early* offense as well. The variability from 0 to 5 passes within this type of offense does not reveal a specific tendency towards a certain type of outcome (Table 8.). Thu, it can be concluded that an eventual inappropriate position defense in the initial set phase is completely independent of the number of passes. The orientation towards eventual differences should be directed towards other constitutive factors of offense.

Table 8. Relation of amount of passes and outcomes in Early offense (ANOVA)

Early off.	SS	DF	MS	F	P
Outcome	6.3708	2	3.1854	2.8913	0.058581
Error	166.3565	151	1.1017		

Table 9. Post-hoc Tukey HSD test – Early offense

	Early off.	1 (2.2400)	2 (2.0690)	3 (1.6190)
1	Positive		0.620075	0.043718*
2	Negative	0.620075		0.211655
3	Neutral	0.043718*	0.211655	



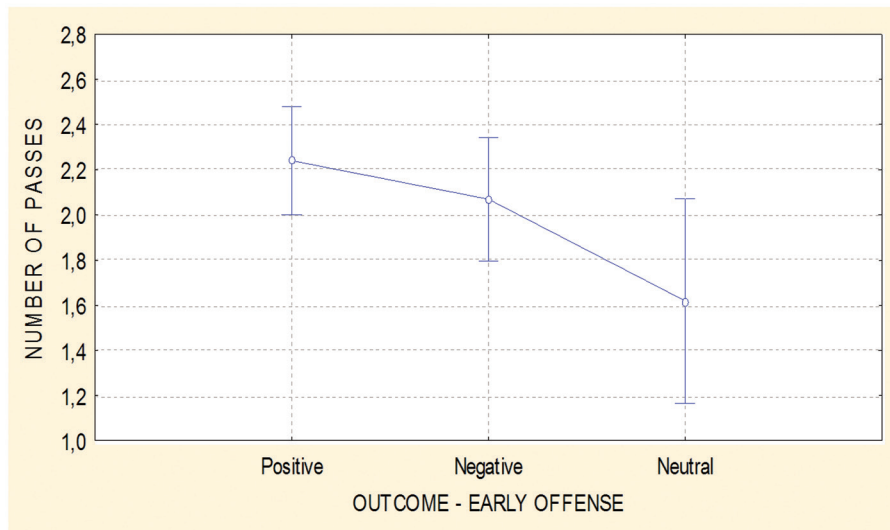


Figure 3. Relation of passes and outcomes in Early offense

By the general observation, a precise and opportune pass plays a critical role in the realization of final maneuver in *early* offense. The common prevalence in literature states that teams must strive for a longer offense with more passes searching for an appropriate chance for an open shot (Gomez, Tsamourtzis, Lorenzo, 2007) if a quick and effective transition has not been attained. However, the results of the present work indicate that players in top basketball are able to materialize the circumstance of inadequately positioned defense with relative success even in the early stage of *set* offense. Relatively favorable measure of effectiveness of *early* offenses (OBV – 0.86) reveals inclination to use the opportunity of an inappropriately placed defensive formation aimed at scoring quick and easy points.

## Conclusion

This study has demonstrated significant differences in the frequency of passes between basic types of attacks and has also identified complete correlations in their duration, efficiency and frequency of passing. More persistent ball distribution indicates higher team cooperation, but the results of the present study show that it does not necessarily indicate higher efficiency. A higher number of passes in the Euroleague set offense registered slightly worse overall efficiency in comparison. Early offenses point to relatively good effectiveness. Passes within such offenses represent a critical means of exploiting advantage against an ineptly set defense. Transition offenses are consisted of the least number of passes and have the highest potential effectiveness despite the fact that they have the shortest duration. A fastbreak's quick attack intends to take advantage of the uncontrolled defense and the favorable formation of the players, and passing is highly efficient in gaining the spatial advantage over the defense. However, given the situational circumstances, the successful execution of a fastbreak cannot be determined by passing frequency. Passing in set offense generally represents an important segment in creating the imbalance in defense, and, taking into account the obtained results, which are contrary to the main findings of the current research, further research suggests the analysis of passing functionality in all offensive time phases, as well as the analysis of the types of passes, the degree of their effectiveness and the relationship with the outcome. Such analysis should include different subtypes of set offenses (offenses against a man-to-man defense; offenses against a zone defense) as well as different transition offenses (primary; secondary fastbreak). Finally, for further research, it would be recommended to include a larger sample of analyzed matches in order to obtain even more accurate information and generalizations about the relationship of passes and their influence on offensive success.

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## BALL PASSING OF FUTSAL PLAYERS WITH DIFFERENT COMPETITIVE PERFORMANCE

Hrvoje Sivrić<sup>1</sup>, Zrinko Čustonja<sup>2</sup>, Damir Rukavina<sup>1</sup>

<sup>1</sup>University of Slavonski Brod, Croatia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

The main scope of the research was to identify and explain the differences in indicators of situational efficiency in the attack phase of futsal players with different competitive performance. The respondent sample represented a total of 111 futsal players from all 10 clubs of the First Minifootball Division in Croatia in the first part of the 2020/2021 season. Sample for variable in this research is divided in 2 groups: competitive performance, situational efficiency. Competitive performance is defined with reference to the quality of the player within the team and the club rank. Situational efficiency was determined by variables that were noted during matches as performance indicators. Futsal players were evaluated using 6 variables ball passing. The chosen performance indicators were used to analyse differences in futsal players with different competitive performance. Methods of data processing included the calculation of descriptive statistics parameters. One-way ANOVA was used in order to identify statistically significant differences between the groups. Bonferroni post hoc was used for identification of statistical significance of the main effect. Variance analysis showed significant differences in all six variables. Futsal players with better competitive performance are significantly better in ball passing or performing an attack in order to activate the game and/or achieving positive transition and/or creating a favorable opportunity to score.

**Key words:** *situational efficiency, differences, active*

### Introduction

The term futsal is an abbreviation of Portuguese words 'futebol de salao' or Spanish 'futbol de sala' which mean indoor football. A scaled down version of football i.e. futsal is a standardized form of indoor football recognized by leading football associations FIFA and UEFA. Futsal is still a growing sport with a significant rise in the number of players in countries throughout Asia, Europe and South America (Gioldasis, 2016; Yeemin, Dias & Fonseca, 2016). As futsal continues to grow, the need for important information, which would be used to develop the sport further, also grows (Yeemin et al., 2016). According to Nemčić, Sedar & Tomić (2016), it is possible to note a big number of various events that indicate the level of players situational efficiency during a match. Therefore, notational analysis is used as a method of noting events during a competition, and it includes video analysis and statistical processing. The main aim is to optimize feedback in order to improve performance. (Clemente, 2012). Information such as the number of attacks, passes and strikes form the basis in programming a training session and preparing a player. (Ren, 2013) Due to its specific features, an early selection of futsal players is required. (Jovanovic, Sporis & Milanovic, 2011). A big problem of this research lies in the fact that there is a deficit in research and a lack of information on situational efficiency. The aim of this research is to ascertain and explain the differences in the chosen indicators of situational efficiency in players with different levels of competitive performance. Therefore, the following hypothesis was formed: H<sub>1</sub>: Futsal players with a higher level of competitive performance will be significantly better at ball passing than futsal players with a lower level of competitive performance.

### Methods

**Examinee sample.** The research included futsal players from all ten clubs of the First Minifootball Division in Croatia (1. HMNL) during the first part of the season 2020/2021. Notational analysis was used in all 45 games (100 %). The respondent sample is comprised of 111 entities or 90,24 % of overall players who met the criteria of successive play lasting not less than 600 seconds. An average of 11,1±1,66 futsal players per club were measured. **Variable sample.** *Competitive performance was determined according to Likert scale* from 1 - 5 on account of two parameters, with regard to the quality of players inside the team and club rank (Table 1.). The quality of players was determined by the coach's assessment of the player's contribution to the team. Every coach classified its team into 3 groups (above-average - lead players, average

- starting lineup players and substitute players who contribute to the quality of the game, below average players - players who rarely or never enter the game). Club rank was determined according to team result in the first part, half-season of the 1. HMNL 2020/2021. The clubs were grouped into three categories (1<sup>st</sup> -3<sup>rd</sup> place, 4<sup>th</sup> -6<sup>th</sup> place and 7<sup>th</sup> -10<sup>th</sup> place). After obtaining the abovementioned parameters, the competitive performance of futsal players was determined (Table 2).

Table 1. Categorization of competitive performance

Club rank	Members of the national team	Above average players	Average players	Below average players
1 <sup>st</sup> – 3 <sup>rd</sup> place	5	5	4	3
4 <sup>th</sup> – 6 <sup>th</sup> place	5	4	3	2
7 <sup>th</sup> – 10 <sup>th</sup> place	5	3	2	1

Table 2. Competitive performance of futsal players in terms of quality within the team and club rank (N=111)

KR	MNK	REP	IINU1+2	IINU3	IINU4	IINU5
1.	MNK Olmissum	5	-	2	3	6
2.	MNK Novo Vrijeme	3	-	4	3	4
3.	MNK Futsal Dinamo	1	-	-	7	3
4.	MNK Square	2	2	5	1	1
5.	MNK Crnica	2	-	3	4	2
6.	MNK Alumnus Sesvete	1	2	8	1	1
7.	MNK Uspinjača Gimka	-	7	3	-	-
8.	AMNK Universitas Split	-	10	3	-	-
9.	HMNK Vrgorac	2	10	3	-	1
10.	MNK Osijek	-	8	4	-	-
	Σ	16	39	35	19	18

Legend: KR - club rank; MNK - indoor soccer club; REP - members of the national team; IINU1+2 - index of individual competitive performance 1+2; IINU3 - index of individual competitive performance 3; IINU4 - index of individual competitive performance 4; IINU5 index of individual competitive performance 5.

The entire sample of futsal players was divided into four groups (IINU – the index of individual competitive performance): IINU1+2 – the least successful futsal players; IINU3 – less successful futsal players; IINU4 – successful futsal players; IINU5 – the most successful futsal players. *Situational efficiency was described in terms of notational analysis.* Variables used as performance indicators are: 1. ball passing, total – SEDL. An event during the attacking phase when a player passes the ball to a teammate was tested; 2. ball passing, active total – SEDL-A. An event during the attacking phase, when the player passes the ball forward with the aim of keeping possession and/or preparing the team for attack with the aim of activating the game and /or achieving positive transition and/or creating an opportunity to score (assist or pre-assist) was tested; 3. with regard to the outcome: SEDL-AU – active successful; 4. With regard to the outcome: SEDL-AUP – active successful (with a score); 5. With regard to the outcome: SEDL-AUN – active successful (without a score); 6. ball passing, active unsuccessful – SEDL-AN. An event during the attacking phase, when the player passes the ball forward with the aim of keeping possession and/or preparing the team for attack with the aim of activating the game and /or achieving positive transition and/or creating an opportunity to score (assist or pre-assist), but unsuccessfully, was tested. **Methods of data processing** included the calculation of descriptive statistics parameters. One-way ANOVA was used in order to identify statistically significant differences between the groups. Bonferroni post hoc was used for identification of statistical significance of the main effect. The data were processed by the computer program Statistics ver.13.0.

## Results

Tables 3.1. and 3.2. show the results of descriptive statistics. The distribution of the results does not exceed the threshold maxD value, and the data were normally distributed. Therefore, it is reasonable to conclude that the variables possess satisfactory metric features, so parametric statistical procedures were used to process the results.

Table 3.1. Descriptive indicators of situational efficiency of futsal players 1 (N=111)

Variable	IINU1+2 (N=39)			IINU3 (N=35)			IINU4 (N=19)			IINU5 (N=18)		
	SKEW	KURT	D* (K-S test)	SKEW	KURT	D* (K-S test)	SKEW	KURT	D* (K-S test)	SKEW	KURT	D* (K-S test)
SEDL	0,99	-0,24	0,19	-0,07	-1,16	0,09	0,64	-0,24	0,12	0,69	0,32	0,15
SEDL-A	1,56	2,14	0,23	0,17	-0,94	0,08	0,92	0,12	0,17	1,31	3,40	0,16
SEDL-AU	1,53	2,28	0,22	0,27	-0,98	0,11	0,52	-0,82	0,17	1,22	2,91	0,15
SEDL-AUP	1,62	2,94	0,19	0,57	-0,46	0,18	0,38	-1,21	0,21	0,86	0,27	0,15
SEDL-AUN	2,03	4,54	0,23	0,30	-0,88	0,11	0,60	-0,84	0,18	1,20	2,79	0,17
SEDL-AN	1,81	3,07	0,21	0,56	0,05	0,08	1,28	1,01	0,22	1,07	1,98	0,14

Legend: IINU1+2 - index of individual competitive performance 1+2; IINU3 - index of individual competitive performance 3; IINU4 - index of individual competitive performance 4; IINU5 - index of individual competitive performance 5; D - K-S test coefficient; SKEW - asymmetry degree; KURT - curvature degree

Table 3.2. shows that the most successful futsal players IINU5 have the highest average scores in all six variables of active ball passing. Also, the average results rise in all variables with the rise in player's performance. With standard deviation measures it can be noticed that the players of the IINU5 group possess, in average, the highest result variability in all variables, and then with the least successful players, IINU1+2. Groups IINU3 and IINU4 are more homogenous, the average variability is lower and the values are consistent. The maximum result values are the highest in IINU5 group while the values in other groups are variable in all variables.

Table 3.2. Descriptive indicators of situational efficiency of futsal players 2 (N=111)

Variable	IINU-1+2 (N=39)			IINU-13 (N=35)			IINU-14 (N=19)			IINU-15 (N=18)		
	AS±SD	Min	Max	AS±SD	Min	Max	AS±SD	Min	Max	AS±SD	Min	Max
SEDL	175,2±175,30	4,0	620,0	287,0±161,09	25,0	556,0	315,0±159,22	69,0	627,0	521,0±246,55	156,0	1035,0
SEDL-A	19,00±20,89	0,0	87,0	33,06±20,28	1,0	71,0	36,37±23,12	6,0	89,0	70,89±33,68	16,0	168,0
SEDL-AU	10,10±11,14	0,0	48,0	17,71±11,93	0,0	38,0	19,47±12,37	2,0	41,0	43,83±20,83	11,0	103,0
SEDL-AUP	9,23±10,29	0,0	46,0	1,57±1,42	0,0	5,0	1,68±1,46	0,0	4,0	3,89±2,74	0,0	10,0
SEDL-AUN	0,87±1,36	0,0	6,0	16,14±10,89	0,0	36,0	17,79±11,67	2,0	38,0	39,94±19,24	9,0	94,0
SEDL-AN	8,90±10,44	0,0	42,0	15,34±9,85	1,0	40,0	16,89±12,15	4,0	48,0	27,06±14,18	5,0	65,0

Legend: IINU1+2 - index of individual competitive performance 1+2; IINU3 - index of individual competitive performance 3; IINU4 - index of individual competitive performance 4; IINU5 - index of individual competitive performance 5; AS - arithmetic mean; SD - standard deviation; Min - minimum score; Max - maximum result.

Table 4. Analysis of variance of situational efficiency of futsal players of different individual competitive performance

Variable	F	p
SEDL	14,98	0,00*
SEDL-A	19,99	0,00*
SEDL-AU	25,76	0,00*
SEDL-AUP	13,28	0,00*
SEDL-AUN	25,01	0,00*
SEDL-AN	10,92	0,00*

Legend: F - coefficient of analysis of variance; p - level of statistical significance of the coefficient; \* - statistically significant coefficient at the level of  $p < 0.05$ .

Table 4. shows how futsal players with different levels of individual competitive performance have significant differences in all variables of ball passing. With the aim of determining differences between certain groups, a Bonferroni test (post hoc analysis test) was used on the variables that have a significant effect on the differences. (Table 5).



Table 5 (5.1 – 5.6.) Post-hoc analysis of differences in individual competitive performance, for futsal players

Table 5.1. Post-hoc: ball passing, total

Variable	IINU1+2	IINU3	IINU4	IINU5
IINU1+2		0,06	0,04*	0,00*
IINU3	0,06		1,00	0,00*
IINU4	0,04*	1,00		0,00*
IINU5	0,00*	0,00*	0,00*	

Table 5.3. Post-hoc: ball passing, active successfully

Variable	IINU1+2	IINU3	IINU4	IINU5
IINU1+2		0,11	0,09	0,00*
IINU3	0,11		1,00	0,00*
IINU4	0,09	1,00		0,00*
IINU5	0,00*	0,00*	0,00*	

Table 5.5. Post-hoc: ball passing, active successfully – no goal scored

Variable	IINU1+2	IINU3	IINU4	IINU5
IINU1+2		0,12	0,10	0,00*
IINU3	0,12		1,00	0,00*
IINU4	0,10	1,00		0,00*
IINU5	0,00*	0,00*	0,00*	

Table 5.2. Post-hoc: ball passing, active

Variable	IINU1+2	IINU3	IINU4	IINU5
IINU1+2		0,07	0,06	0,00*
IINU3	0,07		1,00	0,00*
IINU4	0,06	1,00		0,00*
IINU5	0,00*	0,00*	0,00*	

Table 5.4. Post-hoc: ball passing, active successfully – goal scored

Variable	IINU1+2	IINU3	IINU4	IINU5
IINU1+2		0,47	0,53	0,00*
IINU3	0,47		1,00	0,00*
IINU4	0,53	1,00		0,00*
IINU5	0,00*	0,00*	0,00*	

Table 5.3. Post-hoc: ball passing, active unsuccessfully

Variable	IINU1+2	IINU3	IINU4	IINU5
IINU1+2		0,09	0,07	0,00*
IINU3	0,09		1,00	0,00*
IINU4	0,07	1,00		0,04*
IINU5	0,00*	0,00*	0,04*	

Legend: IINU1+2 - index of individual competitive performance 1+2; IINU3 - index of individual competitive performance 3; IINU4 - index of individual competitive performance 4; IINU5 - index of individual competitive performance 5; \* - statistically significant difference at the level of  $p < 0.05$ .

## Discussion

The indicators of competitive performance in the attack phase, such as receiving the ball and passing the ball, could be described as the basic elements of futsal and a high level of these elements enables achieving a competitive game and an efficient result. Naser and Ali (2016) conclude that the ability of making quick decisions and pass accuracy are the necessary values in futsal. Apart from that, overall ball passing is the most common event in the game, which, in this research, resulted with an average 717,6 ball passes per game (358,8 per team). It could be stated that on average, 12,07 times during half time, all four players achieve a successful active ball pass. The results given by the variance analysis established that all six observed variables differentiate between the most and least successful futsal players. The average value of the overall ball passes rises with the increase in the individual competitiveness from IINU1+2=175,26 to IINU5=521,06 (IINU3=287,03; IINU4=315,00) and significantly differentiates the IINU5 group from all other groups, as well as the IINU4 group from the od IINU1+2 group. The organization of the attacking phase, amongst other things, depends on the ball passing quality and efficiency, because in this way players keep the ball in possession, create space, prepare the team for attack, achieve positive transition and create an opportunity to score without spending a lot of energy, compared to dribbling and handling the ball. According to various research, it has been asserted that organized attacks score 24,3% of goals (Fukuda and De Santana, 2012) and 31% of goals. (Bueno and Alves, 2012). Also, the average value of all described variables in ball passing rises with the rise in competitive performance and significantly distinguishes IINU5 group from all other groups. The most successful players are more efficient in advancing the ball with the aim of ball possession or preparing the team for attacking with the aim of activating the game or achieving positive transition or creating an opportunity to score (assist or pre-assist) and that differentiates them significantly from all the other players. IINU5 group players achieve on average 44,5% of all active ball passes per game, while other groups achieve 55,5%. Although there are differences and all average values grow with the increase in competitive performance, other groups don't significantly vary in the described variables of active ball passes. Also, the most successful futsal players have the highest relative average values in all active ball passes in relation to overall passing number. (IINU5=14,07%, IINU4=11,75%, IINU3=11,63%, IINU1+2=12,73%), overall successful active passing number (IINU5=8,83%, IINU4=6,23%, IINU3=5,91%, IINU1+2=7,17%), overall successful active passing number prior to scoring a goal (IINU5=0,84%, IINU4=0,53%, IINU3=0,53%, IINU1+2=0,77%), and not scoring a goal (IINU5=7,99%, IINU4=5,70%, IINU3=5,38%, IINU1+2=6,40%). In average relative values of overall active unsuccessful ball passes compared to the overall number of passes, the highest values are in group IINU3 (IINU5=5,24%,

IINU4=5,53%, IINU3=5,72%, IINU1+2=5,56%). The average relative values in all variables of active ball passing do not rise with the rise in competitive performance.

## Conclusion

This research used notational analysis to analyze situational efficiency in the attacking phase of futsal players with different competitive performance. 111 futsal players from ten futsal teams of the First Minifootball Division in Croatia in the first part of 2020/2021 season that met the criteria of successive play lasting not less than 600 seconds. The main purpose of the research was to ascertain and explain the differences in futsal players' ball passes with regard to their different competitive performance. There were significant differences in all six described variables of ball passing in the area of situational effectiveness. Therefore, the hypothesis is confirmed. H1: Futsal players with better competitive performance will be significantly better than futsal players with worse competitive performance in ball passing. The overall situational efficiency includes only the part of overall efficiency that is measurable with statistical game record, and therefore represents partial game efficiency. This research does not include all skills and knowledge that could affect the efficiency of futsal players and performance indicators that could affect the evaluation of situational efficiency. The given information are static and limited to single events. Ball passing variable results highlight the results of collective play manifested in individual player skills and abilities, and the best futsal players are more efficient in passing the ball forward and to their teammates with the aim of ball possession or preparing the team for attacking with the aim of activating the game or achieving positive transition or creating an opportunity to score, which was confirmed by this research. Efficient ball passing in order to create spatial and temporal advantage is of enormous importance in opponent playoff and is, with the ability of higher performance percentage, necessary in futsal.

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## ANALYSIS OF THE DEVELOPMENTAL TRENDS IN RESULTS OF SHOT PUTTERS IN CROATIA FROM 2008 TO 2020

Stjepan Strukar, Marija Ivanković, Dražen Harasin

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

This research aims to establish the developmental trends of results in men's and women's shot put results in Croatia. The respondents are all Croatian shot putters that were listed among top ten positions in a respective season between 2008 and 2020. The variables of the research were male and female results in the shot put. 2<sup>nd</sup> and 3<sup>rd</sup>-degree polynomial regression analysis was used as the main statistical method for defining development directions and predicting results. The results of the research indicate differences between the developmental trend of results concerning gender. The developmental trends of all results in women end in a negative direction, while the results vary with men. The analysis of all the results shows that only the SB in male takes a positive direction of development. Currently, Croatia has very good high-level individuals in men's shot put, but the quality of other shot putters is very poor. When it comes to female shot put, due to poor results and the negative developmental direction throughout the total observation period, this discipline is barely surviving. The factors of the positive influence of SB development in men could be quality coaching and professional work based on scientific methods, or the system of the quality selection of young throwers based on their success. The factors that could have influenced the negative directions of the results are various financial investments in sports, insufficient investment in athletes who have not reached the respective level of success, or the young age of Croatian throwers.

*Key words: shot put, male and female throwers, seasonal results, prediction of results*

### Introduction

The developmental trends of sport results can be good indicators of the success of athletes at a particular world, national or local level. Moreover, the developmental trends of results can indicate the state of a particular sport or discipline over some time or at a particular point in time. Thus, for instance, in the research of world records in certain athletic disciplines from 1900 to 2007, a significant increase in results was observed from the beginning to the end of the observed period. In throwing sports, for example, the largest increase in results compared to the first world record is visible in the current world records in the shot put (M = 48.80% and F = 123.00%) and javelin throw (M = 58.00% and F = 186.00%) (Lippi et al., 2008). The analysis of the results in the throwing disciplines collected in the Olympic Games finals shows an increase in the results in the shot put for men from 1896 to the 1980s and an almost linear increase in the results for women from 1948 until the 1980s. From the 1990s until the London 2012 Olympic Games, changeable trends in results in the shot put are shown with both genders (Cieszkowski & Przednowek, 2015; Milinović et al., 2013, 2009). The general question, as well as the problem of this research, is the state of certain athletic throwing disciplines in Croatia. In this case, the developmental trend of results in the shot put for both genders will be analysed and compared. The research will determine a positive or negative trending of the results. The obtained results will be compared with individual national and international norms, which will help in predicting future trends. Finally, it will be established whether some factors could be related to the analysed development trends of results in the shot put for men and women in Croatia.

The aim of this research is, therefore, to determine the directions of developmental trends of results in the shot put for men and women in Croatia. Accordingly, the paper attempts to point out the advantages and disadvantages of the system and factors that influenced the development of the analysed results.

### Research Methods

The sample of respondents consists of all Croatian male and female shot putters (MSP and FSP) (N = 130) who, according to the national season tables for seniors from 2008 to 2020, were listed among the top ten throwers. All data about the annual results of Croatian shot putters and all entry standards for the Croatian Individual Senior Championship (CC) are taken from the official website of the Croatian Athletics Federation. The standards for the 2<sup>nd</sup> and the 3<sup>rd</sup> category of Croatian athletes (2<sup>nd</sup> cat. and 3<sup>rd</sup> cat.) were excluded from the official website of the Croatian Olympic Committee, and the entry standards for the Olympic Games in Tokyo 2021 (OG) are excluded from the official website World Athletics.

The male and female shot put results serve as the variable for this research. The research examines the development trends of the first result of the season (SB), the average of the first 3 results (AM-1-3) and the average of the first 10 results (AM-1-10) grouped by male (M) and female (F) genders. The collected data were processed by the software package Statistics 13.5. The following descriptive indicators were used to display the results: arithmetic mean (AM), minimum value (MIN), maximum value (MAX), total range (Range) and standard deviation (SD). The graphical representations of the results are defined according to the 2<sup>nd</sup>-degree polynomial regression function model. The predicted values of the results for 2021 were obtained by approximating the top 10 results from each season according to the 2<sup>nd</sup> and 3<sup>rd</sup>-degree polynomial regression function models.

## Results

Table 1. Descriptive result statistics in shot put in Croatia from 2008 to 2020

Variables	Gender	Discipline	N	AM	MIN	MAX	Range	SD
SB (m)	M	Shot put	13	20,81	19,95	21,84	1,89	0,60
AM-1-3 (m)	M	Shot put	13	19,63	17,86	20,85	3,00	0,79
AM-1-10 (m)	M	Shot put	13	16,72	14,49	18,61	4,12	1,06
SB (m)	F	Shot put	13	15,82	13,16	17,52	4,36	1,25
AM-1-3 (m)	F	Shot put	13	14,37	12,72	15,30	2,58	0,80
AM-1-10 (m)	F	Shot put	13	12,57	11,95	13,20	1,26	0,46

The overall results from Table 1 show a high average SB in men (20.81m), which would be satisfactory for the 2<sup>nd</sup> cat. ( $\geq 19.90\text{m}$ ). In contrast, the average SB in women (15.82m) is below the 2<sup>nd</sup> cat ( $\geq 16.50\text{m}$ ). Maximum values (MAX) present a very high SB for men (21.84m), which is also above the standard for the OG ( $\geq 21.10\text{m}$ ). The same value for women, MAX SB (17.52m) shows the level quite below the entry standard for the OG ( $\geq 18.50\text{m}$ ). The minimum values (MIN) of all results (AM-1-10) are very low in both genders and do not even satisfy the 3<sup>rd</sup> cat. ( $M \geq 17.15\text{m}$ ;  $\check{Z} \geq 13.60\text{m}$ ). The average AM-1-10 only meets the standards for CC ( $M \geq 13.00\text{m}$ ;  $\check{Z} \geq 10.50\text{m}$ ). Despite the results shown above, AM-1-10 for women has the most stable status under the dispersion (Range = 1.26, SD = 0.46), which indicates consistency and equal results over the observed period.

Table 2 The original men's and women's shot put results from 2008 to 2020 and the predicted values of results for 2021 according to the 2<sup>nd</sup>-degree polynomial regression function ( $b_0+b_1*x+b_2*x^2$ ) (2021<sup>2</sup>) and 3<sup>rd</sup>-degree polynomial ( $b_0+b_1*x+b_2*x^2+b_3*x^3$ ) (2021<sup>3</sup>)

Gender	M	F	M	F	M	F
Year	SB (m)	SB (m)	AM-1-3 (m)	AM-1-3 (m)	AM-1-10 (m)	AM-1-10 (m)
2008	19,95	15,49	19,25	14,93	16,90	12,51
2009	20,31	15,46	19,47	14,20	16,84	12,43
2010	20,56	16,02	19,21	14,23	16,00	12,64
2011	20,10	16,40	19,29	15,29	16,83	13,18
2012	20,66	16,82	19,59	15,24	16,22	13,01
2013	20,59	17,52	19,56	14,81	17,05	12,77
2014	20,68	17,08	20,36	15,01	17,49	13,08
2015	20,58	13,16	20,40	12,72	18,61	11,95
2016	20,71	17,37	20,47	15,30	18,00	13,20
2017	21,48	14,37	20,85	13,62	17,25	12,39
2018	21,36	15,11	19,92	13,74	16,06	11,98
2019	21,84	15,73	18,98	13,97	15,68	12,00
2020	21,69	15,12	17,86	13,80	14,49	12,25
2021 <sup>2</sup>	22,09	14,33	18,07	12,25	14,30	11,67
2021 <sup>3</sup>	22,31	15,86	16,14	13,87	11,80	12,06

By observing the results from Table 2, we can conclude that the most desirable results were given by SB for men with the realistic predictions of the high values given by the regression function of the 2<sup>nd</sup> and 3<sup>rd</sup>-degree polynomials. On the other hand, almost all predictions of other results for 2021 are negative. Such predictions go hand to hand with the current trends in the shot put results in Croatia. Namely, the two best Croatian throwers (MSP1 and MSP2) are still on a rising curve with results. Consequently, an increase in individual results and the breaking of national records can be expected. For women, most predictions for 2021 are negative. The exceptions are the predictions SB and AM-1-3 according to the model of the regression function of 3<sup>rd</sup>-degree polynomials, which indicate possible slight progress. Such predictions are realistically possible but difficult to achieve, given the current negative trend in the development of women's results. The additional cause for concern may be the fact that the female SB retaining at 2<sup>nd</sup> cat. ( $\geq 16.50\text{m}$ ) fell to 3<sup>rd</sup> cat. ( $\geq 13.60\text{m}$ ). All mentioned above shows that Croatia has never had a successful female shot putters on the international scene that could serve as an example to potential young athletes.

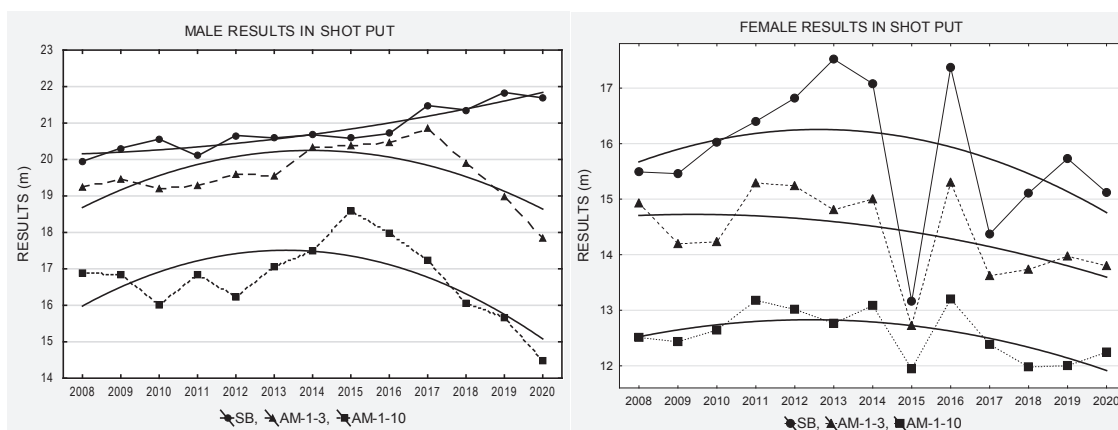


Figure 1. Male and female shot put results and the prediction of results according to the 2<sup>nd</sup>-degree polynomial function regression model

By observing the male results in Figure 1, the smallest ranges are between SB and AM-1-3 in the middle of the studied period, which indicates several throwers of similar quality in that period. The SB and AM-1-3 curves move away in the last third of the observed period and take the opposite directions, which indicates the uneven development of different quality throwers. Furthermore, the AM-1-10 is in a wide range over the overall observation period compared to the other two curves indicating a large difference in thrower quality. By observing the overall results for women (Figure 1), there are the negative directions of the curves almost throughout the entire observation period with a negative ending of all results. All three curves are at equal intervals throughout the observation period, which indicates equal differences in the quality of the female throwers. The large discrepancies in the results in certain years for women are caused by the absence of the most successful throwers from the competition throughout the season. For instance, the Croatian record holder in the shot put (FSP1), performed in 2014, and after skipping 2015, she performed for the last time in her career in 2016. FSP2, who holds the 2<sup>nd</sup> best result in the shot put at Croatian all time list dedicated only to throwing the discus, after her last performance as a shot putter in 2014.

## Discussion

It is evident that there are few quality shot putters in Croatia and only some male shot putters stand out in reaching the international level, comparing to the analysed shot put results achieved by men and women in OG from 1968 to 2012 which have not been changing a lot during the observed OG (Cieszkowski & Przednowek, 2015; Milinović et al., 2013). The best Croatian female shot put results are still lower of world records which took place more than 100 years ago and far from appearing in big competitions as is OG nowadays (Lippi et al., 2008; Milinović et al., 2013). The predictions of this research and the continuous progress of the best male shot putters could lead them to the respectable international level due to the poor and negative development of observed OG results (Cieszkowski & Przednowek, 2015). On the other hand, the setback of male throwers with lower results and all female results could lead them far under the international level. This few phenomenon could be explained by the very young population in the shot put in Croatia. Alongside their poor training experience, this keeps them from reaching the level of great international results. Namely, the Croatian athletic individual senior championships from 2009 to 2018, counted the average 36.17% of male seniors per discipline ( $N < 5$  per discipline), and 25.18% of female seniors ( $N < 3$  per discipline) (Ljubičić et al., 2019). If it takes into account that these data include all athletic disciplines, the number of seniors competing in individual throwing disciplines is likely less than the average for all disciplines.



## Conclusion

The developmental trends in the shot put results in Croatia have different directions concerning gender. Observing the differences between SB, AM-1-3 and AM-1-10, variable directions are observed in men, while in women all results end with a negative direction. The differences between AM-1-10 and AM-1-3 in both genders are greater than the differences between SB and AM-1-3, which indicates that the 10 best shot putters in the observed years differ in quality. Croatia currently has high international results in men's shot put, but this sport still has a negative trending for women. The good results of some male throwers significantly affect the maintenance of high levels of SB and, according to predictions, open the possibility for further progress in 2021. Predictions of all results according to the models of regression function of polynomials of 2<sup>nd</sup> and 3<sup>rd</sup>-degree are realistically achievable, but in addition to analysis of development trends of results, other factors that could in the future affect the development of results, either negatively or positively, must be taken into account. Factors that could have influenced the positive direction of SB development in men are quality coaching and professional work based on scientific methods or the success of young selected throwers. The factors that could have influenced the negative directions of the results are various financial investments in sports, insufficient investment in those athletes who did not achieve the desired results, the age of throwers, and the lack of motivation and interest in the shot put with Croatian athletes.

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## DIFFERENCE IN PHYSICAL PERFORMANCE IN ADOLESCENT SOCCER PLAYERS ACCORDING TO THEIR LEVEL

Nebojša Trajković<sup>1</sup>, Goran Sporiš<sup>2</sup>, Slobodan Andrašić<sup>3</sup>

<sup>1</sup>Faculty of Sport and Physical Education, Serbia

<sup>2</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>3</sup>Faculty of Economics, Serbia

**Introduction:** The ability to differentiate players according to their level is not clearly defined. There is evidence that youth soccer players classified as elite and non-elite differ in body size and maturity (Malina, 2003). but also in strength, flexibility and soccer-specific skills (Hansen et al, 1999; Rosch et al., 2000). However, studies that aimed to determine the level differences in speed, change of direction speed (CODS) and agility are missing. We investigated level differences in speed, change of direction speed and reactive agility in a group of trained adolescent soccer players.

**Methods:** A total of 75 adolescent male soccer players (aged 14–18 years) were recruited. The players were grouped on the basis of level of play to elite, sub-elite and amateur players. Players were tested for 5, 10-m sprint, and 20-m sprint, COD and Reactive Agility Test containing light-based (RAT-Light) and opponent-based stimuli (RAT-Opponent).

**Results:** Elite players had faster reaction time RAT-Opponent ( $p \leq 0.01$ ) compared to sub-elite and amateur players. Moreover, elite players showed faster time during RAT-Light ( $p \leq 0.01$ ) but only compared to amateur players.

**Conclusion:** This study does not recommend to use of agility full time and CODS as indicators to assign the players level differences in adolescents. On the other hand, we can conclude that reaction time in agility test can be a significant factor that differentiate between adolescent soccer players considering their level.

**Key words:** *differences, youth, performance, football*

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## HANDGRIP STRENGTH DURING OFFICIAL JUDO COMPETITION

Tatjana Trivic, Zoran S. Milosevic, Patrik Drid

<sup>1</sup>*Faculty of Sport and Physical Education, University of Novi Sad, Serbia*

**Purpose:** As judo is a weight-categorized sport, one of the most difficult challenges for elite judo athletes is to achieve excellent physical fitness and maintain an optimal body mass (1-3). The purpose of this study was to examine body composition and maximum isometric handgrip strength fluctuations during weight regain period and during official judo competition.

**Methods:** Data were collected on a total 108 judokas (51 females and 57 males). Athletes were tested during an official Serbian judo championship. Maximum handgrip strength for both hands was measured with a portable Takei handgrip dynamometer. Body composition was determined by bioelectrical impedance analysis.

**Results:** Results of the present investigation indicate that male judokas from first five official weight categories gained a significant amount of body weight from the official weigh-in to just before competition. Similar observations were seen if female judo athletes as well. However, as expected, significant decrease in handgrip strength within weight category for both hands was noted after post-match vs. pre-match. Interestingly, values recorded before first fight were unexpectedly lower than the corresponding values recorded before the official weigh-in.

**Conclusions:** In conclusion, after an official weigh-in, majority of athletes regained weight. Also, the results obtained through this study suggest that a judo fight significantly reduces the handgrip strength of both hands. Notably, both genders invested considerably more effort during weigh-in day, than in pre-match measurement.

**Key words:** *body weight, muscle strength, combat sports*

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## DIFFERENCES AMONG SELECTED AND NO-SELECTED MALE WATER POLO PLAYERS IN MORPHOLOGICAL CHARACTERISTICS AND PHYSICAL FITNESS CAPACITY

Ognjen Uljević<sup>1</sup>, Neven Kovačević<sup>2</sup>, Ivan Rukavina<sup>3</sup>, Dean Kontić<sup>4</sup>

<sup>1</sup>Faculty of Kinesiology University of Split, Croatia

<sup>2</sup>Croatian waterpolo association, Croatia

<sup>3</sup>VK Medveščak, Croatia

<sup>4</sup>University of Dubrovnik, Croatia

### Abstract

The aim of the present study was to define and evaluate the differences in physical fitness and anthropological characteristic between young male water polo players. The sample consists of 88 young water polo players ( $14.34 \pm 0.25$ ) participate in the Croatian National Water polo camp. Body height, body mass, body mass index, chest girth, abdominal girth, hip girth were measured. The physical fitness tests comprised: five swimming tests 800 MC, 400MC, 100MC, 50MC, 25MC and one sport specific test 25MCB. Independent sample t-test showed significant differences between qualitative groups of players in BH and in all observed physical fitness variables. No statistically significant difference was obtained in all other anthropological variables measured. Correlation of sports-specific 25MCB test with swimming tests was obtained, while baseline anthropometry was not determined with 25MCB test. The results of this study allow specific insights into the physical fitness capacity and anthropometric features of quality young water polo players and allow coaches to design a the specific training program.

**Key words:** Team sport, maturity, quality group, swimming, specific tests

### Introduction

Water polo is one of the oldest team sports on the Olympic games, it has been played since 1900 (Paris) until this day. While the rules of the game have evolved considerably over this time, physiologically speaking the sport has consistently remained a highly demanding activity (Smith, 1998). Water polo has been continuously evolving to this day, with occasional changes to the rules of the game. The latest rule changes occurred at the 2019 International Water Sports Organization (FINA) extraordinary congress in the Chinese city of Hangzhou in 2019. With these rule changes, water polo as a game has become more dynamic, the frequency of situational parameters of attack and defence has increased, the transition from attack to defence is faster, player contacts stiffer, and more frequent transitions from horizontal to vertical body position (Kovačević, 2012).

Modern water polo is characterized by fast and attractive play as well as frequent mutual contacts of players, which requires specific morphological characteristics from water polo players (Lupo, Tessitore, Minganti and Capranica, 2010). One of the most important factors in every sport, including water polo, is the anthropological characteristic of athletes. Through previous research, it has been recorded that the anthropological characteristics of water polo players change in the direction of higher height and weight with an increase in muscle mass compared to fat weight, which is explained as a consequence of the trend of acceleration and sports morphological adaptation (optimization) (Lozovina, Lozovina and Pavičić, 2012). It is to be assumed that the anthropological characteristics of water polo players change depending on the load in the game and training. One of the most important causes of changes in the load in the game is the change in the rules of the water polo game. Monitoring changes in the rules are very important because they cause changes in physical stress during the competition. Changes in load during competition require changes in the intensity of water polo training. The proper identification (selection) of talented athletes is one of the crucial duties in competitive sport.

Traditionally, water polo is one of the most popular team sports in Croatia, with numerous medals from all kinds of competition. For all these reasons, the Croatian Water Polo Federation (HVS) organizes a training camp for the best water polo players of the same age once or twice a year. At these training camps, talented water polo players are trained by the best water polo coaches that Croatia has. The main goal of such camps is to jointly train the best water polo players, observe them and ultimately select them for the national team. Also, one of the goals is to create, through testing, a database to use for further selection of players. Measuring and testing of anthropological characteristics of young water polo players

is very important for several reasons: the determination of water polo potential, training process control and monitoring as well as the control of growth and development (Hraste Mandić Jelaska and Kliškinjić, 2018). One of the priorities to measured and testing is the anthropological dimension of young water polo players because the anthropological dimension are good predictors of specific motor skill in water polo (Aleksandrovic, Jorgić, Georgiev, Ozsari, & Arslan, 2015). The aim of the present study was to define and evaluate the differences in anthropological characteristic and motor abilities between young male water polo players.

## Methods

The sample of subjects consists of 88 young water polo players who participate in the Croatian National Water polo camp for players 14 years old (U14). The camp was organized three years in a row (2015,16 and 2017.) to select the best water polo players. Selected players played for Croatian National Team on European and World championship. All players had been trained in water polo for at least 4 years. They have trained at least 6 times per week and during the season were included in a competitive system with more than 15 matches per season. The subjects were divided according to their playing level of quality (S-selected players S=30 and NS-non-selected players NS=58).

The sample of variables included six basic anthropometric and six physical fitness tests. The set of anthropological variables were: BH (body height), BM (body mass), BMI (body mass index according to Keys et al., 1972, CG (chest girth), AG (abdominal girth) and HG (hip girth) physical fitness variables were: 800 MC (800m crawl), 400MC (400 m crawl), 100MC (100m crawl), 50MC (50m crawl), 25MC (25m crawl) and one specific physical fitness test 25MCB (25 m water polo crawl with the ball).

The basic descriptive and distribution parameters were calculated: mean (M), standard deviation (SD), maximal (MAX) and minimal (MIN) result, lower (LQ) and upper (UQ) quartile. The distribution normality test was conducted by Kolmogorov-Smirnov test on the significance level of  $p < 0.01$  and all variables are normally distributed. Differences in anthropometric parameters between the two groups were determined by the T-test. Level of statistical significance was set at 5% ( $\alpha = 0.05$ ). Data were processed by the Statsoft Statistica ver. 13.0

## Results

Data show mean values  $\pm$  standard deviation (M $\pm$ SD), minimum (MIN) and maximum (MAX) values, the lower (LQ) and upper (UQ) quartile and values of Kolmogorov-Smirnov test (K-S). All presented variables had normal distribution (Table 1 and 2), there's not significantly depart from a normal distribution. The highest departures between cumulative and theoretical proportions (MaxD) are lower than border values for of 0.144 (n=88). Table 1. and 2. present the basic statistical parameters for anthropometric and specific motor abilities variables.

Table 1. Mean and standard deviation (M $\pm$ SD), minimal and maximal results (min, max), Lower and upper quartile and Kolmogorov-Smirnov test for anthropological variables

Anthropometric variables	Descriptive Statistics						
	M $\pm$ SD	Min	Max	LQ	UQ	K-S	MaxD
AGE	14.34 $\pm$ 0.25	14.03	14.99	14.14	14.49	0.98	0.144
BH	178.66 $\pm$ 6.47	161.00	194.00	174.50	182.00	0.09	0.144
BW	71.83 $\pm$ 11.22	49.00	105.00	64.00	79.00	0.08	0.144
BMI	22.43 $\pm$ 2.76	17.18	29.71	20.70	24.44	0.1	0.144
CG	92.56 $\pm$ 6.89	76.00	109.00	88.00	96.50	0.11	0.144
AG	76.36 $\pm$ 6.47	66.00	100.00	72.00	79.50	0.09	0.144
HG	91.80 $\pm$ 5.78	79.00	109.00	87.50	95.00	0.07	0.144

LEGEND: AGE - age of respondents, BH – body height, BM – body mass, BMI – body mass index, CG – chest girth, AG – abdominal girth and HG – hip girth



Table 2. Mean and standard deviation ( $M \pm SD$ ), minimal and maximal results (min. max), Lower and upper quartile and Kolmogorov-Smirnov test for specific physical variables

Physical fitness Variable	Descriptive Statistics						
	M $\pm$ SD	Min	Max	LQ	UQ	K-S	MaxD
<b>800MC</b>	656.13 $\pm$ 35.30	599.00	770.00	635.00	680.00	0.08	0.144
<b>400MC</b>	323.74 $\pm$ 18.83	288.17	383.00	312.23	333.63	0.09	0.144
<b>100MC</b>	70.45 $\pm$ 4.88	62.00	82.00	67.00	73.00	0.08	0.144
<b>50MC</b>	31.00 $\pm$ 1.85	27.20	38.12	29.79	32.04	0.1	0.144
<b>25MC</b>	14.23 $\pm$ 0.88	12.31	17.00	13.71	14.68	0.07	0.144
<b>25MCB</b>	15.14 $\pm$ 0.91	13.29	18.47	14.54	15.55	0.09	0.144

LEGEND: 800MC – swimming 800 m crawl, 400MC – swimming 400 m crawl, 100MC – swimming 100m crawl, 50MC – swimming 50 m crawl, 25MC – swimming 25m crawl, 25MCB – swimming 25 m water polo crawl

Table 3. show data mean values, standard deviation ( $M \pm SD$ ), values of t-test (t-value) and probability value (p). Independent sample t-test showed significant differences between qualitative groups of players in BH and in all observed motor abilities variables. The selected group achieved significantly higher scores than non-selected group.

Table 3. T- test analysis of anthropological and physical fitness variables

Variable	T-test			
	M $\pm$ SD (NS)	M $\pm$ SD (S)	t-value	p
<b>AGE</b>	14.35 $\pm$ 0.26	14.30 $\pm$ 0.22	0.83	0.40
<b>BH</b>	<b>177.06<math>\pm</math>5.79</b>	<b>182.94<math>\pm</math>6.35</b>	<b>-4.13</b>	<b>0.00</b>
<b>BW</b>	70.45 $\pm$ 11.61	75.50 $\pm$ 9.36	-1.91	0.06
<b>BMI</b>	22.38 $\pm$ 2.91	22.53 $\pm$ 2.31	-0.21	0.83
<b>CG</b>	91.78 $\pm$ 7.39	94.63 $\pm$ 4.86	-1.74	0.08
<b>AG</b>	75.90 $\pm$ 7.06	77.64 $\pm$ 4.29	-1.08	0.28
<b>HG</b>	91.60 $\pm$ 5.95	92.36 $\pm$ 5.38	-0.53	0.60
<b>800MC</b>	<b>669.22<math>\pm</math>35.15</b>	<b>637.91<math>\pm</math>26.87</b>	<b>3.58</b>	<b>0.00</b>
<b>400MC</b>	<b>328.63<math>\pm</math>18.56</b>	<b>310.68<math>\pm</math>12.39</b>	<b>4.38</b>	<b>0.00</b>
<b>50MC</b>	<b>31.53<math>\pm</math>1.80</b>	<b>29.61<math>\pm</math>1.14</b>	<b>4.87</b>	<b>0.00</b>
<b>25MC</b>	<b>14.43<math>\pm</math>0.88</b>	<b>13.72<math>\pm</math>0.64</b>	<b>3.59</b>	<b>0.00</b>
<b>25MCB</b>	<b>15.36<math>\pm</math>0.91</b>	<b>14.55<math>\pm</math>0.60</b>	<b>4.04</b>	<b>0.00</b>

The correlations between the sport specific fitness test (25MCB) and variables of swimming tests were significant (Table 4.) but there no significant between 25MCB and basic anthropometric tests. Correlation coefficient was relatively high for 800M and 400M tests: from 0.43 to 0.64 at 95% level. and for 50M and 25M tests were very high: from 0.79 to 0.80 at 95% level. A higher correlation coefficient on the 25M, 50M and 25MCB tests is expected since all three tests are of shorter duration and use almost similar swimming technique.

Table 4. Correlation of the anthropological, physical fitness variables and 25MCB

Variable	25MCB
<b>BH</b>	-0.22
<b>BW</b>	0.03
<b>800M</b>	<b>0.43</b>
<b>400M</b>	<b>0.64</b>
<b>50M</b>	<b>0.79</b>
<b>25M</b>	<b>0.80</b>

## Discussion

This investigation has three main findings. The first relates to morphological characteristics and physical ability. Comparing the results with similar research, we notice that water polo players are taller and heavier (BH  $1.63 \pm 0.07$ , BW  $57.46 \pm 7.94$ ) than handball players in Greece in the same years (Zapartidis, et al., 2009). This is not surprising because previous research has recorded a trend of selecting senior players in Croatian water polo (Kondrić et al., 2012). By analyzing the results of swimming studies in this study with the results of similar studies, especially tests 400MC, 100MC and 50MC, we can conclude that the tested water polo players in the Croatian water polo camp are more successful than water polo players of their age (Falk et al., 2004).

The second findings tell us how selected water polo players achieve better results in the tested variables than non-selected water polo players. Of course, such results were expected. We can assume that these variables also influenced the selection of players for the national team. This is not surprising because we know that modern water polo requires high swimming skills. Due to the better selection of players in the national team specific water polo movements should be included in the future test procedure. In this study relatively, early age selection ( $14.35 \pm 0.26$ ) was obtained, which may indicate that older water polo players are more desirable than younger water polo players because of their maturity. In any case, this thesis should be analysed in the following studies. To best of our knowledge, this is the first study to present the values of tests by quartiles, which can be used as indicative values for optimizing training process of young water polo players.

A higher correlation coefficient on the 25M, 50M and 25MCB tests is expected since all three tests are of shorter duration and use almost similar swimming technique. It is important to refer to the data indicating that there is no significant correlation between the sport specific 25MCB test and the BH anthropometric test. Previous research has confirmed a positive link between BH and most tests of basic functional swimming skills in water polo players. However, no significant association of morphological characteristics with the sport-specific 25MCB assay was found in this study. In reaching a conclusion, thoughts (certain doubts) arise. BH does not have a positive impact for success in this sport-specific test, but the specific technique of swimming and ball control during swimming is important for it, or selection according to BH question has already been done. Obviously, there is a difference between the technique of ball swimming and the technique of long-range swimming. The length of the underwater propulsion section of the paddle is shorter, so the technique of swimming is different. For better control of the ball in swimming, the water polo player swims with his head above the water, with a higher elbow position.

## Conclusion

The results of the research partially confirmed our hypotheses. Water polo players are taller and heavier than boys of the same age, which confirms previous research that there is a trend towards favouring taller players in Croatian water polo. The water polo players who participated in this study achieved better results in swimming tests than water polo players of the same age. It can be concluded that they have better physical fitness capacities. Presented test values by quartiles of young water polo players can be of great help to water polo coaches in the future overall training process.

The correlation of swimming tests with a specific swimming water polo test was determined, while there is no correlation with anthropological variables. Certainly, future research should include tests that have characteristic water polo movements and the same or similar physical activity to better assess physical fitness capacity.

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## THE DIFFERENCE IN THE PARAMETERS OF SITUATIONAL EFFICIENCY OF SERVE AND RETURN OF SERVE BETWEEN WINNERS AND DEFEATED MEN PLAYERS ON THE ROLAND GARROS 2018

Monika Vajdić, Petar Barbaros, Ivan Bon

University of Zagreb Faculty of Kinesiology, Croatia

### Abstract

Serve is the only shot in a tennis match on which the opponent has no impact, meaning that the player who is serving has an advantage over the player who receives and returns the serve. When returning the serve, the player does not have much time to react, but at the same time, he must return with control in order to continue the play. Since Grand Slam tournaments represent the top level of competition, feedback about a player's performance in such tournaments is the most relevant indicator for direction in planning and programming the training process. The aim of this research is to determine the differences in parameters of situational efficiency of serve and return of the serve between winners and defeated players during Roland Garros 2018. The sample of participants consists of 128 players. The sample of variables includes 16 statistical parameters (9 regarding serve and 7 regarding return of the serve). For the detection of differences between the winners and defeated players, the paired t-test was used. Based on the results it can be concluded that the winners and defeated players in the 1<sup>st</sup> and 2<sup>nd</sup> set differ in few important variables for winning the set. Due to a lapse in concentration and appearance of fatigue, defeated players lose serve quality, unlike the winners. In the 3<sup>rd</sup> set, winners are able to maintain the high quality of observed variables. Based on the results, it can be concluded that the return of serve is most probably one of the key determinants for success in tennis.

*Key words: tennis serve, return of serve, situational efficiency*

### Introduction

Tennis is a polystructural acyclic activity. There are numerous factors that affect result outcome, such as characteristics of tennis balls, type of court, weather conditions. Moreover, every point differs, and players must adjust the situation during the game in order to overcome space, time and the opponent. Besides the mentioned factors, winning a point depends on a player's tactics, i.e. the ability of a player to implement it in a game, and on choosing an optimal type of shot depending on the specific situation during the game. Serve is the only shot in a tennis match on which the opponent has no impact, meaning that the player who is serving has an advantage over the player who receives and returns the serve. In tennis, there are several types of serve. The flat serve, slice serve and top spin serve are most commonly used. A bit less often, the kick serve is also used (Cross, Pollard, 2009). Choosing a type of serve depends on the player himself, his affinity towards a specific type of shot, the opponent, tactics and whether the player serves 1<sup>st</sup> or 2<sup>nd</sup>. Serves differ in ball throw, its height and position, position of the racquet and the moment of impact between ball and racquet. The first serve is faster, as the player is aiming to win a point with that shot, which makes it unreliable, unsecure and with a high probability for mistakes. The second serve is slower and safer, as the players most important task in that serve is that the ball hits the serving box, so he can proceed with the point. Serve tactics is extremely important for success in a match and it is comprised of several principles, as follows: safety, diversity, precision and speed. The safety principal implies hitting the serve in the serving box. The aim of every player is to hit the serve into the court regardless of speed, rotation and ball rebound. Without the safety principal of the serve, basic tactical principals of the whole match are undermined. Furthermore, diversity of the serve implies applying different rotations and combining different parameters of the serve, such as speed, direction and ball rebound. The precision principal implies hitting a specific part of the serving box. The player is trying to serve the ball into the serving box corners or closest to the serving line, which gives his opponent less time to react. Speed is the most demanding principal of the serve, i.e. it is necessary to accomplish high speed along with precision. High speed sometimes is not the key for quality serve, but it helps the player to throw the opponent off balance and minimize his reaction time. (O'Donoghue, Brown, 2009). Return of serve is one of the most complex shots in tennis. The player is receiving a very fast ball, he does not have much time to react, but at the same time, he must return it with control in order to continue with the play. This shot is commonly characterized with a too fast swing, which is not controlled and leads to an error. Because of the above-mentioned, there are many tactical and technical elements that determine the return of serve (Hizan, Whip, Reid, 2011). Players often return the first serve in the middle of the court,

while on the second serve, they are aiming to return as aggressive as they can to attack the opponent. While returning the first serve, players cannot anticipate the direction and speed of the ball, which makes it more difficult to react properly. Because of the speed of the ball in the first serve, players do not have time to assess, react and make a forehand and backhand shot (Applewhaite, 2003). Likewise, serving tactics, return of serve tactics also include several key elements, that of safety, diversity and speed. Safety implies identifying serve characteristics and returning the serve in the same direction. By diversity, one refers to returning the serve with different types of shots, as well as with different speed rotation and ball rebound. It is preferred to return the ball in different parts of the court while using the top spin, slice drop-shot or lob shot. Fast and precise return of the serve is the most complex tactical solution and it requires a great amount of experience (O'Donoghue, Brown, 2009). Li and Zhou (2013) showed in their research that in modern tennis return of the serve is one of the key elements which affects the outcome of the match. The player who is serving has an advantage over his opponent who must involve a great amount of energy to return the serve and level the odds (O'Donoghue, 2012). Data collection during professional sports events became common with the development of sophisticated methods for tracking and recording aspects of sports performance (O'Donoghue, Ingram, 2001). Past studies regarding analysis of the serve and return of the serve targeted only individual elements that affect a player's efficiency. However, in order to get a complete overview on the importance of mentioned elements, it is necessary to include all tactical and technical parameters and analyse them as one whole unit (Corral, 2009). Since Grand Slam tournaments (Australian Open, Roland Garros, Wimbledon and US Open) represent the top level of competition, feedback from such tournaments is the most relevant indicator for direction in planning and programming the training process (Laffaye et.al, 2019). Regarding the above-mentioned, the aim of this research is to determine the differences in parameters of situational efficiency of serve and return of the serve between winners and defeated players during Roland Garros 2018.

## Methods

### Participants

The sample of participants consists of 128 players who entered in the main part of the men's tournament Roland Garros 2018. All 254 matches from the first round to the final match were analysed. First 3 sets were considered for statistical analysis for winning and defeated players.

### Variables

The sample of variables in this research consists of 16 statistical parameters that are officially tracked by ITF on Roland Garros 2018. Nine statistical parameters observed in this research are in relation to serve, while 7 parameters relate to return of the serve. The observed statistical parameters regarding serve are: aces, double faults, played points after serve, played points after 1<sup>st</sup> serve, played points after 2<sup>nd</sup> serve, points won after serve, points won after 1<sup>st</sup> serve, points won after 2<sup>nd</sup> serve, service games.

The observed statistical parameters regarding return of serve are: return games, played points after return, played points after return of 1<sup>st</sup> serve, played points after return of 2<sup>nd</sup> serve, won points after return, won points after return of 1<sup>st</sup> serve, won points after return of 2<sup>nd</sup> serve.

### Statistical analysis

For statistical analysis, the program "Statistica" version 13.5.0.17 (manufacturer: TIBCO Software Inc, Palo Alto, CA; release date: November 2018) was used. Basic descriptive parameters were calculated for all measured variables. The normality of the data distribution was tested by the Kolmogorov–Smirnov test. For the detection of differences between the winners and defeated players, the paired t-test was used. The results were considered as significant in case of  $p < 0.05$ .



## Results and discussion

Table 1. Descriptive statistical parameters and t-test between winners and defeated in variables for evaluation of situational efficiency of the serve

VARIABLES	1 <sup>st</sup> set			2 <sup>nd</sup> set			3 <sup>rd</sup> set		
	M±SD	M±SD	p	M±SD	M±SD	p	M±SD	M±SD	p
	N1	N2		N1	N2		N1	N2	
ACE	2,03±1,86	1,51±1,92	0,03*	2,14±2,29	1,52±1,55	0,01*	2,07±2,00	1,52±1,85	0,02*
DOUBLE_F	0,97±1,10	1,07±1,01	0,45	1,02±1,28	1,12±1,14	0,51	0,87±0,87	1,26±1,26	0,00*
NPAS_T	29,36±8,60	30,75±10,16	0,24	29,74±8,76	30,39±9,06	0,56	28,48±7,62	31,47±8,82	0,00*
NPAS_1	18,11±6,26	18,60±7,47	0,57	17,93±6,35	18,13±6,52	0,80	17,67±5,32	18,94±6,66	0,09
NPAS_2	11,48±4,41	12,07±4,81	0,31	11,64±4,80	12,27±4,80	0,30	6,59±4,27	12,53±4,73	0,00*
NWPAS_T	19,73±5,47	18,02±7,20	0,03*	20,02±5,69	17,76±7,16	0,01*	19,31±5,27	17,97±6,80	0,08
NWPAS_1	13,31±4,56	12,33±5,72	0,13	13,67±4,69	12,02±5,63	0,01*	13,44±4,22	12,23±5,08	0,04*
NWPAS_2	6,34±2,66	5,60±2,81	0,03*	6,27±2,66	5,74±3,03	0,14	5,87±2,70	5,77±2,96	0,78
NSG	4,02±1,20	3,19±1,47	0,00*	4,02±2,34	3,20±1,61	0,00*	3,98±1,21	3,15±1,60	0,00*

N1- winners, N2- defeated players, M- mean, SD- standard deviation, ACE- number of aces, DOUBLE\_F- number of double faults, NPAS\_T- number of played points after serve, NPAS\_1- number of played points after 1<sup>st</sup> serve, NPAS\_2- number of played points after 2<sup>nd</sup> serve, NWPAS\_T- number of total points won after serve, NWPAS\_1- number of points won after 1<sup>st</sup> serve, NWPAS\_2- number of points won after 2<sup>nd</sup> serve, NSG – number of service games. number \* - p≤0,05

Table 1 shows differences ( $p \leq 0,05$ ) between winners and defeated in some parameters of the serve. Match winners on average achieved  $2,03 \pm 1,86$  aces, while the defeated significantly less,  $1,51 \pm 1,92$  ( $p = 0,03$ ) in the 1<sup>st</sup> set. The number of points that winners achieved after serve ( $p = 0,03$ ) was also statistically significant, especially after the 2<sup>nd</sup> serve ( $p = 0,03$ ). Moreover, winners achieved  $6,34 \pm 2,66$  points after the 2<sup>nd</sup> serve, while the defeated had  $5,60 \pm 2,81$ . The number of serving games achieved by winners is on average higher than among defeated players ( $4,02 \pm 1,20$  vs  $3,19 \pm 1,47$ ), i.e. the match winner mostly won the 1<sup>st</sup> set ( $p = 0,00$ ).

The results show differences in 4 observed variables in the 2<sup>nd</sup> set between the winners and defeated players; in the number of aces ( $p = 0,01$ ), points won after serve ( $p = 0,01$ ), points won after 1<sup>st</sup> serve ( $p = 0,01$ ) and number of service games ( $p = 0,00$ ). Winners achieved  $2,14 \pm 2,29$  points with ace serve, while defeated players had  $1,52 \pm 1,55$ . Also, after serve, the winners achieved  $20,02 \pm 5,69$  points compared to defeated players who had  $17,76 \pm 7,16$ . A similar situation is noticeable while observing points won after serve, as the winners achieved  $13,67 \pm 4,69$  in comparison to the defeated  $12,02 \pm 5,63$ . A statistically significant difference is also demonstrated when comparing the number of played games in the 2<sup>nd</sup> set (winners-  $4,02 \pm 2,34$ ; defeated-  $3,20 \pm 1,61$ ). The obtained results point out that the winners are more significantly successful in both the 1<sup>st</sup> and the 2<sup>nd</sup> set in the number of aces, points won after serve and played serving games. Based on the mentioned results, it can be concluded that these are some of the most important variables for winning the set and the match. The number of played points after serve and double faults were very similar between winners and defeated players. In the 3<sup>rd</sup> set, out of the overall 9 measured variables, the winners and defeated players statistically differed in 6 of them. Winning players on average achieved  $2,07 \pm 2,00$  points with ace serve, while defeated players had  $1,52 \pm 1,85$  ( $p = 0,02$ ). In the 3<sup>rd</sup> set, there were also statistically significant differences determined in the number of double faults. Winners had  $0,87 \pm 0,87$  and defeated players  $1,26 \pm 1,26$  ( $p = 0,00$ ). The above-mentioned could be a result of lack of concentration and fatigue that can occur by losing the 2<sup>nd</sup> set. The number of played points after the 2<sup>nd</sup> serve is higher among winners, which was not the case while observing the 1<sup>st</sup> and the 2<sup>nd</sup> set ( $p = 0,00$ ). This variable relates to the number of aces, number of double faults and played serving games. Winning players achieved more aces, less double faults and played more serving games (NSG -  $p = 0,00$ ). The higher number of serving games resulted in a higher number of played points after serve and a higher number of double faults by their opponents. The number of points won after 1<sup>st</sup> serve is higher in the 1<sup>st</sup> and the 2<sup>nd</sup> set than in the 3<sup>rd</sup> set. Winners on average achieved  $13,44 \pm 4,22$ , while defeated players had  $12,23 \pm 5,08$  points ( $p = 0,04$ ). By analysing all the variables of serve in all 3 sets, it can be concluded that the serve is a significant factor for winning the set and also the match. The biggest difference between each of the 3 sets was in the number of double faults, which was higher in the 3<sup>rd</sup> set. Based on the observed data, it can be concluded that the defeated players were similar in the observed serve variables during the first two sets. However, in the 3<sup>rd</sup> set, as fatigue was taking place, and therefore a gradual loss of concentration, so did the gap between winners and defeated players become higher.

Table 2. Descriptive statistical parameters and t-test between winners and defeated in variables for evaluation of situational efficiency of the return of serve

VARIABLES	1 <sup>st</sup> set			2 <sup>nd</sup> set			3 <sup>rd</sup> set		
	M±SD	M±SD	p	M±SD	M±SD	p	M±SD	M±SD	p
	N1	N2		N1	N2		N1	N2	
NRG	1,43±0,87	0,72±0,88	0,00*	1,47±0,91	0,74±0,88	0,00*	1,54±0,97	0,66±0,98	0,00*
NPAR_T	30,69±10,20	29,57±8,23	0,34	30,47±8,86	29,66±8,58	0,46	31,25±8,66	28,52±7,63	0,01*
NPAR_1	18,61±7,44	18,09±6,28	0,55	18,06±6,63	18,10±6,16	0,96	18,98±6,65	17,62±5,31	0,07
NPAR_2	12,15±4,84	11,47±4,43	0,24	12,32±4,70	11,63±4,79	0,25	12,51±4,71	10,82±4,29	0,00*
NWPAR_T	11,65±4,34	9,03±4,54	0,00*	11,59±3,88	8,85±4,26	0,00*	12,20±4,07	8,38±4,62	0,00*
NWPAR_1	6,24±3,05	4,85±3,28	0,00*	6,05±2,91	4,46±2,89	0,00*	6,69±3,15	4,24±2,54	0,00*
NWPAR_2	5,49±2,98	4,15±2,42	0,00*	5,50±2,34	4,39±2,50	0,00*	5,59±2,92	4,13±2,93	0,00*

N1- winners, N2- defeated players, M- mean, SD- standard deviation, NRG- number of return games, NPAR\_T – number of total played points after return, NPAR\_1- number of played points after return of 1st serve, NPAR\_2- number of played points after return of 2nd serve, NWPAR\_T- number of total won points after return, NWPAR\_1- number of won points after return of 1st serve, NWPAR\_2- number of won points after return of 2nd serve \*  $p \leq 0,05$

Table 2 shows data in which the winners and defeated players significantly differ in 4 variables regarding the return of serve in 1st set. The number of return games on average was higher among winners  $1,43 \pm 0,87$  than among defeated players  $0,72 \pm 0,88$  ( $p=0,00$ ). A statistically significant difference was also demonstrated in the number of points after return of serve ( $p=0,00$ ). After return of the 1<sup>st</sup> serve, winners achieved  $6,24 \pm 3,05$  and defeated players had  $4,85 \pm 3,28$  ( $p=0,00$ ). After return of the 2<sup>nd</sup> serve the difference was lower, but significant ( $p=0,00$ ). Winners achieved  $5,49 \pm 2,98$  points, while defeated players had  $4,15 \pm 2,42$ . In the 2<sup>nd</sup> set, as well as in the 1<sup>st</sup>, winners and defeated players statistically differ in 4 variables of return of serve. The number of return games between winners and defeated players was very similar to the results in the 1<sup>st</sup> set. Winning players played  $1,47 \pm 0,91$ , while the defeated had  $0,74 \pm 0,88$  in the number of return games ( $p=0,00$ ). The results for won points after return of serve, after return of the 1<sup>st</sup> serve and after the 2<sup>nd</sup> serve were also similar to the results in the 1<sup>st</sup> set ( $p=0,00$ ). The winners achieved  $11,59 \pm 3,88$  points after return of serve and defeated players had  $8,85 \pm 4,26$  points. The number of achieved points after return of the 1<sup>st</sup> serve was also higher among winners ( $6,05 \pm 2,91$ ;  $4,46 \pm 2,89$ ). Likewise, winners achieved more points after return of the 2<sup>nd</sup> serve ( $5,50 \pm 2,34$ ;  $4,39 \pm 2,50$ ). Differences between winners and defeated players in return of serve relate to the quality of the opponents serve. A quality serve is more difficult to return and the opponent wins fewer points after that serve return. In the 3<sup>rd</sup> set, bigger differences were determined between winners and defeated players than in the first two sets. The number of return games among winners was  $1,54 \pm 0,97$ , while among defeated players it was  $0,66 \pm 0,98$  ( $p=0,00$ ). Winners played significantly more points after return of serve, which was not the case in the first two sets. The winners played  $31,25 \pm 8,66$  points and defeated players had  $28,52 \pm 7,63$  ( $p=0,01$ ). The number of played points after return of the 2<sup>nd</sup> serve was higher among winners ( $12,51 \pm 4,71$ ;  $10,82 \pm 4,29$  -  $p=0,00$ ). After return of the 1<sup>st</sup> and the 2<sup>nd</sup> serve, the winners achieved a total of  $12,20 \pm 4,07$  points, while defeated players had  $8,38 \pm 4,62$  points ( $p=0,00$ ). The number of played and won points relates to the serve and the ability to return the serve. Winners kept the quality of their serve, thus not allowing the opponent to win a point while serving. On the other hand, among defeated players the quality of both serve and return of serve decreased during the match. When return of serve is on a high level, the opponent has less chance to continue the point. Most of today's professional players have high quality and powerful serve. That shot is one of the key factors that influences the outcome of the match. Because of the above-mentioned, coaches should pay attention to developing serve and return of serve in the training process, which nowadays is not often the case. Based on the results in this research, it can be concluded that the return of serve is most probably one of the key determinants for success in tennis. Limitation of this study is that the research was conducted only on 1<sup>st</sup> 3 sets of the matches. It could be interesting to incorporate 4<sup>th</sup> and 5<sup>th</sup> set. Also the outcome of the match is not only determined with serving and serving return which are the beginning of the point. It is possible for future researches to incorporate middle of the point and end of the point statistical parameters, commonly named rally statistics.

## Conclusion

Based on the conducted research, it can be concluded that the winners and defeated players in the 1<sup>st</sup> and the 2<sup>nd</sup> set differed in few important variables for winning the set. Due to a lapse in concentration and appearance of fatigue, defeated players lost their serve quality unlike the winners. Also the reason for serves becoming less effective could be progression of anticipation during the opponents serve. Moreover, player who is losing at particular moment in the match can start to try "harder" and it can cause more errors while serving. While serving and returning the serve, big differences were determined when comparing the first two sets with the 3<sup>rd</sup> set. In the first two sets, winners and defeated players differed

in some statistically significant variables based on which the winners won the set. Moreover, quality serve and return of serve are some of the key factors for winning the match. This was most noticeable in the 3<sup>rd</sup> set where winners were able to maintain a high quality of the mentioned variables. Most of today's players have a powerful serve that can be maintained throughout the whole match, unlike the return of serve. Return of serve is a complex element whose success depends on a number of factors. Based on the results of this research, more training should be focused on return of serve. It can improve the game of both amateurs and professional players.

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## EVALUATION OF SCORING SYSTEMS IN SWIMMING RESULTS

**Bartol Vukelić, Goran Leko, Klara Šiljeg**

*University of Zagreb Faculty of Kinesiology, Croatia*

### Abstract

The research was carried out to determine if specific scoring systems in swimming are sensible and precise enough in detection of real quality of the result described with FINA points. The sample consisted of 132 swimmers (76 boys and 56 girls) aged 13. Data processing and statistical analysis in Statistics 13 provided the basic descriptive parameters: Mean, Standard deviation, Minimum and Maximum value. The distribution normality was tested by the Kolmogorov - Smirnov test which established normal distribution for all variables. Pearson's correlation coefficient and T – test for independent sample were used. The statistical significance was determined on the level of  $p < 0,05$ .

The study determined that both tested scoring systems, Power points calculator and Rudolph table, are sensitive and precise enough to evaluate quality of swimming result. T – test showed that boys and girls have statistically significant difference in mean of all variables (result in 100-meter freestyle, FINA points, Rudolph table) except in variable Power point calculator.

**Key words:** *FINA points, Power points calculator, Rudolph table, Age group*

### Introduction

FINA is world swimming organization that unites swimming, water polo, artistic swimming, diving and open water swimming (FINA, 2020a). With the fact that swimming Olympic program has 35 swimming events (disciplines) there is a need to compare quality of the result between disciplines and between gender. For that purpose, every year FINA publishes a point table(s) where the world record in every event is valorized with 1000 points. There is a table for male and a table for female swimmers. This scoring system is accepted in whole world for valorization of the result. In fact, in open age category (seniors) this evaluation is appropriate. But, besides seniors (open age category), European and national federations divide younger swimmers in age categories.

Because of differences in biological growth between gender (Šiljeg, 2018), age group margins are not the same for boys and girls. Girls grow faster and because of that they enter the higher age group one year before boys. The question arises whether the current division between age group categories adequate considering biological differences between genders.

If we want to compare results in same events but in different age groups, FINA tables will show the difference in points but not in the quality of the results between these age categories. Besides that, the growth in accomplished FINA points throughout the years of aging does not show if that growth is adequate for that age group to maintain the quality of result.

For that purpose, scientists have created “tools” with which is possible to compare quality of the result between different age groups and between genders.

One of these “tools” is Rudolph table. They are published every year for male and female swimmers, for every event in 50-meter pool (long course), for every chronological year. Results are divided into 20 classes where 20<sup>th</sup> class represent the top range of results in single age group. This “tool” gives the ability to compare quality of results between genders, age groups and events. Besides that, class shows if it is progress of the result adequate to maintain the same quality as in younger age groups.

Other “tool” is Power points calculator that is predominantly used in USA. Computer program calculates number of points that is in correlation with value of result, age, gender and pool length. With simple entry of default parameters, the program calculates number of points for the result in certain event, certain age group and pool length for each gender. In that way, it is possible to easily follow and compare quality of any two swimmers no matter the age, gender or event.

With tools like this, coaches still dominantly use FINA points for evaluation of swimming results because it is official FINA paper. Use of other “tools” for comparison and evaluation is somewhat avoidable because of doubts in their precision and adequacy.

Goal of this research is to determine if these two “tools” are sensitive and precise enough in detection of real quality of the result described with FINA points.

## Methods

*Participants:* The sample consisted of 132 swimmers (76 boys and 56 girls). All of them were 13 years old when the research was carried out. All swimmers competed at official competitions placed in calendar of Croatian swimming federation between January and August of 2019.

*Procedure:* The results were taken from official database of results from website of Croatian Swimming Federation (HPS, 2020). FINA points were taken from official Fina website (FINA, 2020b). Power points calculator and Rudolph table which we used are available at websites (USA, 2020; Vienna, 2020).

*Measurements:* All the results in 100 meters freestyle were measured by Automatic Equipment or by at least three officials for each swimmer, otherwise, results would not be valid by FINA swimming rules (FINA, 2020c). FINA points are points that describe value of the result without unit of measurement. The points are calculated using a cubic curve. With the swim time (T) and the base time (B) in seconds the points (P) are calculated with the following formula:  $P = 1000 * (B / T)^3$ . Base time is the world record time in that event. (FINA, 2020b) Power point calculator is scoring system designed by USA Swimming Federation and the calculator evaluates swimming result including gender and age of a swimmer. The power point scale ranges from 1 to 1100 points. Scale shows higher points value for better result (USA, 2020). The Rudolph table is a table published by [Klaus Rudolph](#) for age - appropriate performance evaluation in swimming. Based on age, gender, and event (stroke), the table gives level (1-20) for range of results. The table refreshes each year with database of results from previous year (Vienna, 2020).

*Statistical analysis:* Statistic for Windows 10, version 13.0, was used for the statistical analysis. Statistic showed basic descriptive parameters (mean, minimum and maximum value, and standard deviation). Results distribution normality was tested with Kolmogorov – Smirnov test, which showed that distribution is normal in all variables. Pearson’s correlation coefficient was calculated to establish the relationship between swimming result and several scoring systems. The statistical significance was determined on the level of  $p < 0,05$ . T – test for independent samples was used to see if there is significant difference off mean in variables: swimming result in 100 meters freestyle, FINA points, Power points calculator and Rudolph table between gender.

## Results

The research was carried out on 132 swimmers aged 13 (76 male swimmers and 56 female swimmers). All swimmers are members of Croatian swimming teams. Table 1. (male) and Table 2. (female) show their descriptive parameters such as mean, minimum, and maximum value and standard deviation in variables: result in 100 meters freestyle (in seconds), FINA points, Power points calculator and Rudolph table.

Table 1. Descriptive parameters – male swimmers

Descriptive statistics; Gender: MALE					
Variable	N	Mean	Minimum	Maximum	Standard Deviation
TIME (seconds) (100 m freestyle)	76	65,72	69,39	58,26	2,68
FINA points	76	367,12	308,00	522,00	48,33
POWER POINT calculator	76	501,87	374,00	787,00	97,49
RUDOLPH TABLE	76	5,18	1,00	14,00	3,23

Table 2. Descriptive parameters – female swimmers

Descriptive statistics; Gender: FEMALE					
Variable	N	Mean	Minimum	Maximum	Standard Deviation
TIME (seconds) (100 m freestyle)	56	67,67	72,74	60,86	3,26
FINA points	56	451,95	359,00	613,00	66,98
POWER POINT calculator	56	521,27	344,00	787,00	119,98
RUDOLPH TABLE	56	6,79	1,00	15,00	3,74



Table 3. (male) and Table 4. (female) show Pearson's correlation coefficient between each variable. Results show that all variables between themselves have statistically significant Pearson's correlation coefficient. The negative sign in front of correlation coefficient in a variable that includes time (like in 100 meters freestyle) is there because the result in that variable is better if it is accomplished in fewer seconds.

Table 3. Correlation matrices for all variables – male swimmers

Correlations: Marked correlations are significant at $p < .05000$ ; Gender: MALE; N=76						
Variable	Mean	Standard Deviation	TIME (100 m freestyle)	FINA points	POWER POINT calculator	RUDOLPH TABLE
TIME (100 m freestyle)	65,718	2,682	1,000	-0,994*	-0,999*	-0,996*
FINA points	367,118	48,329	-0,994*	1,000*	0,998*	0,989*
POWER POINT calculator	501,868	97,495	-0,999*	0,998*	1,000	0,995*
RUDOLPH TABLE	5,184	3,232	-0,996*	0,989*	0,995*	1,000

All results marked with \* are statistically significant on the level of  $p < 0.05$

Table 4. Correlation matrices for all variables – female swimmers

Correlations: Marked correlations are significant at $p < .05000$ ; Gender: FEMALE; N=56						
Variable	Mean	Standard Deviation	TIME (100 m freestyle)	FINA points	POWER POINT calculator	RUDOLPH TABLE
TIME (100 m freestyle)	67,673	3,256	1,000	-0,996*	-0,999*	-0,997*
FINA points	451,946	66,977	-0,996*	1,000	0,999*	0,995*
POWER POINT calculator	521,268	119,976	-0,999*	0,999*	1,000	0,997*
RUDOLPH TABLE	6,786	3,735	-0,997*	0,995*	0,997*	1,000

All results marked with \* are statistically significant on the level of  $p < 0.05$

This high correlation coefficients indicates that all these scoring systems evaluates quality of a result with high precision. FINA points show absolute value of the result while Power points calculator and Rudolph table show relative value of the result because they include age of a swimmer in consideration. Scoring systems that include age as a factor evaluate quality of a result in age group swimming with higher level of precision.

Table 5. shows result of T – test for independent sample, variables between gender. Male and female swimmers showed statistically significant difference between each other in mean of all variables except in mean of variable Power point calculator.

Table 5. T – test for independent sample, variables – male and female swimmers

Variable	T-tests; Grouping: GENDER Group 1: MALE Group 2: FEMALE										
	Mean M	Mean F	t-value	df	p	N (M)	N (F)	Std. Dev. (M)	Std. Dev. (F)	F-ratio	p
TIME (100 m freestyle)	65,718*	67,673*	-3,778*	130,000	0,000*	76*	56*	2,682*	3,256*	1,473*	0,119*
FINA points	367,118*	451,946*	-8,455*	130,000	0,000*	76*	56*	48,329*	66,977*	1,921*	0,009*
POWER POINT calculator	501,868	521,268	-1,024	130,000	0,308	76	56	97,495	119,976	1,514	0,095
RUDOLPH TABLE	5,184*	6,786*	-2,633*	130,000	0,009*	76*	56*	3,232*	3,735*	1,336*	0,243*

All results marked with \* are statistically significant on the level of  $p < 0.05$

Statistically significant difference between gender is probably because girls grow faster than boys. Because of that girls are already included in more serious training process than boys and the training process resulted with better quality of swimming result (Vorontsov, 2002).

## Discussion

Results showed that these relatively new scoring systems can be useful in swimming result evaluation, especially considering age of a swimmer. However, the problem is the lack of research and papers about comparison between several scoring systems in swimming. The suggestion for further development in this area is to take other disciplines and swimming strokes into research. Also, systems should be tested in more age groups to see if they remain precise and sensitive enough for practical use.

## Conclusion

Scoring systems like Power point calculator and Rudolph table have very good practical use because they can help in selection process of (age group) swimmers in a swimming team (Germany, 2021). We leave to coaches to decide which of these two scoring systems to use because both evaluate the quality of a result equally well.

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## WINNING AND LOSING WOMEN'S HANDBALL TEAMS AT THE OLYMPIC HANDBALL TOURNAMENT RIO 2016

Dinko Vuleta<sup>1</sup>, Krešimir Pažin, Katarina Ohnjec<sup>1</sup>, Marko Milanović<sup>2</sup>

<sup>1</sup>University of Zagreb Faculty of Kinesiology, Croatia

<sup>2</sup>Zagreb University of Applied Sciences, Croatia

### Abstract

The goal of this study was to determine the differences in the situational efficiency of winning and defeated women's handball teams at the Olympic Tournament in Rio 2016. in the preliminary part of the competition. There were 12 teams played in two groups, 6 teams in group A and 6 in group B. The sample consisted of 28 matches played with the same number of winners or defeated teams. For the purposes of research, 17 variables were used, of which 14 for the attack phase and 3 for the defense phase. The frequency of successful and unsuccessfully executed technical - tactical elements (variables), was recorded through the notational analysis of each played match. To determine the difference between winning and defeated teams, the Mann - Whitney U test was used. It was established that there are significant statistical differences in the 4 observed variables, three related to the attack phase and one that refers to the defense phase: 9-meter shot failed, shot from the counterattack successfully, blocked shot and assists. Winning teams with a very mobile and organized defense have a greater number of seized balls in the form of blocking the shot and opening up a chance to achieve easy goals from the counterattack. Winning team organize a group and individual tactic much better, where is the space created for assist or last pass before the shot. Also, the shot from the outside positions of the winning teams are much better which suppose better preparation of the attack but also the high-level selection of shot on goal.

*Key words: handball, Olympic game, situational efficiency, female teams, differences*

### Introduction

Over the past decade, coaches and researchers have developed various strategies for observing, analysing and evaluating the performance of handball players and teams (Volossovitch, 2017). Match statistics are a powerful tool for assessing both individual and team performance in sports (Daza, Andrés, Tarragó, 2017). O'Donoghue (2010) defined performance indicators as "the variables that have been proved as the valid measures of some important performance aspects. These variables also possess the metric properties - they have an objective measuring procedure, a standard scale of measurement and a valid means of interpretation."

As far as handball match analysis is concerned, available studies have examined the players' and teams' performance from several complexity perspectives (Ferrari, Sarmento, Vaz, 2019). The studies have been based on the individual players' and teams' attacks and defences that have been recorded in order to obtain the final set of data and thus describe what happened at the end of the match, without considering how it happened (Ferrari, et. al., 2019). Previous handball performance studies were more focused on the analysis of men's world and European championships and Olympic tournaments, rather than women's (Prieto, Gomez, Sampaio, 2015). In team sports, the chief outcome of a group performance is usually evident in the result of the game, that is, win or loss (Daza et al., 2017, according to Hughes and Bartlett, 2002; O'Shaughnessy, 2006; Oliveira, Gómez, and Sampaio, 2012). For women's handball teams, the indices that played the vital role and affected the final ranking are, in order of importance: performance efficacy, game experience indices and team scoring efficiency (Konstantinos et al., 2018). Performance or success in a women's handball game was substantially defined by the successful outcome of counterattacks (Bajgorić et al., 2016; Ohnjec et al., 2013) and by the successful prevention of positional attacks and counterattacks (Hianik, 2013). The overall attack efficiency (shot efficiency) was also significantly lower in the defeated than in the winning teams (Konstantinos et al., 2018, Leuciuc & Pricop, 2016; Yamada et al., 2014). Winning teams are superior in the performance of shots on goal, they have more counterattacks and successful realizations, as well as the higher number of goalkeeper's saves during the match (Vurgun et al., 2014). Karastergios et al. (2017) showed that the winning teams have a larger total number of shots, with more 9-meter and lateral-side-shots, more penetrations and more counterattacks. Saavedra et al. (2018) study results showed that the differences between winning and losing teams were also in the number of received red cards and assists. The discriminant analysis selected five variables (shots, goalkeeper-blocked shots, technical fouls, steals, and goalkeeper-blocked fast-break shots) that correctly classified 83% of matches.

The goal of this study was to determine the differences in the situational efficiency between winning and losing teams in relation to the result of the match, i.e. win or loss of women's handball teams at the Women's Handball Olympic Tournament Rio 2016, during the preliminary rounds of the competition. We hypothesized that is a statistically significant difference between the winning and losing women's handball teams in individual indicators of situational efficiency registered during the matches played.

## Methods

### Participants

The sample of entities consisted of 28 matches, that is, of the attacks and defences of 56 opposed handball teams during the preliminary round of the Handball Olympic Tournament Rio 2016. Twelve national teams, divided into two groups (A and B) of six teams, participated in the tournament. Every team played five matches of the preliminary round in each group. A total of 30 games were played in the preliminary round, but only the resolved matches - the matches that ended either with a win for one team and a loss for the other - were analysed in this study. Since two games ended in a tie, 28 matches were analysed, that is, the game performance of 28 winning and 28 losing teams.

### Measures

The method of notational analysis was used to collect data. The variables' sample consisted of successful and unsuccessful technical-tactical performance frequencies of the game elements in the attacking and defending phases of 28 handball matches. 17 variables were analysed, and they included 14 indicators of the game performance in the attacking phase (situational efficiency) and three indicators of the game performance in the defending phase (Table 1). Shots on goal, taken from different playing positions, are presented as successful or completed (COMP) and unsuccessful (MISSED) shots. All data were officially collected by the IHF notators.

Table 1. Sample of variables

Variable	Description
6MSHCOMP	successful 6-metre shot - a goal scored
6MSHMISSED	unsuccessful 6-metre shot - a goal not scored
WSHCOMP	successful wing shot - a goal scored
WSHMISSED	unsuccessful wing shot - a goal not scored
9MSHCOMP	successful outside-9-metre-line (back court positions) - a goal scored
9MSHMISSED	unsuccessful outside- 9-metre-line shot (back court positions) - a goal not scored
7MSHCOMP	successful 7-metre-line (penalty) shot
7MSHMISSEC	unsuccessful 7-metre-line (penalty) shot - a goal not scored
FBSHCOMP	successful shot taken after a fast break - a goal scored
FBSHMISSED	unsuccessful shot taken after a fast break - a goal not scored
BTSHCOMP	successful shot taken after a break-through defence wall - a goal scored
BTSHMISSED	unsuccessful shot taken after a break-through defence wall - a goal not scored
ASS	assists
TO	turnovers
ST	steals
BLSH	blocked balls
2MIN	2-minute suspension

### Statistical Analysis

Arithmetic mean (Mean) and standard deviation (SD) - central and dispersion parameters of the observed variables - were determined by applying descriptive statistics. The Mann-Whitney U-test was used to determine differences between the winning and losing teams in game performance variables set. The level of statistical significance was set at  $p=0.05$ .

## Results

The descriptive statistical data of the variables for the winning and the losing women's handball teams and the results of the Mann-Whitney U-test are presented in Table 2. The significant differences between the winning and losing teams in the game performance variables set, shown in the Table 2, were obtained for four variables: unsuccessful long-range shots (9MSHMISSED), successful fast-break shots (FBSCOMP), blocked balls (BLSH) and assists (ASS).

Table 2. Descriptive statistics of the performance variables registered for the winning and losing women's handball teams and results of the Mann-Whitney U-test of the difference between the successful (winning) and unsuccessful (losing) women's handball teams

Variable	Winning teams	Losing teams	Different from the winning team	z	p
	Mean ± SD				
6MSHCOMP	7.39 ± 2.90	6.07 ± 2.65	+1.32	1.17	0.08
6MSHMISSED	4.00 ± 2.14	4.43 ± 2.56	-0.43	-0.59	0.59
WSHCOMP	3.93 ± 2.76	3.36 ± 1.87	+0.57	-0.75	0.46
WSHMISSED	3.14 ± 1.48	4.29 ± 2.55	-1.15	-1.51	0.13
9MSHCOMP	5.00 ± 2.60	4.36 ± 2.54	+0.64	0.75	0.46
9MSHMISSED	7.11 ± 2.06	10.21 ± 4.48	<b>-3.10</b>	<b>-2.81</b>	<b>0.00</b>
7MSHCOMP	3.46 ± 1.90	3.57 ± 1.71	-0.11	-0.16	0.87
7MSHMISSEC	0.96 ± 0.96	1.39 ± 1.13	-0.43	-1.35	0.18
FBSCOMP	5.07 ± 2.72	3.14 ± 2.17	<b>+1.93</b>	<b>2.75</b>	<b>0.01</b>
FBSHMISSED	1.57 ± 1.81	1.07 ± 0.94	+0.50	0.52	0.60
BTSHCOMP	3.00 ± 1.72	2.07 ± 1.65	+0.93	1.67	0.09
BTSHMISSED	1.29 ± 1.36	0.89 ± 0.92	+0.40	0.74	0.46
ASS	13.14 ± 3.26	14.25 ± 4.41	<b>-1.11</b>	<b>2.43</b>	<b>0.02</b>
TO	12.25 ± 3.68	10.96 ± 3.29	+1.29	-1.50	0.13
ST	2.96 ± 1.95	2.11 ± 1.66	+0.85	1.64	0.10
BLSH	2.36 ± 1.87	1.18 ± 1.02	<b>+1.18</b>	<b>2.57</b>	<b>0.01</b>
2MIN	4.68 ± 2.55	4.64 ± 1.75	+0.04	0.48	0.63

## Discussion

The descriptive analysis results have showed that the most frequently represented variables in the winning teams are: assists (13.14), lost balls (12.25), successful 6-metre-shots (7.39) and unsuccessful 9-metre-shots (7.11). In losing teams, most frequently represented variable is lost balls (14.25), assists (10.96), unsuccessful-9-metre shots (10.21) and successful 6-metre-shots (6.07). The same variables' structure in dominant representation has been established for both teams. Due to the great time pressure, in most situations during the game, fast and correct decisions are required in order to score (Weigel, 2018). When establishing differences between winning and losing teams, the results show that the teams differ in following variables: unsuccessful 9-metre-shot ( $p=0,00$ ), successful counterattack shot ( $p= 0,01$ ), blocked shots ( $p= 0,01$ ) and assists ( $p=0,02$ ). Losing teams have less organised attacks from which no opportunities to shoot on goal from the back-court positions occur. It is also evident that winning teams have far more organised attacks, but also better shooters, who have higher realization of chances. Fast-breaks themselves do not contribute to the team unless the fast-break situation leads to creating of a scoring position (Milanović et al., 2018, Vurgun et al., 2014). The winning teams score so called "easy goals" by well-played transitions, quick openings and attacking the defence before it has time to set up, which, on one hand, lessens energy loss and psychological stress of the winning team, and on the other, the "easy goals" boost their mood, motivation and morale. In comparison to the losing teams, the winning teams perform a larger number of blocked shots on account of their markedly quicker and more cohesive movement. Because of the poor attack organisation and the lack of space for the outer shooters, the losing teams are forced to shoot on goal over a single, double or even triple block. Furthermore, there seems to be a decreasing tendency in the average number of assists per game in the winning teams (Saavedra et al., 2018), which is, however, still greater than in the losing ones. All above mentioned leads to the conclusion that the winning teams are better tuned in, they understand the game and each other better, which leads to better assists. This parameter is indicative of both high individual, as well as high team quality and it is at a statistically significant level.



## Conclusion

The analysed game performance indicators in the elite women's handball show that considering the attack play tactics variables, the winning teams are superior to the losing ones. The winners' attack play profile includes a successful implementation of fast-breaks - counterattacks, successful finalization of attacks with a strict selection of backcourt players' shots and fast-break shots, numerous assists and blocks. The high-quality teams examined in this paper prepare good shooting opportunities, so they have better backcourt players' shots. The winning teams obtain many block balls, that is, by forcing the opponent to make a mistake or to shoot before they create an appropriate shooting situation, which enables the winning team to transition and score more quickly and easily. In a well-organized attack, the winning teams demonstrate great unselfishness evident in the number of assists. Create the shooting opportunities in an effective way by entering their opponent's unprotected area and by passing the ball precisely. This game segment displays not only a team's, but also an individual player's quality of making the right decisions timely, which is why decision-making in handball is increasingly often recognized and discussed as a performance-limiting factor (Weigel, 2018). Considerable variability of the observed parameters and awareness that only fragments of the complexity of the game of handball were covered in this research, indicate the necessity to modify and improve the way of recording and assessing performance in team handball.

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## A STUDY ON THE FOUL BEHAVIOR CHARACTERISTICS OF BIANCA WALKDEN, A WORLD ELITE FEMALE ATHLETE

Yuting Yang<sup>1</sup>, Suying Wu<sup>2</sup>

<sup>1</sup>Beijing Sport University, China

<sup>2</sup>China University of Petroleum, China

**Purpose:** In taekwondo competition, foul behavior also has a certain impact on the outcome of the competition, because once the foul behavior, the opponent will be added one point, so the score is tied often due to foul loss of the game. Based on the 2018 world taekwondo championship, world taekwondo championship in 2019 and 2019 world championships in 18 games video as material, analysis from the perspective of different distance bianca walker's foul behavior characteristics, female athletes for our country taekwondo key Zheng Shuyin provide theoretical basis for the Tokyo Olympic Games and training practice reference.

**Methods:** This paper uses the method of documentary data, video analysis and mathematical analysis, logical analysis.

**Results:** Bianca Walkden committed 37 fouls, the grabbing or pushing the opponent is 40.54%. The lifting the legs to hinder and attack below the waist accounting for 13.51%.The fouls at close range were the most, accounting for 40.54%; Next was proximity distance, accounting for 29.73%. The middle distance ranked third, accounting for 18.92%; The long distance were rare, accounting for 10.81%.

**Conclusion:** Bianca Walkden's main fouls were grabbing or pushing the opponents, followed by lifting the legs and attacking below the waist. At close range, she mainly grabbing or pushing the opponents, and the behavior of leg grabbing mainly appears. Under proximity distance, she mainly grabbing or pushing the opponents, and concentrated in hugging and grasping clothes or protective equipment. In the middle distance, she mainly lift the legs to hinder and attack below the waist. At long distance, the main foul is lift the legs to hinder.

**Key words:** Taekwondo, women's athlete, Bianca Walkden, foul behavior

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## A STUDY ON THE CHARACTERISTICS OF THE WORLD'S EXCELENT FEMALE TAEKWONDO ATHLETE LEE AHREUM'S SCORING AND LOSS OF SCORING

Siyuan Zhang, Jianzhong Wu

*Beijing Sport University, China*

**Purpose:** Lee Ahreum is the world's excellent female taekwondo athlete, and she is currently ranked fourth in the world in her competition class. This paper provides a statistical analysis of Lee Ahreum's scoring and loss of scoring in 11 world class taekwondo tournament videos from 2018 and 2019 from the perspective of the new rules, to explore Lee Ahreum's scoring and loss of scoring characteristics that can provide a reference for female taekwondo athletes and help improve their performance.

**Methods:** (1) Literature Review Method: A total of 383 relevant documents were retrieved from the China national knowledge infrastructure (CNKI), of which 11 were selected as references for study and research in this paper. (2) Video observation method: This article derives Lee Ahreum's scoring and loss of scoring by counting 11 world class Taekwondo matches recorded in 2018 and 2019. (3) Mathematical statistics. (4) Logical analysis method.

**Results:** (1) Lee Ahreum's overall scoring was high. The difference between the front roundhouse kick and the front side kick was not much; the back roundhouse kick scored more than all the front leg techniques combined. (2) Lee Ahreum conceded a low number of points per miss, fewer high scores, and more often when using the front leg technique, followed by when using punches.

**Conclusions:** (1) Lee Ahreum's style of play is aggressive and easily pushes her opponent back, scoring high and mostly offensive points overall, with her main scoring pattern being to get close to her opponent and use the "push + back roundhouse kick" at close range. (2) Lee Ahreum concedes more points, but fewer high scoring points, mainly when she uses the front leg technique or punches. As the match progresses, the number of points she concedes decreases when using front side kick and punches, and increases when using no technique.

**Key words:** *sport, analysis, taekwondo*

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## RESEARCH ON THE CHARACTERISTICS OF PANIPAK'S LOSING POINTS IN TAEKWONDO WOMEN'S 49KG ELITE ATHLETE

Yang Zhao, Dan Wang

Beijing Sport University, China

**Purpose:** The technical loopholes of the athletes can be found through the technique of losing points, so as to optimize the tactics and improve the odds of winning the game. Panipak is the number one athlete in the women's 49kg Olympic points. This study uses Panipak's 2018 and 2019 Taekwondo Grand Prix and 2019 Taekwondo World Championships as the research material, and analyses her skills in losing points in different stances, different positions, different venue positions, and different battle conditions. In order to discover the main characteristics of Panipak's loss technique, and provide a certain theoretical basis for Chinese athletes to play against Panipak in the future.

**Methods:** Document data method, video observation method, mathematical statistics method and logical analysis method.

**Results:** The most points are lost in the left open style, and the technique that loses the most points is the front kick technique. The most commonly used leg is the right leg, and the side kick technique with the front leg loses the most points. She lost the most points in the lead, and lost points under the fierce offensive of the opposing athletes. At the same time, the most points are lost in the middle distance and the center of the field. The main points lost are the ribs and the head. In the leading game, the third round of the game is relatively negative. The strategy is mainly to keep the points, so the most points are lost.

**Conclusion:** Panipak's front kick technique is its advantage and its disadvantage. When she is in the lead under the left frame, she proactively organizes the attack and hitsher ribs and head.

**Key words:** Taekwondo, women's 49 kg, Panipak, points lost

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46. Anita Lauri
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49. Branka Matković
50. Pavle Mikulić
51. Dragan Milanović
52. Luka Milanović
53. Ivana Milovanović
54. Dušan Mitić
55. Marijana Mladenović
56. Marko Mustapić
57. Tihana Nemčić
58. Dario Novak
59. Andrej Ivan Nuredinović
60. Katarina Ohnjec
61. Darija Omrčen
62. Tomaž Pavlin
63. Relja Pekić Carić
64. Benjamin Perasović
65. Marko Perić
66. Vilko Petrić
67. Lidija Petrinović
68. Biljana Popeska
69. Giuseppe Rabita
70. Sandra Radenović
71. Višnja Rajić
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## INDEX OF AUTHORS

- |                              |                              |                                 |
|------------------------------|------------------------------|---------------------------------|
| Abalašei Beatrice 210, 742   | Bilić Zlatan 725             | Cihová Iveta 428                |
| Abarra Airnel 546            | Biondić Zvonimira 352        | Coakley Jay 25                  |
| Abazović Ensar 229, 254      | Blažević Iva 466, 670        | Cojocariu Adrian 81, 742        |
| Ajman Hrvoje 662             | Bobić Goran 69, 730          | Comyns Tom 313                  |
| Albu Adriana 210             | Boca Stefano 518             | Cvenić Josip 362, 662           |
| Aleksić Neda 86              | Bogataj Špela 706            | Cvetkovic Milan 700             |
| Alić Jelena 423              | Bojić-Ćaćić Lidija 734       | Čaušević Denis 229              |
| Andrašić Slobodan 865        | Bok Daniel 288               | Čavala Marijana 294, 379        |
| Andreff Wladimir 24          | Bokuvka Dominik 331          | Čavrag Sara 613                 |
| Andrijašević Mirna 693       | Bolčević Filip 461, 554      | Čihounková Jitka 559            |
| Antala Branislav 428         | Bon Ivan 776, 872            | Čolakovac Ivan 562              |
| Antekolović Ljubomir 788     | Boranić Živoder Snježana 166 | Čorak Sanda 166                 |
| Antonini Sara 613            | Bosnar Ksenija 591           | Čubrić Stipe 107, 155           |
| Antunovic Dunja 488          | Bradić Asim 254              | Čule Marko 92, 221              |
| Arabaci Ramiz 322            | Brkljačić Ivan 97            | Čuljak Petar 44                 |
| Ataman Rebecca 558           | Bruno Damjan 112             | Čuljak Zoran 374                |
| Babić Maja 92                | Bučar Kristina 170           | Čustonja Zrinko 641, 856        |
| Babić Vesna 92               | Budalica Nera 294, 743       | Čaleta Jerko 563                |
| Babin Bojan 348, 453         | Budetić Branimir 817         | Ćurković Sanja 356, 403         |
| Badrić Marko 216             | Budetić Vedran 817           | Dabo Ivana 743                  |
| Baić Mario 706, 712          | Budíková Marie 274           | Dadeliene Ruta 747              |
| Bajramović Izet 229          | Bulović Grgur 44             | Dadelo Stanislav 747            |
| Baković Marijo 97, 788       | Burger Ante 102              | Dadić Marin 808                 |
| Balciuniene Vaiva 547        | Bursać Boris 170             | Dai Jin 236                     |
| Ban Maja 752                 | Cacek Jan 299                | Dajaković Stipo 335, 716        |
| Barbaros Petar 833, 872      | Cao Guo-Huan 57              | Davidović Luka 225, 237         |
| Barić Renata 621             | Cao Jianmin 236              | De Laat Antoon 129              |
| Barišić Valentin 716, 803    | Caput-Jogunica Romana 356    | De Vroey Henri 129              |
| Barković Iva 562             | Cardona Maria Isabel 312     | Degens Hans 265                 |
| Bartoluci Dino 46            | Cazha Jan 299                | Delaš Kalinski Sunčica 748, 771 |
| Bartoluci Sunčica 488, 489   | Cetinić Marko 738            | Dergić Vanja 489                |
| Bašić Leo 339                | Cheng Ye-u-Yao 558           | Deymeci Orhan 610               |
| Bazanov Boriss 318           | Chirazi Marin 829            | Dilmakhanbetov Ermek 248        |
| Belcic Ivan 712              | Chivaran Alexandru 116       | Djukić Koroljević Zrinka 45     |
| Benassi Loris 665, 670       | Choi Hong Jun 361, 408       | Doczi Tamas 546                 |
| Bernaciková Martina 274, 281 | Chou Shannon 558             | Dolenec Aleš 92                 |
| Bertović Danijel 725         | Ciešla Elžbieta 674          | Dominković Ivan 563             |
| Bi Zhongchun 136, 650        | Ciešla Marzena 674           | Dominković Luka 563             |
| Bianco Antonino 326, 518     | Cigrovski Berković Maja 235  | Dopsaj Milivoj 160              |
| Bigelman Kevin 300           | Cigrovski Vjekoslav 107      | Dragičević Slobodan 125         |

Dragin Aleksandra 687	Hedbávný Petr 274	Kazazović Elvir 229
Drid Patrik 326, 866	Heimer Stjepan 698	Kezić Ana 748, 771
Dubois De Mont Marin Geoffroy 279	Horvat Patrik 301	Klaričić Ivana 390
Dukarić Vedran 136, 776	Horvat Vatroslav 370	Klas Alexander 558
Durdová Irena 567	Horvatin Maja 683, 776	Knezovic Svetec Anđelka 58
Đelić Marina 86	Hou Yunyun 34	Knežević Danijel 170
Đerek Ana 679	Hraski Marijana 370	Knjaz Damir 155, 776
Đolo Karla 366	Hraski Željko 125	Knjaz Katarina 413
Đurković Tomislav 752, 793	Hraste Mladen 767	Kolářová Kateřina 120
Đurović Nikša 767	Hrg Krešimir 449	Kong Jiamin 780, 781
Đuzel Josefina 294, 379	Hrstić Ivan 497	Konings Marco 129
East Whitfield 300	Hrženjak Miroslav 591	Konstantin Lucija 395
Emeljanovas Arunas 226	Hu Qingrui 648	Kontić Dean 385, 867
Fatkulina Natalja 226	Hublin Tomislav 725	Korać Živojinović Tamara 444
Fayard Jean-Marie 279	Isselée Hans 129	Koražija Filip 243
Feng Liang 236	Ištuk Ema 395	Korovljević Darinka 687, 705
Foretić Nikola 102, 570	Ivanković Marija 374, 861	Kossakowski Radosław 27
Foster Carl 26	Ivezić Ivan 180	Kovačević Erol 229, 254
Franjković Alan 756	Ivković Gordana 423, 600	Kovačević Neven 867
Freychet Benjamin 279	Jandrić Matija 50	Kovačević Željko 379
Furjan-Mandić Gordana 626	Jašić Dajana 596	Kovačić Katija 175
Galić Marin 519, 574	Jelić Tomislav 379	Kralj Lucija 782
Geambesa Mihail Michi 116	Jencikova Katerina 130	Krističević Tomislav 821
Geng Guoqiang 90	Jenko Miholić Srna 409, 413	Krmpotić Mateja 752
Gentile Ambra 312, 518	Jerak Tonći 798, 850	Krnić Rašeljka 506
Gerekarovska Tatjana 466	Jiang Zhong-Ye 57	Krtalic Slaven 721
Gimunová Marta 120	Jovanović Sara 687, 699	Kunješić Sušilović Mateja 352
Gladović Neven 46	Jozić Marijan 308	Kuvačić Goran 496
Glavina Jelaš Ivana 505, 578	Jukic Igor 705	Kyselica Adam 187
Gokcek Eslem 586	Jularić Josip 97	La Grasta Sabolić Lavinia 235
Gorgulu Recep 586, 587	Jurak Ivan 432	Lakicevic Nemanja 312, 326
Gregov Cvita 301, 327	Jurakić Danijel 679, 698	Lauš Damir 457
Grgantov Zoran 366, 813	Jurić Petra 227	Lazarić-Zec Danijela 670
Grgić Stipica 493	Juříková Jana 274, 281	Lazzer Stefano 265
Gruić Igor 761	Jurković Ivana 65	Leko Goran 782, 877
Grün Vojtěch 260	Jurković Rahela 501	Lelonek Magdalena 140, 674
Gulin Jere 288, 335	Kalmatayeva Zhanna 248	Leng Bo 236
Guo Tianxiao 648	Karaula Dajana 385, 782	Lenoir Matthieu 28
Gutović Tea 496	Karlović Ruža 505, 578	Li Feng 136, 650
Gyori Ferenc 700	Karminčić Hrvoje 266	Li Yingkui 59, 60
Hadžić Vedran 228	Karuc Josip 228	Li Youhua 59, 60
Hajdune Petrovsky Zita 700	Kasović Mario 130, 180	Liang Yapu 313
Háp Pavel 698	Katona Zsolt 687	Liu Jiaqi 787
Harasin Dražen 861	Katović Darko 626	Livson Matleena 698

Lochbaum Marc 621	Mijatov Nikola 514	Novak Dario 428
Lorger Marija 140, 476	Mijić Šime 44	Novak Orlić Sanja 65
Lovreković Bruno 225, 237	Mikalonyté Rasa 797	Nuredinović Andrej Ivan 527
Lovrinčević Jurica 399	Mikša Andrija 798	Nykodym Jiri 331
Lucaci Paul 61	Mikulić Ivan 716, 803	O'loughlin Padhraig 279
Luptáková Martina 428	Milanović Dragan 196, 734	Obradović Borislav 496, 700
Ljajic Samir 617	Milanović Luka 486, 808	Obradović Jelena 344
Ljubičić Sanja 738, 788	Milanović Marko 798, 881	Obradović Tajana 636
Ma Chaoyue 313	Milašius Kazys 248	Očić Mateja 776
Macan Iva 362	Milčić Lucija 145, 821	Ohnjec Katarina 656, 881
Madić Dejan 496	Milić Mirjana 649, 813	Oja Pekka 698
Madiyeva Galiya 248	Milinović Ivan 92, 221, 518	Omrčen Darija 605
Magdić Tea 600	Mills Richard 31	Onose Ionut 210
Maksimovic Nebojsa 204, 705	Milošević Zoran 866	Onose Raluca Mihaela 210
Maras Benassi Hermina 665	Milošević Milan 237, 253, 403	Oprean Alexandru 829
Marelić Marko 793	Milovanović Ivana 532	Orešković Dražen 136
Marelić Nenad 793, 841	Milovuković Saša 817	Oršolić Mario 833
Marić Dora 238	Mindek Mihael 803	Ostojić Sergej 699, 705
Marin Mihnea Ion 116, 154	Miodrag Melanija 600	Otković Petar 399
Marinčić Mile 730	Miron Doina 154	Pačelat Jurica 505, 578
Marinković Dragan 496	Mišigoj-Duraković Marjeta 228, 282	Palomo-Nieto Miriam 611
Marković Goran 228	Miškulin Andrea 65	Papec Mislav 693
Martinaš Petruța 742	Mitrečić Kristijan 808	Papić Vladan 102
Martincová Andrea 688	Mladineo Brničević Melis 149, 348	Paripović Tomislav 833
Martinko Antonio 243, 486	Mohammed Hamdan Hashem	Parlov Jasmina 626
Marušić Eli 157	Mohammed 361, 408	Paulauskas Rūtenis 797
Marušić Zrinka 166	Moraru Elena - Cristina 445	Pavelić Karamatić Lara 471
Mašina Tonći 403	Možnik Marijo 821	Pavičić Vukičević Jelena 613
Matić Radenko 204	Mraković Snježana 370, 409	Pavlinović Vladimir 570
Matijević Branka 538	Mučalo Marina 519	Pavlović Davor 221
Matijević Valentina 45	Muntianu Vlad-Alexandru 317	Pažin Krešimir 881
Matković Bojan 107, 756	Mustapić Marko 497, 523	Pedak Kirsti 318
Matković Branka 45	Nakić Josipa 229, 254	Pedišić Željko 698
Matolić Tena 689, 698	Narici Marco 265	Peić Mirela 419
Matošić Doris 496	Navardauskiene Gabriele 846	Pekas Damir 706, 712
Mauger Lex 29	Navarro Enrique 160	Pekkola Heidi 698
Mavrin Jeličić Martina 244	Neculaes Marius 61	Penjak Ana 748, 771
Mazúr Jakub 274	Nedimović Tanja 444	Perasović Benjamin 489
Mcgurk Michael 300	Nekriosius Ricardas 747	Perić Mia 743
Međimorec Dora 510	Neljak Boris 449	Perkušić Matea 605
Meyer Tim 30	Nemčić Tihana 716, 825	Peršun Josipa 413
Mieziene Brigita 226	Nikolić Ivana 161, 409	Peškirić Daniel 225, 237
Mihaljević Vicko 850	Nikolić Siniša 85	Petričević Duje 175
Mijatov Maja 687	Nikolovski Zoran 570	Petrić Vilko 395, 419

Petrović Vanja 423	Rukavina Ivan 867	Sun Chengmengxue 483
Petrušič Tanja 439	Rupčić Tomislav 107, 155	Sun Jin 475
Piršl Danica 617	Rusu Ligia 116, 154	Sviličić Nikša 636
Piršl Tea 617	Rusu Mihai Robert 154	Svobodová Lenka 688
Pišot Rado 32, 265	Ružić Lana 721	Šagat Peter 107
Pišot Saša 532	Sabyrbek Zhanna 248	Šaravanja Lucas 200
Plevnik Alen 683	Sajković Dubravka 259	Šarlija Marko 228
Podnar Hrvoje 449, 698	Sakizlian Eduard Robert 154	Šćepanović Tijana 687
Polasek Radim 274	Samozino Pierre 33	Šerbetar Ivan 161
Popa Catalin 154	Sandu Oana Alis 154	Ševčík Radek 281
Port Kristjan 318	Sarkauskiene Asta 846	Šiljeg Klara 385, 877
Pouresa Sepehr 558	Savola Jorma 698	Šimić Krešimir 505
Požgaj Šepec Marija 235	Schuster Snježana 69, 730	Šimunič Boštjan 265
Prlenda Nikola 554	Sebera Martin 688	Šipušić Magdalena 362
Prosoli Rebeka 621	Sedláček Tomáš 187	Škegro Dario 288, 641
Prskalo Ivan 140, 216	Segedi Ivan 433	Škerbić Matija Mato 537
Průžek Michal 428	Sekot Aleš 567, 631	Škorić Sanela 200, 204
Puni Rares-Alexandru 829	Selmanović Aleksandar 850	Škrinjarić Bruno 180
Qi Bing 236	Sertić Hrvoje 308, 433	Šola Matilda 327
Qiu Junqiang 90	Shao Jia 57	Šop Suzana 644
Radaš Josipa 626	Shen Yanfei 648	Štemberger Vesna 439
Radenović Sandra 533	Simović Slobodan 136	Šunda Mirela 390, 449
Radman Ivan 698	Sinković Antonela 196, 238	Šunjerga Renato 266
Radenović Ozren 432	Sinković Valent 196	Švaić Vjeran 432
Rakonjac Dušan 344	Sivrić Hrvoje 856	Takšić Vladimir 591
Rakovac Marija 259, 698	Skotáková Alena 73	Talan Mihaljevic Monika 69
Ranisavljev Marijana 699	Sonnery-Cottet Bertrand 279	Tanasă Anca - Raluca 445
Rannama Indrek 318, 837	Sorić Maroje 227, 243	Tao Kuan 648
Rašković Bojan 687, 700	Soytürk Mümine 438, 610	Tepeköylü Öztürk Özden 438, 610
Reggiani Carlo 265	Spasić Miodrag 102	Teraž Kaja 270
Reguli Zdenko 73, 701	Sporiš Goran 716, 865	Teskera Margareta 449
Reinpöld Karmen 837	Stajer Valdemar 326, 705	Thaunat Mathieu 279
Rejc Enrico 265	Stanišić Ljubica 767	Todorović Marija 538
Rešetar Tomica 841	Starosta Włodzimierz 712	Todorović Nikola 699
Ricov Janja 192	Stipančić Gordana 235	Tokár Filip 281
Roberson Donald N. Roberson, Jr. 611	Stosic Jelena 160	Tomac Zvonimir 453
Roca Leona 216	Stračárová Nikola 77	Tománek Ľubor 428
Rodoplu Coskun 322	Struhár Ivan 260, 331	Tomljenović Braco 457, 461
Rogulj Nenad 102, 379	Strukar Stjepan 738, 861	Tomljenović Frane 461, 554
Roklicer Roberto 312, 326	Stukas Rimantas 226	Tomljenović Sanjin 457
Romanov Romana 476	Sturza Milić Nataša 444	Toplek Anja 841
Rosca Andreea 116	Su Hao 57	Tot Dora 493
Ruiz Pérez Luis Miguel 611	Suchánek Michal 701	Trajković Nebojša 706, 865
Rukavina Damir 856	Suliga Edyta 674	Trajkovski Biljana 453, 466



Trinidad Alfonso 160	Vrbik Andrea 693	Yerzhanova Yeldana 248
Trivic Tatjana 426, 866	Vrdoljak Dario 649	Yu Laikang 280
Trofin Petruț - Florin 317, 445	Vrgoč Goran 279	Yu Liang 37
Trošt Bobić Tatjana 46, 282	Vučetić Vlatko 335	Zarevski Predrag 161
Ukić Marita 542	Vuglovečki Irena 46	Zečić Miroslav 308, 706
Uljević Ognjen 867	Vujičić Lidija 419	Zegnal Koretić Marija 476
Ungurean Bogdan 742	Vuk Saša 112, 339	Zhang Junjie 345
Ungurean Bogdan-Constantin 81	Vukadinović Jurišić Mila 344	Zhang Siyuan 886
Ungureanu Andreea 116	Vukelić Bartol 877	Zhao Conghuan 483
Vajda Petr 73	Vukušić Dino 527	Zhao Li 280
Vajdić Monika 872	Vuleta Dinko 734, 881	Zhao Yang 887
Váňa Petr 274, 281	Wang Dan 887	Zhou Zhi Bo 37
Vasić Goran 85	Wang Qiong 650	Zhou Zhihui 236
Vašičková Jana 428	Wang Xiaoting 236	Zhu Xiao Lan 37
Veiga Santiago 160	Wang Xueshuang 428, 457	Zvonař Martin 120, 130
Vencúrik Tomáš 260, 331	Wang Zheng Song 37	Žáková Alena 274, 281
Veršić Šime 238	Wei Hongwen 345	Žanetić Dominik 433
Vidaković Samaržija Donata 471	Wen Tian-Hao 57	Žanetić Marija Martina 282
Vidranski Tihomir 390, 399	Wu Jianzhong 90, 886	Žigman Katarina 486
Vieira Thais D. 279	Wu Suying 885	Živčić Kamenka 145
Vlahović Lidija 149, 348	Xia Ziyi 90	Živković Filip 301
Vlašić Jadranka 86, 683	Xiao Shuhong 34	Žnidarec Čučković Ana 656
Vodička Tomáš 120, 299	Yang Yuting 885	



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Faculty of Sport Sciences  
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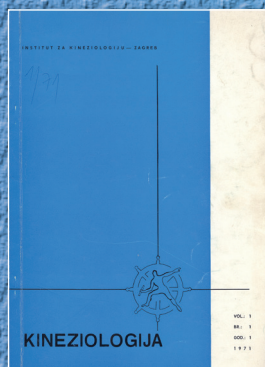


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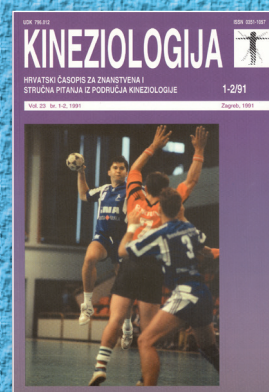
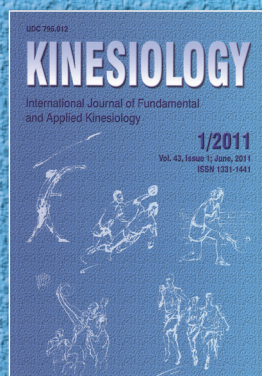
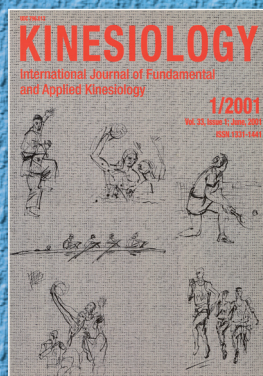
## IN THE FUTURE

1. Publishing of the articles that have potential for being cited.
2. Invite world-renowned scientists to become members of the Editorial Board or Advisory Board.
3. The final selection of articles must be more rigorous.
4. The period from the submission of a paper till its either rejection or acceptance for the publication has to be shorter.
5. Recruitment of staff for the editorial jobs.
6. The IF higher than 2.0 in the next years.

## 50<sup>th</sup> anniversary 1971 – 2021

### SHORT HISTORY

- Founded in 1971
- Published twice a year
- Scientific field: Kinesiology
- Included in Hrčak: since 11/4/2006
- External reviews, mostly foreign, double blind
- The Journal is an open access



### Indexed:

- Since 2008 - WEB OF SCIENCE CORE COLLECTION, Journal Citation Report
- Since 2009 - SCOPUS
- American Psychological Abstracts: PsycLIT, PsycINFO

WoS - IF of the journal is continuously growing:

2011 - 0.335,

2015 - 0.525,

2019 - 1.383

today - 1.452

SCOPUS - SCImago Journal Rank (SJR) indicator for the year 2020 is 0.530 and H index is 21

The journal *Kinesiology* has become the most important scientific product of the Faculty of Kinesiology, with which it can successfully represent the Faculty but also the University of Zagreb throughout the world.





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