SPORT SCIENCE

INTERNATIONAL SCIENTIFIC JOURNAL OF KINESIOLOGY

Univerzitet u Travniku
Edukacijski fakultet

SPORT SCIENCE
INTERNATIONAL SCIENTIFIC JOURNAL OF KINESIOLOGY
Vol. 11, Issue 2. December 2018
Print ISSN 1840-3662,
Web ISSN 1840-3670UDK 796,
Catalogued in: COBISS BH

Publisher
Faculty of Education,
University of Travnik,
Aleja konzula 5, Travnik, Bosnia and Herzegovina

Editor-in-Chief
Nihad Selimović
(Travnik, Bosnia&Herzegovina)

Executive Editor
Maid Omerović
(Travnik, Bosnia&Herzegovina)

Consultant
Amra Tuzović
(Travnik, Bosnia&Herzegovina)

Secretary
Jasmin Hrnjić
(Travnik, Bosnia&Herzegovina)

Public relations
Mersiha Beganović
(Travnik, Bosnia&Herzegovina)

Design
Jasmir Smailbegović
(Travnik, Bosnia&Herzegovina)

Technical Editors
Aljo Delić
(Travnik, Bosnia&Herzegovina)
Aldin Obućina
(Travnik, Bosnia&Herzegovina)
Jasmir Smailbegović
(Travnik, Bosnia&Herzegovina)

Print
Print d.o.o.Travnik
Circulation: 300 copies

Communication
Faculty of Education,
University of Travnik,
Aleja konzula 5, Travnik,
Bosnia and Herzegovina
Tel: +387 (0)30 540 876
GSM:+387 (0)61 475 922
Fax: +387 (0)30 540 876
info@sportscience.ba
www.sportscience.ba

Publishing
Sport Science publishes twice a year in English with Bosnian abstracts.
Full journal text avaliable on http://www.sportscience.ba/

Indexed in
'Elsevier Scopus', 'SJR - Scimago Journal & Country Rank', 'CAB Abstracts', 'CABI Leisure Recreation and Tourism Abstracts', 'CABI Leisure Tourism Database', 'CABI Global Health', 'CABI Nutrition Abstracts and Reviews Series A: Human and Experimental','FSO', 'ProQuest CSA Physical Education Index', 'ProQuest CSA Natural Sciences', 'ProQuest CSA Social Sciences', 'Genamics Journal Seek', 'EBSCO SPORTDiscus with Full Text', 'EBSCO TOC Premier','EZB - Electronics Journals Library', 'Scientific Journal Impact Factor (SJIFactor)', 'Directory of Research Journals Indexing (DRJI)' , 'Universal Impact Factor (UIF)', 'ROOT INDEXING - Journal Abstracting and indexing service', 'ESJI - Eurasian Scientific Journal Index', 'ROAD - Directory of open access scholary resources', 'Academic Keys', 'Academic Resource Index - Research BIB', 'WCOSJ - World Catalogue of Scientific Journals', 'DAIJ - Directory of Abstract Indexing for Journals', 'I2OR - International Institute Of Organized Research', 'JournalIndex.net', 'OCLC - WorldCat', 'SIS - Scientific indexing service', 'IIJIF - International Innovative Journal Imact Factor', 'IFSIJ - Impact Factor Services For International Journals', 'Open Academic Journals Index - OAJI', 'Scholarsteer - Scholartly Information', 'Scientific world index - sciwindex', 'Journal Impact Factor - JIFACTOR', 'Journal Factor', 'Journal Guide', 'NCBI - National Center for Biotechnology Information'

Editorial Board
Clarissa T. Stefani
(Sao Paulo, Brasil),
Ming Kai Chin
(Cedar Falls, USA),
Gudrun Doll-Tepper
(Berlin, Germany),
Dragan Milanovic
(Zagreb, Croatia),
Žarko Kostovski
(Skoplje, Macedonia),
Abas Asadi
(Iran),
Izet Rađo
(Sarajevo, BiH),
Maurizio Sibilio
(Salerno, Italy),
Tommi Vasankari
(Tampere, Finland),
Jose A. P. Turpin
(Alicante, Spain),
Kasuhiko Watanabe
(Hiroshima, Japan),
Branimir Mikić
(Travnik, BiH),
Erika Zemkova
(Bratislava, Slovakia),
Edita Kastratović
(Belgrade, Serbia),
Milan Žvan
(Ljubljana, Slovenia),
Ifet Mahmutović
(Sarajevo, BiH),
Boyanka I. Peneva
(Sofia, Bulgary),
Mario A.C. Marques
(Covilha, Portugal),
Damir Ahmić
(Travnik, BiH),
Raquel Escobar Molina
(Granada, Spain),
Michael Y. H. Chia
(Nanyang, Singapore),
Toivo Jurimae
(Tartu, Estonia),
Hazim Selimović
(Travnik, BiH),
Ken Hardman
(Worcester, UK),
Fatih Hazar
(Aydin, Turkey),
Osmo Bajrić
(Travnik, BiH),
Tudor O. Bompa.
(Toronto, Canada),
Samir Mačković
(Tuzla, BiH),
Jean Firica
(Craiova, Romania),
Lisette Burrows
(Otago, New Zealand),
Edvin Dervišević
(Ljubljana, Slovenija),
Denis Hauw
(Montpellier, France),
Farid Ljuca
(Tuzla, BiH),
Marta Zalewska
(Warsaw, Poland),
Branko Škof
(Ljubljana, Slovenia),
Maja Selimović
(Travnik, BiH),
Elena Plakona
(Solun, Greece),
Blerim Saiti
(Tetovo, Macedonien),
Hana Valkova
(Olomouc, Czech),
Marin Čorluka
(Mostar, BiH),
Georgios Fragkiadakis
(Athens, Greece),
Denysiuk Volodymyr
(Kyiv, Ukraine),
Dana Badau
(Brasov, Romania),
Sukru S. Balci
(Konya, Turska),
Ricardo M, L. Barros
(Campinas, Brasil),
Duško Bjelica
(Podgorica, Montenegro),
Jonathan Bloomfield
(Ulster, N. Ireland),
Manuel F. Botelho
(Porto, Portugal),
Marina M. Bulatova
(Kyiv, Ukraine),
Mark King
(Leicester, UK),
Monia Laccheb
(Tunis, Tunis),
Patrick Laclemence
(Troyes, France),
Hazir Salihu
(Prishtine, Kosovo),
Anatolij Shirjayev
(St. Petersburg, Russia),
Milan Čoh
(Ljubljana, Slovenia)

TABLE OF CONTENTS

Filipe Manuel Clemente, Sixto González-Víllora, Adam Owen, Juan Carlos Pastor-Vicedo, Fernando Manuel Lourenço Martins
(Original scientific paper)
NETWORK PROPERTIES AND PHYSIOLOGICAL RESPONSES ARE CONSTRAINED BY DIFFERENT CONDITIONS IN SMALL-SIDED SOCCER GAMES 8

Adam Hawkey
(Original scientific paper)
EFFECTS OF A WHOLE BODY VIBRATION TRAINING INTERVENTION ON THE JUMP PERFORMANCE OF MALE UNIVERSITY BASKETBALL PLAYERS 16

Žarko Kostovski, Branimir Mikić, Valon Niqci, Shkelzen Shalja
(Original scientific paper)
BLOOD LACTATE CONCENTRATION IN KARATE ATHLETES MEASURED TWICE IN THE PRE-COMPETITIVE AND COMPETITIVE PROGRAMMED ANNUAL PERIOD 22

Ludmula Shesterova, Liliana Riadova, Irina Masliak
(Original scientific paper)
A CHANGE OF THE TACTILE ANALYSER FUNCTIONAL STATE INDICATORS OF 10-16 YEAR OLD PUPILS WITH VISUAL IMPAIRMENT UNDER THE INFLUENCE OF SPECIALLY DIRECTED EXERCISES AND OUTDOOR GAMES 25

Jadranka Otašević, Dragana Kljajić, Vera Rajović, Zoran Mašić, Vesna Bratovčić
(Original scientific paper)
THE SIGNIFICANCE OF DIFFERENTIATED MOTOR HAND MOVEMENTS IN DEVELOPMENT OF SPEECH IN CHILDREN 33

Sadeghi M, Ghasemi GH, Karimi MT
(Original scientific paper)
THE EFFECT OF 12-WEEK REBOUND (TRAMPOLINE) EXERCISE ON CORE MUSCLE STRENGTH IN SPINAL CORD INJURY PATIENTS 40

Dibyojyoti Bhattacharjee, Abhishek Chakraborty
(Original scientific paper)
"BREATHING ROOM" FOR BOWLERS: ON SCRAPPING OF BATTING POWERPLAY FROM 50 OVERS CRICKET 46

Dino Mujkić, Jana Čarkadžić, Dejana Sadžak, Amna Tuzović, Dijana Rađo, Maya Djuric
(Original scientific paper)
THE IMPACT OF CULTURE ON OLYMPIC HERITAGE 54

Mo'een Ahmad Oudat, Majed Abu Eisha, Mohammad Khalaf Thiyabat
(Original scientific paper)
DIFFICULTIES FACED BY PHYSICAL EDUCATION STUDENTS IN PRACTICAL COURSES 59

Alexandr Aghyppo, Irina Kuzmenko, Irina Masliak, Ludmula Shesterova, Tetiana Bala, Natalia Krivoruchko, Tatyana Dorofeeva
(Original scientific paper)
THE INFLUENCE OF SPECIALLY DIRECTED EXERCISES ON THE FUNCTIONAL STATE OF THE TACTILE ANALYSER AND PHYSICAL FITNESS OF 7-15 YEAR OLD PUPILS 70

Fatemeh Alirezaei, Eadric Bresse
(Original scientific paper)
STIFFNESS REGULATION AND JOINT POWER IN RESPONSE TO THE DIFFERENT SHOE INSOLE HARDNESS DURING JUMP-LANDING 78

Milan Dragić, Edita Kastratović, Damir Ahmić, Kada Selimović
(Original scientific paper)
RESEARCH OF YOUNG ATHLETES' RELATIONSHIPS TO FAIR PLAY OR JUST PLAY 84

Amir Shams, Davoud Fazeli
(Original scientific paper)
DO OBSERVATIONAL LEARNING AND RANDOM PRACTICE INCREASE THE LEARNING OF MOTOR SKILLS? 94

Jelena Alić, Gordana Ivković, Nevia Mavra
(Original scientific paper)
DIFFERENCES IN THE LEVEL OF PHYISICAL ACTIVITY BETWEEN STUDENTS WITH DIFFERENT NUTRITIONAL STATUS 101

Artan Kryeziu, Bujar Begu, Fadil Nika
(Original scientific paper)
THE EFFECT OF A 30-DAY PLYOMETRIC TRAINING PROGRAMME ON INCREASING EXPLOSIVE STRENGTH AND AGILITY IN BASKETBALL PLAYERS 107

Nermin Nurković, Faris Rašidagić, Dženana Imamović, Hana Hadžibulić-Nurković
(Original scientific paper)
ANALYSIS OF STUDENT ATTITUDES TOWARDS PHYSICAL EDUCATION LESSONS 114

Pegah Rahmani, Vahid Zolaktaf, Amir Hossein Barati
(Original scientific paper)
THE EFFECT OF EXERCISE TRAINING USING STABLE AND UNSTABLE SURFACES ON BALANCE, GAIT, FATIGUE AND THE QUALITY OF LIFE IN PATIENTS WITH MULTIPLE SCLEROSIS 121

Ivana Petrović, Nikola Utvić, Ratko Stanković
THE RELATIONSHIP OF MOTOR-BASED ANAEROBIC CAPACITY TESTS WITH VARIOUS SPORTS ACTIVITIES: A SYSTEMATIC REVIEW 128

SADRŽAJ

Filipe Manuel Clemente, Sixto González-Víllora, Adam Owen, Juan Carlos Pastor-Vicedo, Fernando Manuel Lourenço Martins
(Original scientific paper)
KARAKTERISTIKE MREŽA I FIZIOLOŠKI ODGOVORI SU OGRANIČENI RAZLIČITIM USLOVIMA U IGRAMA NA SKRAĆENOM PROSTORU U FUDBALU 8

Adam Hawkey
(Original scientific paper)
EFEKTI VIBRACIJSKOG TRENINGA CIJELOG TIJELA NA IZVOĐENJE SKOKA KOD UNIVERZITETSKIH KOŠARKAŠA 16

Žarko Kostovski, Branimir Mikić, Valon Niqci, Shkelzen Shalja
(Original scientific paper)
KONCENTRACIJA LAKTATA U KRVI KARATISTA IZMJERENA DVA PUTA U GODIŠNJEM PERIODU PRIJE I TOKOM TAKMIČENJA 22

Ludmula Shesterova, Liliana Riadova, Irina Masliak
(Original scientific paper)
PROMJENA INDIKATORA FUNKCIONALNOG STANJA OSJETNOG ANALIZATORA UČENIKA SA OŠTEĆENJIMA VIDA U DOBI OD 10-16 GODINA POD UTICAJEM POSEBNO USMJERENIH VJEŽBI I IGARA NA OTVORENOM PROSTORU 25

Jadranka Otašević, Dragana Kljajić, Vera Rajović, Zoran Mašić, Vesna Bratovčić
(Original scientific paper)
ZNAČAJ DIFERENCIRANIH MOTORNIH POKRETA ŠAKE ZA RAZVOJ GOVORA KOD DJECE 33

Sadeghi M, Ghasemi GH, Karimi MT
(Original scientific paper)
EFEKAT VJEŽBI ODSKOKA NA TRAMPOLINU U TRAJANJU OD 12 SEDMICA NA SNAGU MIŠIĆA TRUPA KOD PACIJENATA SA POVREDOM KIČMENE MOŽDINE 40

Dibyojyoti Bhattacharjee, Abhishek Chakraborty
(Original scientific paper)
"PREDAH" ZA BACAČE: O ODBACIVANJU POWERPLAY OGRANIČENJA ZA UDARAČE U 50 OVERS KRIKETU 46

Dino Mujkić, Jana Čarkadžić, Dejana Sadžak, Amna Tuzović, Dijana Rađo, Maya Djuric
(Original scientific paper)
UTICAJ KULTURE NA OLIMPIJSKU BAŠTINU 54

Mo'een Ahmad Oudat, Majed Abu Eisha, Mohammad Khalaf Thiyabat
(Original scientific paper)
POTEŠKOĆE SA KOJIMA SE STUDENTI FIZIČKOG OBRAZOVANJA SUSREĆU TOKOM PRAKTIČNE NASTAVE 59

Alexandr Aghyppo, Irina Kuzmenko, Irina Masliak, Ludmula Shesterova, Tetiana Bala, Natalia Krivoruchko, Tatyana Dorofeeva
(Original scientific paper)
UTICAJ POSEBNO USMJERENIH VJEŽBI NA FUNKCIONALNO STANJE OSJETNOG ANALIZATORA I FIZČKU SPREMNOST UČENIKA U DOBI OD 7 DO 15 GODINA 70

Fatemeh Alirezaei, Eadric Bresse
(Original scientific paper)
REGULACIJA UKOČENOSTI I SNAGE ZGLOBOVA KAO ODGOVOR NA TVRDOĆU RAZLIČITIH ULOŽAKA ZA CIPELE KORIŠTENIH TOKOM DOSKOKA 78

Milan Dragić, Edita Kastratović, Damir Ahmić, Kada Selimović
(Original scientific paper)
ISTRAŽIVANJE ODNOSA MLADIH SPORTISTA PREMA FAIR PLAY ILI POŠTENOJ IGRI 84

Amir Shams, Davoud Fazeli
(Original scientific paper)
DA LI OPSERVACIJSKO UČENJE I NASUMIČNI TRENINZI POBOLJŠAVAJU UČENJE MOTORIČKIH VJEŠTINA? 94

Jelena Alić, Gordana Ivković, Nevia Mavra
(Original scientific paper)
RAZLIKE U RAZINAMA TJELESNIH AKTIVNOSTI IZMEĐU STUDENATA SA RAZLIČITIM STATUSIMA UHRANJENOSTI 101

Artan Kryeziu, Bujar Begu, Fadil Nika
(Original scientific paper)
EFEKAT PLIOMETRIČKOG TRENINGA U TRAJANJU OD 30 DANA NA POVEĆANJE EKSPLOZIVNE SNAGE I AGILNOSTI KOŠARKAŠA 107

Nermin Nurković, Faris Rašidagić, Dženana Imamović, Hana Hadžibulić-Nurković
(Original scientific paper)
ANALIZA STAVOVA UČENIKA PREMA NASTAVI TJELESNOG I ZDRAVSTVENOG ODGOJA 114

Pegah Rahmani, Vahid Zolaktaf, Amir Hossein Barati
(Original scientific paper)
EFEKAT TRENINGA SA VJEŽBAMA U KOJIMA SE KORISTE STABILNE I NESTABILNE POVRŠINE NA RAVNOTEŽU, DRŽANJE, UMOR, I KVALITET ŽIVOTA PACIJENATA SA MULTIPLA SKLEROZOM 121

Ivana Petrović, Nikola Utvić, Ratko Stanković
POVEZANOST MOTORIČKI BAZIRANIH TESTOVA ZA PROCJENU ANAEROBNOG KAPACITETA SA RAZLIČITIM SPORTSKIM AKTIVNOSTIMA 128

DEAR READER,

This issue brings forth scientific papers of authors and co-authors from 15 countries and five continents which validates the universal value of the magazine trying to maintain its continuity in publishing.

The issue also has papers from the area of sports psychology, transformation processes, sports management, sports medicine and kinesiological education.

By supporting the research conducted by young scientists, this issue contains their papers with which we strive to motivate other young people to publish their work.

The members of the Editorial Board are prompt and responsible in their approach to recognising originality and quality of the work done by authors with which we ensure value and recognition of the magazine.

Our Editorial Board would like to promote new values being discovered through research, to make the space available for research to all who have the potential to become visible in that area, and thus connect researchers through their ideas, results and discoveries.

We believe that the papers published in this issue will find their way to the readers and that they will be useful to other authors in their future work.

We would like to invite all who wish to be a part of our project and research team to contact us, send you CV to the e-mail address of the magazine and a short cover letter, so that we would be familiarised with your spheres of interest.

Through this call, we would like to strengthen our Team and provide a chance for people who would like to work, research and prove themselves in the area of sports, as well as to provide a scientific contribution to its development.

Nihad Selimović, MD, MSc
Editor in chief

DRAGI ČITATELJU,

Ovaj broj nam donosi naučne radove autora i koautora iz 15 zemalja sa pet kontinenata što potvrđuje univerzalnu vrijednost časopisa koji se trudi zadržati kontinuitet u objavljivanju.

I u ovom broju imamo radove iz oblasti sportske psihologije, iz oblasti transformacionih procesa, sportskog menadžmenta, sportske medicine i kineziološke edukacije.

Podržavajući istraživanja mladih naučnika i u ovaj broj smo uvrstili njihove radove čime nastojimo motivirati i druge mlade ljude da objavljuju svoje radove.

Članovi recenzentskog odbora su ažurni i odgovrni u pristupu prepoznavanja orginalnosti i kvalitete autorskog djela čime osiguravamo vrijednost i priznatost časopisa.

Naš urednički odbor želi da promoviše nove vrijednosti koje se otkrivaju kroz istraživanje, da učini dostupnim prostor istraživanjima svima koji imaju potencijal da u tom prostoru postanu vidljivi i da tako spajaju istraživače kroz njihove ideje, rezultate i otkrića.

Vjerujemo da će radovi objavljeni u ovom broju naći put do čitalaca i da će koristiti drugim autorima u njihovom budućem radu.

Pozivamo sve vas koji želite da budete dio našeg projektnog i istraživačkog tima da nam se javite, pošaljete svoj CV na e-mail adresu časopisa i kratko motivaciono pismo kako bi znali Vaše sfere interesovanja.

Ovim pozivom želimo jačati naš Tim i pružiti šansu ljudima koji žele raditi, istraživati i dokazivati se u oblasti sporta i dati naučni doprinos u njegovom razvoju.

Mr. sci. dr. Nihad Selimović
Glavni urednik

NETWORK PROPERTIES AND PHYSIOLOGICAL RESPONSES ARE CONSTRAINED BY DIFFERENT CONDITIONS IN SMALL-SIDED SOCCER GAMES

Filipe Manuel Clemente[1,2], Sixto González-Víllora[3], Adam Owen[4], Juan Carlos Pastor-Vicedo[5], Fernando Manuel Lourenço Martins[2,6]

1. Instituto Politécnico de Viana do Castelo, Escola Superior de Desporto e Lazer, Portugal
2. Instituto de Telecomunicações, Delegação da Covilhã, Portugal
3. University of Castilla-La Mancha, Faculty of Education (Cuenca), Spain
4. Centre de Recherche et d'Innovation sur le Sport, Université Claude Bernard Lyon.1, Lyon, France
5. University of Castilla-La Mancha, Faculty of Education (Toledo), Spain
6. Instituto Politécnico de Coimbra, Escola Superior de Educação, Departamento de Educação, Portugal

ABSTRACT

This study aims to examine the effect of differences in a small-sided game (SSG) format (3-a-side and 5-a-side) and task conditions, as well as tactical content (regular, defensive and attacking) on heart rate responses and collective organization (network density, clustering coefficient and total arcs) during small-sided and conditioned games. Thirty-six male players (age: 11.4 ± 0.9; and years of practice: 3 ± 1.1) from the Spanish National League played six different small-sided and conditioned games. It was verified that, during the SSGs format 3 vs. 3 without a goalkeeper and a task condition with attacking tactical content, a significantly greater intensity ($p < 0.001$) shown through time spent between the 81-90% HR zones was revealed. Greater values of network density were observed in the smaller 3 vs. 3 SSG format ($p < 0.001$). The study provided evidence for coaches that smaller formats increase the individual technical demand on players, network density and percentage of time in high intensity heart rate zones.

Keywords: Graph Theory, Adjacency Matrices, Network Analysis, Match Analysis, Youth Football.

INTRODUCTION

Traditionally, small-sided games can be manipulated in order to change the physical and technical demands placed on players. Manipulating player numbers is one of the methods that can be used to alter the training effect, however, it is too limited to develop the tactical perception of players (Davids, Araújo, Correia, & Vilar, 2013). In fact, in the specific case of youth players, the changes in SSGs imply that coaches only vary the rules and the structure of the game in order to try and increase the focus of players on specific technical actions (Davids et al., 2013) such as pass, reception, shot or dribble, tactical behaviours such as covering or penetration and decision-making processes such as to pass or keep the ball (González-Víllora, García-López, Pastor-Vicedo, & Contreras-Jordán, 2011). For this reason, the changes or conditions in the specific structure (such as format or size of the field) and dynamics (such as a way to score or the number of ball touches per player) of the SSG lead coaches to using new terminology, namely, small-sided and conditioned games (SSCG) (Clemente, Wong, Martins, & Mendes, 2014; Davids et al., 2013).

Despite these findings in the SSCG activities, the majority of results are associated with only physiological parameters or only technical indicators. A comparison between various-sided games revealed that SSGs had significantly more passing, receiving, dribbling and shooting than MSGs and LSGs (Owen et al., 2014). Nevertheless, such results come from a study conducted in elite players. Studies conducted amongst younger soccer players are limited, with a lack of research that may contribute to the understanding of how SSCG may influence the learning and performance of the youth. Additional limitations within the current research are that the majority of SSCG research focuses on specific constraints such as player numbers and pitch dimensions rather than the development of tactical tasks or knowledge. Through the use of multiple constraints such as space limitation, scoring possibilities, tactical decision making or through the use of neutral players (a player that provides a momentary numerical superiority for the team with possession of the ball). Consequently, with the current literature taken for analysis, this study aims to be the first of its type in examining the effects of different game formats, task conditions and tactical content on HR responses, technical performance (i.e., measuring the volume of play, efficiency index and performance score) and collective organization (i.e., using the network analysis to measure network density, clustering coefficient and total arcs) during SSCGs consisting of 3-a-side and 5-a-side playing conditions in professional youth players (U-12).

METHODOLOGY

Participants: Thirty-six male professional youth soccer players (age: 11.4 ± 0.9; and years of practice: 3 ± 1.1) from the same club participated in this research study. A minimum of 2 years of practice was established as inclusion criteria. The players had been previously training for an eight-month period. The coach established communication with their parents after which they signed a consent form before this study commenced. The study was carried out respecting the Helsinki Declaration.

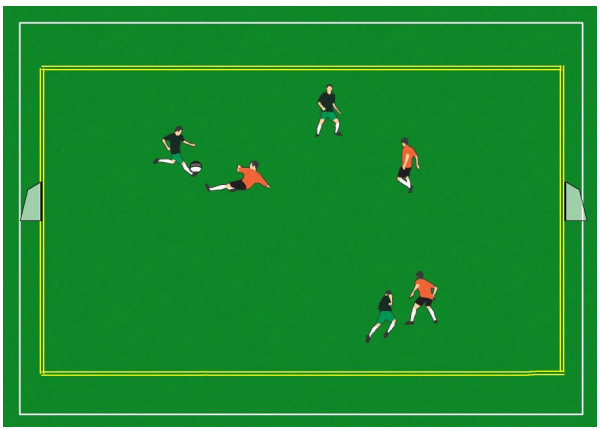
Small-sided games (SSGs)
The players were assigned by their coaches to teams of three and five players that performed three conditions in 3-a-side and 5-a-side games, respectively.

All SSCGs lasted for 5 minutes, with 3-minute recovery between games (Table 1). During the recovery periods, participants were allowed to recover actively and rehydrate as suggested by previous studies (Silva et al., 2014).

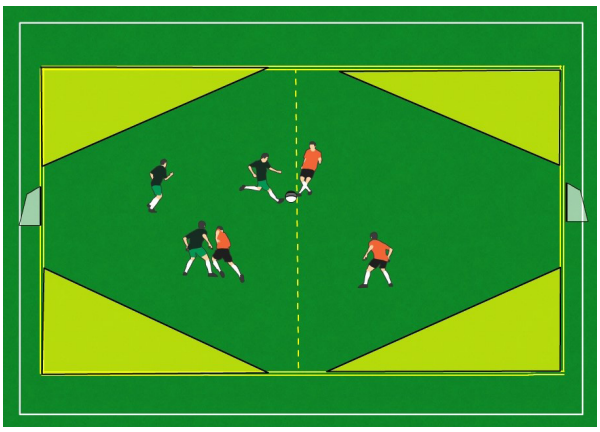
The area per game was computed based on a direct conversion (proportional) of official measures, and the format of the game was in under-12 (7-a-side game in a field of 60 x 40 m) for the formats of 3-a-side and 5-a-side. The field ratio was computed excluding the neutral players that had the task of attacking (Clemente et al., 2014), resulting in 73 m2 per player in 3-a-side and 122 m2 in 5-a-side format.
The three conditions (regular, defensive and attacking) were designed to promote the specific tactical principles (Figure 1).

In the case of the regular task (T1), the SSCG occurred with mini-goals and were played according to the official rules of Association Football, with the exception of the offside rule that was not applied as in previous studies (Silva et al., 2014). The defensive SSCG (T2) was designed to develop the tactical content of spatial concentration (small distances between teammates).

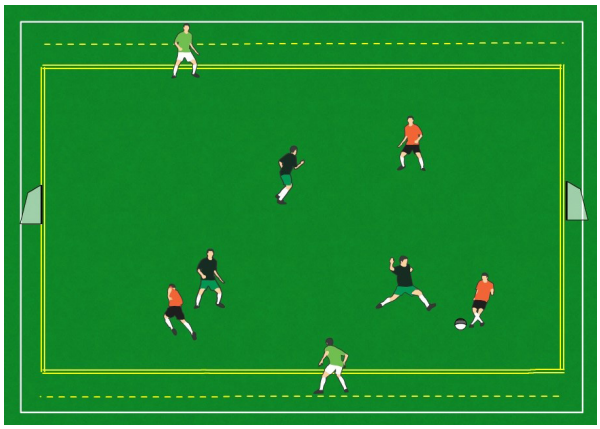
In this condition, the field was reorganized (as possible to observe in Figure 1) and the defenders could only mark and remove the ball inside a "virtual" area. The corner could not be used in order to reduce attacking space and promote defensive efficacy, namely, the number of conquered balls.



T1: Regular SSCG



T2: Defensive SSCG
(Concentration tactical principle)



T3: Attacking SSCG (Width and length tactical principle)

Legend: (T1) regular SSCG with a mini-goal in the centre of the end line and following the standard rules without offside; (T2) defensive SSCG with inactive corners to stimulate the proximity between team members during moments without possession of the ball and to reduce the space for the opponents with the ball; and (T3) attacking SSCG with two neutral players in the wings of the field in order to provide numerical advantage to the team with possession of the ball.

Figure 1. Three SSCGs used in the study.

Finally, the attacking SSCG (T3) was developed to promote the length and width offensive tactical principle (Costa, Garganta, Greco, Mesquita, & Seabra, 2010). In this game, there were two neutral players (a neutral player is a player that does not belong to any team and provides momentary numerical superiority to the team with possession of the ball) in the wing position that provided numerical advantage to the team with possession of the ball. The team was obligated to pass the ball to one neutral player before trying to take the shot. One central mini-goal (2 meters) without a goalkeeper was placed on each side of the field.

PROCEDURES

Data collection was conducted during one week at the end of the season 2014-2015 (in-season). All players participated in both SSCG formats with the 3 different conditions (3 and 5-a-side) (regular, defensive and attacking format) in the same training session, but following different sequences of SSCG to avoid the fatigue effect in the results. A total of 6 games were examined throughout the study in two different training sessions (one-week interval). During the session, the order of the three scoring methods was randomized. HR responses and technical/tactical performance were measured per SSCG to compare the two formats and three conditions. Players were ensured recovery periods of 48 hours before the day of data collection so no training sessions were scheduled. All sessions were conducted in dry conditions, with temperature ranging from 23°C to 25°C. The HR response of each player was assessed through lightweight, portable HR monitors (Polar H7 Bluetooth connected to PolarTeam App, Polar ElectroOY, and Kempele, Finland). Each strap was positioned on the player's chest and the data was recorded at 1-second sampling intervals. The mean and HRmax achieved during each game were calculated for each player, as well as each player's total time spent in specific HR zones (Z) (Owen et al., 2014) (% of total time in the following HRmax zones: Z1 – 51-60%; Z2 – 61-70%; Z3 – 71-80%; Z4 – 81-90%; and Z5 – 91-100%).

NETWORK MEASUREMENTS

The collective organization of the team was measured by using Social Network Analysis (Wasserman & Faust, 1994). This approach allows identifying the cooperation level of teammates during specific types of interactions (Cotta, Mora, Merelo, & Merelo-Molina, 2013). In the case of this study, the attacking cooperation represented by passes between teammates was assessed. The protocol of observation followed the previous studies in this field of analysis (Clemente et al., 2015). The following network metrics were computed in the SocNetV (version 1.9.): i) total arcs; ii) network density; and iii) clustering coefficient. Total arcs is a network measure that quantifies different connections between the nodes (players) of the team. Network density quantifies the general affection of players (values close to 1 reveal more homogeneity in the connections). Average clustering coefficient quantifies how players promote cooperation among their colleagues.

STATISTICAL PROCEDURES

The influence of formats and conditions on the %HRmax, %Time per HRmax Zone (% of total time), graph density (value from 0 to 1) and clustering coefficient (value between 0 and 1) were analysed using a two-way MANOVA after validating normality and homogeneity assumptions. When the MANOVA detected significant statistical differences between the two factors, we proceeded to the two-way ANOVA for each dependent variable, followed by Tukey's HSD post-hoc test (O'Donoghue, 2012). When the two-way ANOVA showed an interaction between factors, it also generated a new variable that crossed the two factors for each dependent variable to identify statistical significance (Clemente et al., 2014). Ultimately, the statistical procedures used were one-way ANOVA and Tukey HSD post-hoc. All statistical analyses were performed using IBM SPSS Statistics (version 22) at a significance level of $p<0.05$. The following scale was used to classify the effect size (ES) (partial eta square) of the analysis of variance (Lakens, 2013): small, 0.2-0.49; moderate, 0.50–0.79; large, 0.80–1.

RESULTS

Individual Analysis – Heart Rate Responses

Format and task condition interaction was found between factors for Z1 (F = 4.855; p = 0.009; η_p^2= 0.048; small ES), Z2 (F = 4.798; p = 0.009; η_p^2= 0.048; small ES), and Z4 (F = 4.853; p = 0.009; = 0.048; small ES). No differences were found for HR average(F = 0.612; p = 0.543; η_p^2= 0.006; small ES), Z3 (F = 1.129; p = 0.325; η_p^2 = 0.012; small ES), Z5 (F = 2.138; p = 0.121; η_p^2= 0.022; small ES), VP (F = 1.977; p = 0.141; η_p^2= 0.020; small ES), EI (F = 1.478; p = 0.231; η_p^2= 0.015; small ES) and PS (F = 2.144; p = 0.120; η_p^2= 0.022; small ES).

One-way ANOVA tested the crossing between factors. Statistical differences were found between the new variable (cross between format and task condition) and the dependent variables of Z1 (F = 3.304; p = 0.007; η_p^2 = 0.079; small ES), Z2 (F = 2.756; p = 0.020; η_p^2= 0.067; small ES), and Z4 (F = 2.919; p = 0.015; η_p^2= 0.071; small ES). The post-hoc results observed are shown in Table 1.

Table 1: Descriptive table (mean and standard deviation) and statistical comparison between format and the type of task for the HR variables of Z1, Z2 and Z4.

3-a-side			
	Task 1	Task 2	Task 3
HRZ1(%)	8.91 (11.44)	10.79 (15.65)[d]	4.27 (8.02)
HRZ2(%)	14.45 (14.04)	16.82 (16.15)[c]	6.73 (7.17)[b]
HRZ4(%)	39.91 (20.56)	30.55 (22.06)[c]	45.73 (18.32)[b,e]
5-a-side			
	Task 1	Task 2	Task 3
HRZ1(%)	2.24 (2.56)[b]	3.67 (5.64)	7.24 (13.56)
HRZ2(%)	9.82 (10.93)	14.30 (12.61)	15.42 (16.47)
HRZ4(%)	34.27 (17.30)	36.70 (20.13)	30.36 (20.46)[c]

Significantly different compared with 3-a-side *T1[a], 3-a-side *T2[b], 3-a-side *T3[c], 5-a-side *T1[d], 5-a-side *T2[e], and 5-a-side *T3[f] at p<0.05

In the case of HR average, Z3 and Z5, a one-way ANOVA was performed on each independent variable because no interaction was found between the factors. The statistical values resulted from the comparison between task conditions can be observed in Table 2.

Table 1: One-way ANOVA values of task conditions in each format in HR average, Z3 and Z4.

			M(SD)	p	η_p^2
HR average (bpm)	3-a-side	T1	78.58 (9.63)	0.976	0.001
		T2	78.63 (11.97)		
		T3	78.06 (13.11)		
	5-a-side	T1	82.70 (8.33)	0.148	0.039
		T2	79.24 (7.17)		
		T3	78.85 (10.37)		
Z3 (%)	3-a-side	T1	18.55 (10.33)	0.306	0.024
		T2	18.03 (13.72)		
		T3	22.45 (13.74)		
	5-a-side	T1	24.18 (18.23)	0.506	0.014
		T2	29.33 (18.44)		
		T3	25.73 (18.35)		
Z5 (%)	3-a-side	T1	18.24 (21.44)	0.677	0.008
		T2	23.82 (30.22)		
		T3	20.82 (24.33)		
	5-a-side	T1	29.48 (29.90)	0.138	0.040
		T2	16.00 (22.78)		
		T3	21.24 (29.21)		
		T3	5.27 (2.14)		

Significantly different compared with T1[a], T2[b] and T3[c] at p<0.05

One-way ANOVA was also carried out to compare the values between formats for the variables of HR average, Z3 and Z5. The values can be verified in Table 4.

Table 4: One-way ANOVA values of task conditions in each format in HR average, Z3, Z4, VP, EI and PS.

			M(SD)	p	η_p^2
HR average (bpm)	Task 1	3-a-side	78.58 (9.63)	0.067	0.051
		5-a-side	82.70 (8.33)		
	Task 2	3-a-side	78.63 (11.97)	0.804	0.001
		5-a-side	79.24 (7.17)		
	Task 3	3-a-side	78.06 (13.11)	0.787	0.001
		5-a-side	78.85 (10.37)		
Z3 (%)	Task 1	3-a-side	18.55 (10.33)	0.127	0.036
		5-a-side	24.18 (18.23)		
	Task 2	3-a-side	18.03 (13.72)[b]	0.006	0.111
		5-a-side	29.33 (18.44)[a]		
	Task 3	3-a-side	22.45 (13.74)	0.415	0.010
		5-a-side	25.73 (18.35)		
Z5 (%)	Task 1	3-a-side	18.24 (21.44)	0.084	0.046
		5-a-side	29.48 (29.90)		
	Task 2	3-a-side	23.82 (30.22)	0.240	0.022
		5-a-side	16.00 (22.78)		
	Task 3	3-a-side	20.82 (24.33)	0.949	0.001
		5-a-side	21.24 (29.21)		
		5-a-side	5.27 (2.14)[a]		
		5-a-side	5.13 (2.72)[a]		

Significantly different compared with 3 vs. 3[a] and 5 vs. 5[c] at p<0.05

COLLECTIVE BEHAVIOUR – NETWORK ANALYSIS

Two-way MANOVA revealed that the format (p = 0.001; η_p^2 = 0.992; large effect size) had significant main effects on the general network variables. No statistical differences were found between task conditions (p = 0.503; η_p^2 = 0.085; small effect size). There was no significant interaction (Pillai's Trace = 0.133; F = 0.687; p = 0.661; η_p^2 = 0.066; small effect size) between format and task condition on general network variables. Based on the absence of interaction between factors (p > 0.05), one-way ANOVA per each factor was carried out. The statistical values resulted from the comparison between task conditions can be observed in Table 5.

Table 5: One-way ANOVA values of format in each task condition in Density, Clustering Coefficient and Total Arcs.

			M(SD)	p	η_p^2
Density (n.)	3-a-side	T1	0.92 (0.09)	0.588	0.068
		T2	0.92 (0.09)		
		T3	0.86 (0.12)		
	5-a-side	T1	0.52 (0.20)	0.304	0.147
		T2	0.60 (0.14)		
		T3	0.45 (0.13)		
Clustering Coefficient (n.)	3-a-side	T1	0.59 (0.45)	0.768	0.035
		T2	0.59 (0.45)		
		T3	0.42 (0.46)		
	5-a-side	T1	0.18 (0.28)	0.148	0.225
		T2	0.36 (0.27)		
		T3	0.08 (0.12)		
Total Arcs (n.)	3-a-side	T1	5.50 (0.55)	0.577	0.071
		T2	5.50 (0.55)		
		T3	5.17 (0.75)		
	5-a-side	T1	10.00 (4.38)	0.319	0.141
		T2	12.00 (2.76)		
		T3	9.00 (2.68)		

Significantly different compared with T1[a], T2[b] and T3[c] at p<0.05 The statistical values resulted from the comparison formats can be observed in Table 6.

Table 6: OOne-way ANOVA values of tasks conditions in each format in Density, Clustering Coefficient and Total Arcs.

			M(SD)	p	η_p^2
Density (n.)	Task 1	3-a-side	0.92 (0.09)[b]	0.001	0.654
		5-a-side	0.52 (0.20)[a]		
	Task 2	3-a-side	0.92 (0.09)[b]	0.001	0.683
		5-a-side	0.60 (0.14)[a]		
	Task 3	3-a-side	0.86 (0.12)[b]	0.001	0.750
		5-a-side	0.45 (0.13)[a]		
Coefficient (n.)	Task 1	3-a-side	0.59 (0.45)	0.094	0.255
		5-a-side	0.18 (0.28)		
	Task 2	3-a-side	0.59 (0.45)	0.327	0.096
		5-a-side	0.36 (0.27)		
	Task 3	3-a-side	0.42 (0.46)	0.111	0.234
		5-a-side	0.08 (0.12)		
Total Arcs (n.)	Task 1	3-a-side	5.50 (0.55)b	0.032	0.384
		5-a-side	10.00 (4.38)a		
	Task 2	3-a-side	5.50 (0.55)b	0.001	0.762
		5-a-side	12.00 (2.76)a		
	Task 3	3-a-side	5.17 (0.75)b	0.007	0.532
		5-a-side	9.00 (2.68)a		

Significantly different compared with 3–a-side[a] and 5-a-side[c] at p<0.05

DISCUSSION

In this study, no differences between formats were found in the %HRmax average. These results are not in accordance with the generality of the studies that compared regular SSG (Clemente et al., 2014; Köklü et al., 2011; Owen et al., 2014). Nevertheless, the specific analysis performed by % of time per HR intensity zones showed that in Z4 (81-90% HRmax) was statistically different between 3-a-side and 5-a-side game formats. This may suggest that smaller formats of the game may induce higher HR intensities, hence resulting in possibly high-intensity aerobic workload as noted in (Little, 2009) review on soccer context. The higher intensities found in smaller formats can be explained by the increase in individual participation and action in the game (Jones & Drust, 2007; Katis & Kellis, 2009). It would seem that the reduced number of players leads to more dynamic defensive and attacking moments. For that reason, engagement in the game may influence the HR responses. Following this point-of-view, it is possible to verify greater values of the volume of play and performance score in smaller format games. This conclusion follows previous studies that compared technical actions in SSG and SSCG with different formats (Clemente et al., 2014; Dellal et al., 2012; Katis & Kellis, 2009; Rudolf & Václav, 2009).

A different topic of analysis during this study was the collective organization of players during attacking moments. Social network analysis was used to measure the general properties of the teams. No statistical differences were found between SSCGs in the structure of cooperation between teammates. This can be explained by the small number of players involved in the games which may reduce the possibility to make multiple decisions and be variable in the passing sequences (González-Víllora et al., 2011). This possibility can be justified by the analysis of variance performed between formats. In this analysis, it was found that statistically greater values of density exist in the 3-a-side format and statistically smaller values of total arcs are present in the same format.

Network density explains how teammates cooperate as a whole (Wasserman & Faust, 1994). Typically, greater values of density are associated with higher values of success in football (Clemente et al., 2015; Grund, 2012). In the particular case of the study in SSCGs, it is normal that the reduced number of players per team may increase the interaction level between teammates. This evidence can be also verified in the case of the larger format tested in this study in which the increase of possibilities to pass may decrease the network density. Therefore, it is possible to observe that the increase in the

number of players will influence the structure of cooperation in football players.

The total arcs values were greater in the conditioned tasks played at 5-a-side, thus making sense based on the fact that such measure quantifies the number of different relations in a team. Previous studies have used such a measure to quantify the capacity of a team in order to promote an increase in different connections between teammates (Clemente et al., 2015). No significant differences of total arcs were found between the types of tasks, thus suggesting that, for this reduced number of players, the used conditions may not influence the relationships between players.

This study had some limitations. First, the results cannot be generalized for all football training and can only be applied to young players. Moreover, future studies must verify the time-motion profiles of players during different SSCGs and the decision-making profiles that occur in SSCGs with different tactical content. Nonetheless, the study proves that SSCGs can change players' performance, even in collective organization.

CONCLUSION

It was observed that the smaller formats increased the percentage of time spent in high intensity HR zones, as well as network density. The results can provide useful information for coaches when developing soccer drills with tactical content. Regular SSCGs can be used to increase the attacking participation and success of the players, and defensive task conditions may be used to hamper the attackers and increase the defensive participation of players. Moreover, smaller formats can be used to develop the anaerobic metabolic system and increase individual participation, and bigger formats may be used for aerobic workout and to increase the variability in the teammates' cooperation.

ACKNOWLEDGEMENTS

This work is funded by FCT/MEC through national funds and when applicable co-funded by FEDER - PT2020 partnership agreement under the project UID/EEA/50008/2013.

REFERENCES

1. Clemente, F. M., Martins, F. M. L., Kalamaras, D., Wong, D. P., & Mendes, R. S. (2015). General network analysis of national soccer teams in FIFA World Cup 2014. International Journal of Performance Analysis in Sport, 15(1), 80–96.
2. Clemente, F. M., Wong, D. P., Martins, F. M. L., & Mendes, R. S. (2014). Acute Effects of the Number of Players and Scoring Method on Physiological, Physical, and Technical Performance in Small-sided Soccer Games. Research in Sports Medicine (Print), 22(4), 380–397.
3. Costa, I. T., Garganta, J., Greco, P. J., Mesquita, I., & Seabra, A. (2010). Influence of Relative Age Effects and Quality of Tactical Behaviour in the Performance of Youth Football Players. International Journal of Performance Analysis in Sport, 10(2), 82–97.
4. Cotta, C., Mora, A. M., Merelo, J. J., & Merelo-Molina, C. (2013). A network analysis of the 2010 FIFA world cup champion team play. Journal of Systems Science and Complexity, 26(1), 21–42.
5. Davids, K., Araújo, D., Correia, V., & Vilar, L. (2013). How small-sided and conditioned games enhance acquisition of movement and decision-making skills. Exercise and Sport Sciences Reviews, 41(3), 154–161.
6. Dellal, a, Owen, a, Wong, D. P., Krustrup, P., van Exsel, M., & Mallo, J. (2012). Technical and physical demands of small vs. large sided games in relation to playing position in elite soccer. Human Movement Science, 31(4), 957–69.
7. González-Víllora, S., García-López, L. M., Pastor-Vicedo, J. C., & Contreras-Jordán, O. R. (2011). Tactical knowledge and decision making in Young Football players (10 years old). Revista de Psicología Del Deporte, 20(1), 79–97.
8. Grund, T. U. (2012). Network structure and team performance: The case of English Premier League soccer teams. Social Networks, 34(4), 682–690.
9. Jones, S., & Drust, B. (2007). Physiological and technical demands of 4 v 4 and 8 v 8 games in elite youth soccer players. Kinesiology, 39, 150–156.
10. Katis, A., & Kellis, E. (2009). Effects of small-sided games on physical conditioning and performance in young soccer players. Journal of Sports Science & Medicine, 8(3), 374.
11. Köklü, Y., Asçi, A., Koçak, F. Ü., Alemdaroglu, U., & Dündar, U. (2011). Comparison of the physiological responses to different small-sided games in elite young soccer players. The Journal of Strength & Conditioning Research, 25(6), 1522–1528.
12. Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. Frontiers in Psychology, 4, 863.
13. Little, T. (2009). Optimizing the use of soccer drills for physiological development. Strength and Conditioning Journal, 31(3), 67–74.
14. O'Donoghue, P. (2012). Statistics for sport and exercise studies: An introduction. London and New York, UK and USA: Routledge Taylor & Francis Group.

15. Owen, A. L., Wong, D. P., Paul, D., & Dellal, A. (2014). Physical and Technical Comparisons between Various-Sided Games within Professional Soccer. International Journal of Sports Medicine, 35(4), 286–292.

16. Rudolf, P., & Václav, B. (2009). Heart rate response and game-related activity of younger school-age boys in different formats of soccer game. Ovidius University Annals, Series Physical Education & Sport/Science, Movement & Health, 9(1), 69–74.

17. Silva, P., Duarte, R., Sampaio, J., Aguiar, P., Davids, K., Araújo, D., & Garganta, J. (2014). Field dimension and skill level constrain team tactical behaviours in small-sided and conditioned games in football. Journal of Sports Sciences, 32(20), 1888–1896.

18. Wasserman, S., & Faust, K. (1994). Social network analysis: Methods and applications. New York, USA: Cambridge University Press.

KARAKTERISTIKE MREŽA I FIZIOLOŠKI ODGOVORI SU OGRANIČENI RAZLIČITIM USLOVIMA U IGRAMA NA SKRAĆENOM PROSTORU U FUDBALU

Ova studija ima za cilj da ispita efekat razlika u formatu igara na skraćenom prostoru (eng. SSG - small-sided game: igra na skraćenom prostoru) (3 na 3 i 5 na 5) i uslova u kojima se izvršavaju zadaci, kao i taktike (uobičajena, odbrambena i napadačka) na srčanu frekvenciju i kolektivnu organizaciju (gustoću mreže, koeficijent grupisanja i ukupne lukove) tokom uvjetovanih i igara na skraćenom prostoru. Trideset šest igrača (dob: 11,4 ± 0,9; i godine praktičnog iskustva: 3 ± 1,1) iz Španske lige je igralo šest različitih uvjetovanih i igara na skraćenom prostoru. Potvrđeno je da je tokom formata igara na skraćenom prostoru 3 na 3 bez golmana i uslova za izvršenje zadatka sa napadačkom taktikom otkriven značajno veći intenzitet ($p < 0,001$) prikazan putem vremena provedenog između zona srčane frekvencije od 81-90%. Veće vrijednosti gustoće mreže su uočene kod manjeg formata SSG-a 3 na 3 ($p < 0,001$). Studija je pružila dokaze trenerima da manji formati povećavaju individualne tehničke zahtjeve za igrače, gustoću mreže i procenat vremena provedenog u zonama srčane frekvencije visokog intenziteta.

Ključne riječi: Teorija grafova, matrice povezanosti, analiza mreža, analiza podudaranja, omladinski fudbal .

Received: December 01, 2018 / Accepted: December 15, 2018
Correspondence to: Filipe Clemente, Instituto Politécnico de Viana do Castelo, Portugal
E-mail: filipe.clemente5@gmail.com

EFFECTS OF A WHOLE BODY VIBRATION TRAINING INTERVENTION ON THE JUMP PERFORMANCE OF MALE UNIVERSITY BASKETBALL PLAYERS

Adam Hawkey[1,2]

1. School of Sport, Health and Social Sciences, Solent University, UK.
2. School of Medicine, University of Dundee, UK.

ABSTRACT

Recent research reports significant improvements in performance following whole body vibration training (WBVT). However, studies investigating those who regularly incorporate jumping into their training regimes report contradictory findings. The current study examined the effects of a short-term WBVT program on vertical countermovement jump (VCMJ) and range of motion (ROM) performance in basketball players. Following institutional ethics approval, 14 male university basketball players were randomly assigned to either a WBVT or control group. All players performed three VCMJs on a contact mat, and three ROM tests using a standard sit-and-reach box, prior to, and on completion of, the six-week study. The WBVT group underwent six-weeks of vibration training, once-a-week on a side-alternating platform. Training, consistent with the overload principle, consisted of three different squatting exercises (half, deep and dynamic); each performed once for one-minute with one-minute recovery between each set of squats. While platform amplitude remained at 4mm, frequency increased in 2 Hz increments from 20 Hz to 26 Hz during the study. The control group followed an identical programme, without vibration exposure. A 2-way repeated measures ANOVA revealed no significant difference, by time ($P = 0.138$) or group ($P = 0.838$), in pre- to post-VCMJ performances of the WBVT and control groups. There was also no significant difference, by time ($P = 0.576$) or group ($P = 0.374$), in pre- to post-ROM measures of the WBVT and control groups. The current study suggests that a 6-week WBVT intervention has no performance-enhancing effect on VCMJ or ROM in university basketball players.

Keywords: Vibration Training, Exercise, Power, Jumping, Basketball.

INTRODUCTION

An individual's vertical jumping performance is regarded as a valid measure of lower body power and is regularly used to assess capability in a sporting context (Markovic, 2007). This is particularly evident in basketball, where there have been a number of studies investigating jump performance in a range of players; often with the aim of distinguishing between males and females, those from a range of abilities, and for the purpose of assessing different training interventions (Balciunas et al., 2006; Matavulj et al., 2001; Khlifa et al., 2010; Santos and Janeira, 2008; Santos and Janeira, 2012). Some studies have made recommendations regarding the most effective training methods for basketball players; generally endorsing plyometric and resistance-based regimes (Matavulj et al., 2001; Khlifa et al., 2010; Santos and Janeira, 2008; Santos and Janeira, 2012; Ziv and Lidor, 2010). Recently though, whole body vibration training (WBVT), also referred to as vibration training or vibration exercise, has become a popular technique among trained and untrained individuals, either as the sole training method or as a supplementary training aid (Osawa et al., 2011). Some have reported that performance enhancements following WBVT are comparable to those observed during resistance-based training (Marin and Rhea, 2010).

It is believed that WBVT can aid athletic performance through the physiological adaptations that occur as the body responds to vibratory waves generated by the vibration platforms used for training (Cardinale and Bosco, 2003; Nordland and Thorstensson, 2007).

Stimulation of neuromuscular pathways and muscle spindles are most often described as the reason for such adaptations, but other theories, including increased muscle temperature and alterations in hormone secretion, have also been proposed (Hawkey, Rittweger and Rubin, 2016).

Part of the reason for WBVTs popularity has been attributed to its time efficiency, easy regulation, and that it can be conducted indoors. Additionally, it has been demonstrated that WBVT can illicit performance benefits without increasing overall training load (Wyon, Guinan and Hawkey, 2010); further promoting its incorporation into training regimes.

The majority of WBVT studies, conducted on sedentary and recreationally active populations, report enhancements in performance of between 8-14% following relatively short-term (6-12 weeks) exposure (Delecluse Roelants and Verschueren, 2003; Hawkey, 2012; Hawkey et al., 2016; Hawkey and Bowman, 2017). However, WBVT's effectiveness in trained groups, including basketball players, is less definitive. Wyon, Guinan and Hawkey (2010) reported significant improvements in ballet-specific jumping performance following 6-weeks of WBVT in a dance population. Similarly, Perez-Turpin et al. (2014) found that WBVT improved volleyball and beach volleyball players' jump performance over that of their control group. Professional soccer goalkeepers have also been shown to dramatically increase their task-specific jumping ability following WBVT with Hawkey and Morrison (2017) reporting a ~9% improvement after a 6-week training intervention.

However, other studies such as those investigating vertical countermovement jump (VCMJ) performance in national league (Hawkey, Lau and Nevill, 2009) and competitive basketball players (Colson et al., 2010), have reported no performance enhancement following WBVT. The reason for these discrepancies is not currently clear, although they are likely to be multifactorial; differing protocols, utilisation of various equipment for both training and testing, and performance level of participants, all suggested as having the potential to influence results (Hawkey, 2012a; Lorenzen et al., 2009; Petit et al., 2010).

AIM

Given the importance of jumping performance to basketball players (Shaji and Saluja, 2009; Ziv and Lidor, 2010), and the conflicting evidence relating to WBVT in trained populations, the primary aim of the current study was to determine the influence of this training modality on the jumping performance of a university basketball population. As a supplementary measure, which has been previously investigated with WBVT and basketball players, range of motion (ROM) was also determined. A mixed research design with independent, randomly assigned groups, undertaking different interventions, with repeated measures (testing pre- and post- the intervention period) was implemented.

METHODS

Following institutional ethics approval, and in accordance with the latest delineation of the Helsinki declaration (World Medical Association, 2013), 14 male university basketball players (age mean 21 ± 2years, height mean 187.3cm ± 6.92cm, mass mean 82.42kg ± 12.1kg) were recruited through a convenience sampling method.

By completing an informed consent form, physical activity readiness questionnaire (PAR-Q), and through verbal confirmation throughout the study, all players self-reported that they were not suffering from any injuries or illnesses that would prevent or restrict their participation.

Specific exclusion criteria for WBVT included cardiovascular complaints, metal/synthetic implants, migraines, thrombosis, epilepsy, and lumbar disc problems (Hawkey, 2012b). All participants (WBVT and control) were asked to maintain their current training levels and to not alter their dietary intake throughout the duration of the intervention period as specified in previous WBVT research (Babraj and Hawkey, 2017).

Wearing training clothing (shorts and t-shirt), all players underwent basic anthropometrical assessment, which included height measurements (conducted on a seca 213 stadiometer) to the nearest 0.01m and mass measurements (using seca 761 scales) to the closest 0.1 kg. Players were then randomly assigned to either a WBVT or control group.

The WBVT group then trained once-per-week, over a six-week period, performing three different squatting exercises (half, deep and dynamic squats); each exercise performed twice for 60s each followed by 60s recovery on a side-alternating vibration platform (Crazy Fit Massage, WBV-X1150). During the squats, feet were required to remain flat on the platform surface, placed on markers to ensure parity between training sessions and participants; this was particularly important in respect of amplitude levels, which remained at 4mm throughout the study.

In accordance with the overload training principle (Ingham, 2007; Ramirez-Campillo et al., 2015), in acknowledgement of a meta-analysis by Marin and Rhea (2010), which reported that ~24Hz is the most commonly implemented frequency to enhance performance when using a side-alternating platform, and in line with previous research using an identical vibration platform (Hawkey and Bowman, 2017), the frequency of the platform was gradually increased from 20Hz – 24Hz over the six-week study (Figure 1).

Rest periods between the sets were maintained at 60s in accordance with American College of Sports Medicine (ACSM) recommendations for resistance-type training (Ratamess et al., 2009). The control group followed an identical isometric training protocol, performing the same exercises without vibration exposure.

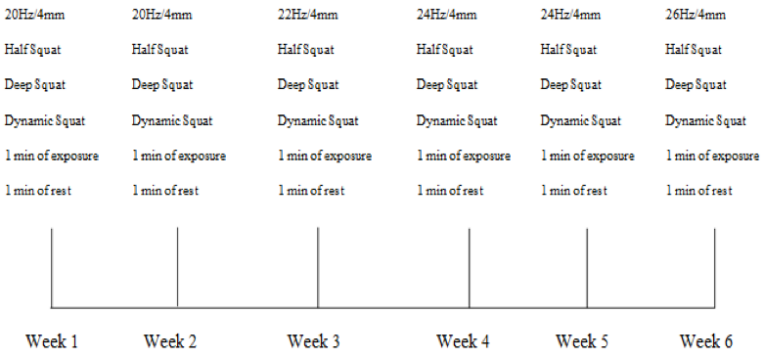


Figure 1: Training programme for the WBVT group

Muscular power was assessed pre- and post-intervention using three maximal vertical countermovement jumps (VCMJ) performed on a Just Jump contact mat (Probiotics Inc.) in accordance with Hawkey (2012).

Hands were required to remain on hips during performance of the VCMJ to be consistent with protocols used in previous research (Arteaga et al. 2000; Byrne et al. 2017) and to ensure consistency between trials and participants (Harman et al. 1990; Lees et al. 2004). A period of 15s was implemented between each VCMJ in accordance with Read and Cisar (2001) who found this to be the optimal recovery time when conducting maximal jump testing. ROM was assessed via a standard sit-and-reach test in accordance with previous WBVT and basketball research by Hawkey, Lau and Nevill, (2009).
To allow for sufficient recovery (McLester et al. 2003; Westcott, 2010), and to avoid the confounding influence of circadian variation (Drust et al. 2005; Teo et al. 2011), post-intervention VCMJ and ROM performance was assessed 72 hours following the last training session and at a similar time of day (± 1 hrs) as the pre-intervention testing. Maximal VCMJ and ROM, in both the WBVT and control groups, were analysed using a 2-way analysis of variance (ANOVA). The alpha level was set at $P<0.05$.

RESULTS AND DISCUSSION

The 2-way ANOVA with repeated measures indicated that there was no significant improvement ($P = 0.138$) in participants' countermovement jump performance over time. There was also no significant difference ($P = 0.838$) in countermovement jump performance between the intervention (pre- 49.16cm ± 7.9cm to post- 50.26cm ± 7.59cm) and the control group (pre- 46.13 ± 4.85cm to post- 47.56cm ± 3.33cm) (Figure 2).

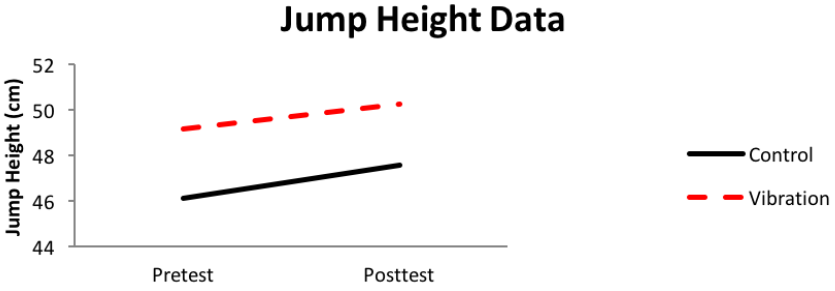


Figure 2: Plot from the 2-way ANOVA showing pre- and post-test jump performance in the vibration and control groups

The 2-way ANOVA with repeated measures also indicated that there was no significant improvement (P = 0.576) in participants' flexibility performance over time. Furthermore, there was no significant difference (P = 0.374) in flexibility performance between the intervention (pre- 16.71cm ± 12.65cm to post- 17.57 cm ± 11.08cm) and the control group (pre- 17.2cm ± 12.07cm to post- 17cm ± 10.86cm) (Figure 3).

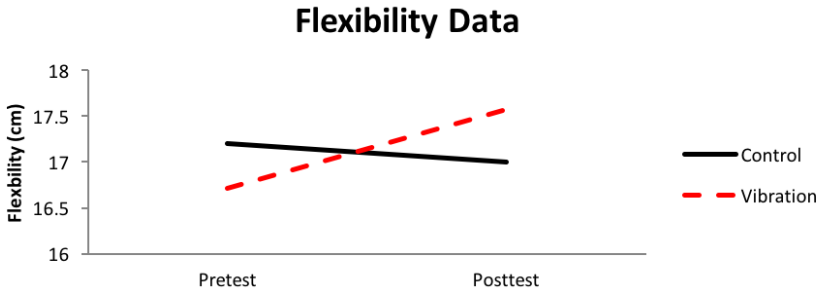


Figure 3: Plot from the 2-way ANOVA showing pre- and post-test flexibility performance in the vibration and control groups

With reports that vibration exposure can induce performance enhancements comparable to those observed during more traditional, resistance-based, training (Marin and Rhea, 2010), without increasing overall training load (Wyon, Guinan and Hawkey, 2010), WBVT is becoming a popular technique among trained and untrained individuals (Osawa et al., 2011). While the majority of WBVT studies, conducted on sedentary and recreationally active populations, report enhancements in performance of between 8-14% following relatively short-term (6-12 weeks) exposure (Delecluse Roelants and Verschueren, 2003; Hawkey, 2012; Hawkey et al., 2016; Hawkey and Bowman, 2017), its effectiveness in trained groups is less conclusive; some show improvements of up to ~9% (Wyon, Guinan and Hawkey, 2010; Perez-Turpin et al., 2014; Hawkey and Morrison, 2017), while others highlight no performance enhancement (Hawkey, Lau and Nevill, 2009; Colson et al., 2010). Given the importance of jumping performance to basketball players (Shaji and Saluja, 2009; Ziv and Lidor, 2010), and the conflicting evidence relating to WBVT in trained populations, the primary aim of the current study was to determine the influence of this training modality on the jumping performance of a university basketball population.

The results of the current study consolidate those of Hawkey, Lau and Nevill (2009) and Colson et al. (2010) who reported no improvement in VCMJ performance following WBVT in national league and competitive basketball players respectively. These similarities were found despite some major differences in the studies' designs and protocols. The current study's players undertook WBVT just once-per-week for six-weeks on a side-alternating platform. Those in Hawkey, Lau and Nevill (2009) trained twice-per-week, also for six-weeks, on a NEMES vertical vibration system, while Colson et al. (2010) required the players in their 4-week study to train three-times-per-week using a Silverplate vertical vibration platform. The current study also utilised university standard players compared to those competing at national level in Hawkey, Lau and Nevill (2009); with Colson et al. (2010), simply describing their players as competitive, it is difficult to ascertain the actual level of competition. In contrast, the results of the current study, therefore, contradict the findings of Perez-Turpin et al. (2014) who found significant improvements in jumping performance in both volleyball and beach volleyball players following vibration exposure. Results also conflict with those of Hawkey and Morrison (2017), who reported improvements in professional soccer goalkeepers following a similar training intervention, and Wyon, Guinan and Hawkey (2010) who reported enhancements in dancers' jumping ability following a short-term WBVT intervention. The reason for these discrepancies is not clear. While the use of different training protocols, the utilisation of dissimilar equipment for both training and testing, and the variation in performance levels of the participants all have the potential to influence results (Hawkey, 2012a; Lorenzen et al., 2009; Petit et al., 2010), it is not obvious why such analogous regimes should produce such differing findings. While there is perhaps some logic in the theory that jump training being staple in basketball (Shaji and Saluja, 2009; Ziv and Lidor, 2010) may have had some influence, additional research is now needed to better understand the reasons for the apparent lack of improvement in basketball players' jumping performance following WBVT.

CONCLUSION

While numerous studies have demonstrated that WBVT is an effective exercise modality that can enhance muscular strength and power, results from the current study suggest that a 6-week WBVT programme has no performance enhancing effect on the VCMJ or flexibility performance of university

basketball players. The results of this current study, and of other WBVT research conducted on basketball populations, appear to suggest that this mode of exercise is not beneficial to basketball players. Therefore, based on these results, WBVT would not be recommended to this population. However, as other trained populations such as soccer goalkeepers, dancers, and volleyball players have benefitted from WBVT, and with no apparent increase in overall training load, the lack of improvement in basketball players warrants further investigation to ascertain if there is specific reason why this population appears unreceptive to such an intervention.

REFERENCES

1. Babraj, J., Hawkey, A. Improved insulin sensitivity following a short-term whole body vibration intervention. Al Ameen Journal of Medical Sciences 2017, 10(1): 3-9.
2. Balciunas, M, Stonkus, S, Abrantes, C., Sampaio, J. Long-term effects of different training modalities on power, speed, skill and anaerobic capacity in young male basketball players. Journal of Sports Science and Medicine 2006, 5: 163–170.
3. Cardinale, M. Bosco, C. The use of vibration as an exercise intervention. Exercise and Sport Sciences Reviews 2003, 31(1): 3-7.
4. Colson, S.S., Pensini, M., Espinosa, J., Garrandes, F., Legros, P. Whole-body vibration training effects on the physical performance of basketball players. Journal of Strength and Conditioning Research 2010, 24(4): 999-1006.
5. Delecluse, C., Roelants, M., Verschueren, S.M. Strength increases after whole-body vibration compared with resistance training. Medicine and Science in Sports and Exercise 2003, 35: 1033-1041.
6. Drust, B., Waterhouse, J., Atkinson, G., Edwards, B., Reilly, T. (2005). Circadian rhythms in sports performance: An update. Chronobiology International, 22: 21-44.
7. Hawkey, A. Whole body vibration training improves muscular power in a recreationally active population. SportLogia 2012, 8(2): 116–122.
8. Hawkey, A. Editorial: Quantification, clarification and standardisation of whole body vibration. Journal of Sports Therapy 2012, 5(1).
9. Hawkey, A., Griffiths, K., Babraj, J., Cobley, J.N. Whole-body vibration training and its application to age-related performance decrements: an exploratory analysis. Journal of Strength and Conditioning Research 2016, 30(2), 555-560.
10. Hawkey, A., Rittweger, J., Rubin, C. Vibration exercise: evaluating its efficacy and safety on the musculoskeletal system. The Sport and Exercise Scientist 2016, 50(4): 26-27.
11. Hawkey, A. Morrison, D. In-season whole body vibration training enhances vertical jump performance in professional soccer goalkeepers. Turkish Journal of Sport and Exercise 2017, 19(2): 143-149.
12. Hawkey, A., Lau, Y., Nevill, A. Effect of six-week whole body vibration training on vertical jump and flexibility performance in male national league basketball players. Journal of Sport Sciences 2009, 27(4): S138-S139.
13. Hawkey, A., Bowman, C. Six-week whole body vibration training improves power in recreationally active females. Journal of Sports Sciences 2017, 34(S1): S18-9.
14. Ingham, S. The physiology of strength training. In G. Whyte, The Physiology of Training 2007: 135-162. London: Churchill Livingston.
15. Khlifa, R., Aouadi, R., Hermassi, S., Chelly, M.S., Jlid, M.C., Hbacha, H., Castagna, C. Effects of a plyometric training program with and without added load on jumping ability in basketball players. Journal of Strength and Conditioning Research 2010, 24: 2955–2961.
16. Marin, P.J., Rhea, M.R. (2010). Effects of vibration training on muscle strength: a meta-analysis. Journal of Strength and Conditioning Research, 24(2), 548-556.
17. Markovic, G. Does plyometric training improve vertical jump height? A meta-analytical review. British Journal of Sports Medicine 2007, 41: 349-355.
18. McLester, J.R., Bishop, P.A., Smith, J., Wyers, L., Dale, B., Kozusko, J., Richardson, M., Nerett, M.E., Lomax, R. A series of studies – A practical protocol for testing muscular endurance recovery. Journal of Strength and Conditioning Research 2003, 17(2): 259-273.
19. Matavulj, D., Kukolj, M., Ugarkovic, D., Tihanyi, J., Saric, S. Effects of plyometric training on jumping performance in junior basketball players. Journal of Sports Medicine and Physical Fitness 2001, 41: 159–164.
20. Nordland, M.M., Thorstensson, A. Strength training effects of whole-body vibration? Scandinavian Journal of Medicine and Sports Science 2007, 17(1): 7-12.
21. Perez-Turpin, J.A., Zmijewski, P., Jimenez-Olmedo, J.M., Jove-Tossi, M.A., Martinez-Carbonell, A., Suarez-Llorca, C., Andreu-Cabrera, E. Effects of whole body vibration on strength and jumping performance in volleyball and beach volleyball players. Biology of Sport 2014, 31(3): 239-254.
22. Ramirez-Campillo, R. et al. Effect of progressive volume-based overload during plyometric training on explosive and endurance performance in young soccer players. Journal of Strength and Conditioning Research 2015, 29(7): 1884- 1893

23. Ratamess, N.A., Alvar, B.A., Evetoch, T.K., Housh, T.J., Kibler, W.B., Kraemer, W.J., Triplet, N.T. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Medicine and Science in Sports and Exercise 2009, 41: 687-708.

24. Santos, E., Janeira, M.A. Effects of complex training on explosive strength in adolescent male basketball players. Journal of Strength and Conditioning Research 2008, 22: 903–909.

25. Santos, E., Janeira, M.A. The effects of resistance training on explosive strength indicators in adolescent basketball players. Journal of Strength and Conditioning Research 2012, 26(10): 2641-2647.

26. Shaji, J., Saluja, I. Comparative analysis of plyometric training programme and dynamic stretching on vertical jump and agility in male collegiate basketball players. Al Ameen Journal of Medical Sciences 2009, 2(1): 36-40.

27. Teo, W., Newton M.J., McGuigan M.R. Circadian rhythms in exercise performance: implications for hormonal and muscular adaptation. Journal of Sports Science and Medicine 2011, 10(4), 600-606.

28. Westcott, W.L. How often should clients perform strength training? ACSM's Certified News 2010, 20(2): 10-11.

29. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. Journal of the American Medical Association 2013, 310:2191- 2194.

30. Wyon, M., Guinan, D., Hawkey, A. Whole body vibration training increases vertical jump height in a dance population. Journal of Strength and Conditioning Research 2010, 24(3): 866-870.

31. Ziv, G., Lidor, R. Vertical jump in female and male basketball players: a review of observational and experimental studies. Journal of Science and Medicine in Sport 2010, 13(3): 332-9.

EFEKTI CILJEVA INTERVENCIJE OBUKA VIKERSKE VEĆE NA PERFORMANU KOŠARKAŠKIH KOŠARKAŠKIH MALIH UNIVERZITETA

Nedavna istraživanja pokazuju značajna poboljšanja u performansama nakon treninga vibracije cijelog tijela (WBVT). Međutim, studije koje istražuju one koji redovno uključuju skakanje u svoje sisteme obuke prijavljuju kontradiktorne nalaze. Sadašnja studija ispitala je efekte kratkoročnog programa WBVT na vertikalnu skokovsku skok (VCMJ) i opseg pokreta (ROM) u performansama košarkaša. Nakon odobrenja institucionalne etike, 14 muških univerzitetskih košarkaša su nasumično dodijeljene ili WBVT ili kontrolnoj grupi. Svi igrači su izvodili tri VCMJ na kontaktnoj matrici i tri ROM testa koristeći standardnu kutiju za sedenje i dostizanje, pre i nakon završetka šestrednevne studije. Grupa WBVT je prošla šest nedelja vibracije, jednom nedeljno na bočnoj platformi. Obuka, u skladu sa principom preopterećenja, sastojala se od tri različite vježbe za skakanje (pola, duboke i dinamične); svaka izvedena jednom za jedan minut sa jednominutnim oporavkom između svakog skupa skauta. Dok je amplituda platforme ostala na 4mm, frekvencija je povećana u koracima od 2 Hz od 20 Hz do 26 Hz tokom studije. Kontrolna grupa je pratila identičan program, bez izlaganja vibracijama. Dvostruke ponovljene mere ANOVA nisu otkrile značajne razlike po vremenu (P = 0,138) ili grupi (P = 0,838), pre post-VCMJ performansi WBVT i kontrolnih grupa. Nije bilo značajne razlike po vremenu (P = 0.576) ili grupi (P = 0.374), pre post-ROM mera WBVT i kontrolnih grupa. Trenutna studija pokazuje da 6-nedeljna intervencija WBVT-a nema uticaj na performanse na VCMJ ili ROM u univerzitetskim košarkaškim igračima.

Ključne riječi: Vibracijski trening, vježba, snaga, skokovi, košarka.

Received: June 06, 2018 / Accepted: June 15, 2018
Correspondence to: Adam Hawkey, Head of Sport Science and Performance, Solent University, East Park Terrace, Southampton, SO14 0YN, UK
E-mail: adam.hawkey@solent.ac.uk

BLOOD LACTATE CONCENTRATION IN KARATE ATHLETES MEASURED TWICE IN THE PRE-COMPETITIVE AND COMPETITIVE PROGRAMMED ANNUAL PERIOD

Žarko Kostovski[1], Branimir Mikić[2], Valon Niqci[3] Shkelzen Shalja[4]

1. Faculty of Physical Education Sport and Health, Skopje, Republic of Macedonia
2. Faculty of Education and Rehabilitation, University of Tuzla, Bosnia and Herzegovina
3. Faculty of Physical Education Sport and Health, Skopje, Republic of Macedonia
4. Kolegji AAB, Prishtina, Kosovo

ABSTRACT

The survey was conducted on a sample of 29 male karate athletes, from the age categories of younger seniors (U21) and older seniors from the Republic of Macedonia. A portable Scout + Lactate analyser device was used to determine the amount of blood lactates. Capillary blood samples were taken by experienced medical laboratory technicians, every time from a different finger. Blood used to determine lactate concentration was taken during rest periods, before the start of the working series, between each of the series and at the end of the performed cool-down period - recycling of the lactates. In total, blood tests were performed at 6 mark points during the workout. Three variables showed statistically significant differences in blood lactate levels between the two measurements, with application of a t-test for small dependent samples.

Keywords: Training, recovery, periodization.

INTRODUCTION

Karate is probably one of the most popular martial arts practiced around the world, becoming a popular martial sport that attracts participants and a large number of supporters around the world (Gibson and Wallace, 2004). Traditional karate trainings, in their training programme, include basic techniques, kata, and sparring activities (Imamura et al., 1998). The competitions organized by the World Karate Federation (WKF), in modern karate, consist of two equally important disciplines, sports combat (kumite) and form (kata) (Korpanovski et al., 2011; Taben et al, 2013). The kumite discipline is increasingly attracting attention of a large number of researchers, educational workers, coaches and interns who daily explore this area. Achieving top sports results is conditioned by a number of predispositions that modern competitors should possess. Great importance is given to high technical performance, motor and functional abilities, psychological preparedness and anthropometric and morphological predispositions (Lehmann & Jedliczka, 1998; Jukić et al., 2012).

Career training and the diagnostic procedures in it should contain, develop and analyse the height of the specific energy capacities, the specific structure of the movements, in specific situations, arising from

the structure of karate sports. It can be said that physiological parameters can play a key role in achieving efficient readiness of karate athletes for achieving top results.

METHODS

The survey was conducted on a sample of 29 male karate athletes, from the age categories of younger seniors (U21) and older seniors from the Republic of Macedonia, in the pre-competitive and competitive period. All respondents are competitors who participated in the national championship and the three main leagues organized by the World Karate Federation (WKF). The sample of variables consists of 6 blood tests taken during training. Capillary blood samples were taken by experienced medical laboratory technicians, every time from a different finger.

After only ten seconds, the lactate level, which is measured at a given moment and expressed in mmol/l, is shown on the display. The measurements were carried out separately, on two occasions, once in the pre-competitive and once in the competitive period, with a 30-day time interval between the first and second measurement. A portable Scout + Lactate analyser was used to determine the amount of blood lactates, and its validity was confirmed in previous studies carried out by Baldari et al. (2009). Blood used to determine lactate levels was taken during rest periods, before the start of the working series, between each of the series and at the end of the performed cool-down period - recycling of the lactates. A t-test for small dependent samples was applied to determine the differences in blood lactate levels between the two measurements.

RESULTS AND DISCUSSION

From the results of the t-tests (Table 1), it can be seen that statistically significant differences were found in the variables L0 (t -test = 3.23; sig = 0.00), L2 (t -test = 3.90; sig = 0.00) and L3 (t -test = 1.98; sig = 0.05) between the pre-competitive and the competitive period. Based on the numerical values of arithmetic means, it can be seen that, in the second measurement, the blood lactate concentration in the variable L0 has lower values of 25.11% compared to the first measurement.

In the variable L2, lower values were recorded by 36.27% compared to the first measurement, while the variable L3 showed lower values by 19.18% compared to the first measurement. In the other variables, although statistically significant differences have not been established, a numerical change in the results for the variables L4 and L5 can be observed in the positive direction, i.e. a decrease in the lactate level in the second measurement, while in the variant L1 the level goes in a negative direction.

Table 1: Blood lactate concentration measured in several training phases, in the pre-competitive and competitive period

	I training		II training		%	r	T-test	p
	Mean	SD	Mean	SD				
L0	2.19	0.82	1.64	0.43	25.11	0.01	3.23	0.00
L1	3.10	1.61	3.26	1.70	-5.16	0.31	-0.43	0.67
L2	10.23	4.68	6.52	2.61	36.27	0.11	3.90	0.00
L3	10.22	3.85	8.26	3.26	19.18	-0.12	1.98	0.05
L4	9.83	3.99	8.89	3.34	9.56	0.36	1.22	0.23
L5	3.24	1.70	2.72	1.38	16.05	0.23	1.45	0.16

CONCLUSION

Based on the analysis of the obtained results, it can be noted that the level of blood lactates analysed at different stages of training has a high variability, which shows a different anaerobic glycolytic contribution to the metabolic processes. This leads to the conclusion that, although a significant statistical decline in the blood lactate levels of 9.83 mmol/l and 8.89 mmol/l at values of 3.24 mmol/l and 2.72 mmol/l has been confirmed, the time period for complete lactate recycling and recovery, as well as the recovery of the athletes' organisms with 12-minute

running or jumping with rope as the only method is not long enough. If, in the recovery of athletes, other procedures for the complete recovery of the athletes such as cryotherapy, jacuzzi, muscle relaxation with the use of massage, etc. are involved and applied, the recovery results will probably be at a higher level. In situations where there are no conditions for a higher level of day-to-day recovery of athletes, we suggest that running and jumping with rope become a practice after using high-intensity training processes so that athletes can recover more quickly and, thus, be prepared to continue their training periodization in the next period of time from the determined cycle of the training programme.

REFERENCES

1. Amusa, L. O., Onyewadume, I. U. (2001). Anthropometry, body composition and somatotypes of Botswana national karate players: a descriptive study. Acta Kinesiologiae Universitatis Tartuensis 6: 7-14.
2. Baldari, C., Bonavolontà, V., Emerenziani, G., Gallotta, M, C. & Silva, A, J. (2009) Accuracy, reliability, linearity of Accutrend and Lactate Pro versus EBIO plus analyzer, European Journal of Applied Physiology.
3. Beneke, R., Beyer, T., Jachner, C.; Erasmus, J.; Hutler, M. (2004). Energetics of karate kumite. European Journal of Applied Physiology, 92(4-5), 518-523.24.
4. Doria, C., Veicsteinas, A., Limonta, E., Maggioni, M.A., Aschieri, P., Eusebi, F., Fanò, G. and Pietrangelo, T. (2009). Energetics of Karate (Kata and Kumite Techniques) in top-level Athletes. Eur J ApplPhysiol, 107:603-610.
5. Gibson, A. & Wallace, B. (2004) Competitive karate: featuring the superfoot system. Champaign, 111: Human Kinetics Publishers. 183 p.
6. Imamura, H., Yoshimura, Y., Uchida, K., Nishimura, S., Nakazawa, A.T. (1998). Maximal Oxigen Uptake, Body Composition and Strength of Highly Competitive and Novice Karate Practitioners. Journal of Physiological Anthropology, Apll Human Sci, 17(5): 215-218.
7. Jukić, J., Katić, R., Blaţević, S. (2012). Impact of Morphological and Motor Dimensions on Success. CollAntropol, 36(4): 1247-1255.
8. Koropanovski N., Berjan B., Bozic P., Pazin N., Sanader A., (2011) Anthropometric and Physical Performance Profiles of Elite Karate Kumite and Kata Competitors. J Hum Kinet 30:107114.
9. Lehmann, G., Jedliczka, G. (1998). Investigations about the event specific profile of karate. Leistungssport, 28(3), 56–61.
10. Roschel H., Batista M., Monteiro R., Bertuzzi R.C., Barroso R., et al. (2009). Association between neuromuscular tests and kumite performance on the Brazilian karate national team. J Sports Sci Med 8:2024
11. Tabben, M., Jeremy, Coquar; Helmi, C., Emerson F., Karim Chamar, Claire, Tourny (2013) Validity and Reliability of a New Karate-Specific Aerobic Field Test for Karatekas, Volume: 9, Issue: 6, Pages: 953-958, Human Kinetics Journals International Journal of Sports Physiology and Performance

KONCENTRACIJA LAKTATA U KRVI KARATISTA IZMJERENA DVA PUTA U GODIŠNJEM PERIODU PRIJE I TOKOM TAKMIČENJA

Ispitivanje je provedeno na uzorku od 29 karatista iz dobnih kategorija mlađih seniora (U21) i starijih seniora iz Republike Makedonije. Prenosivi Scout + Lactate uređaj za analizu se koristio kako bi se utvrdila količina laktata u krvi. Uzorci kapilarne krvi su uzeti od strane iskusnih zdravstveno-laboratorijskih tehničara, svaki put iz drugog prsta. Krv korištena za utvrđivanje koncentracije laktata je uzeta tokom perioda odmora, prije početka radne serije, između svake serije i na kraju perioda hlađenja - recikliranja laktata. Ukupno je provedeno 6 testova krvi tokom vježbanja. Tri varijable su pokazale statistički značajne razlike u nivoima laktata u krvi između dva mjerenja, uz primjenu t-testa za male zavisne uzorke.

Ključne riječi: Trening, oporavak, periodizacija.

Received: December 03, 2018 / Accepted: December 15, 2018
Correspondence to: Prof. Žarko Kostovski, PhD, University Ss. Cyril and Methodius, Faculty of Physical Education, Sport and Health, Skopje, Republic of Macedonia
E-mail: zarkok@ukim.edu.mk

A CHANGE OF THE TACTILE ANALYSER FUNCTIONAL STATE INDICATORS OF 10-16 YEAR OLD PUPILS WITH VISUAL IMPAIRMENT UNDER THE INFLUENCE OF SPECIALLY DIRECTED EXERCISES AND OUTDOOR GAMES

Ludmula Shesterova, Liliana Riadova, Irina Masliak
Kharkov Sate Academy of Physical Culture, Ukraine

ABSTRACT

Purpose: to define the influence of specially directed exercises and outdoor games on tactile analyser functional state indicators of middle school-aged children with visual impairment. Material: the research was conducted on the basis of special general education boarding schools of Kharkov and Dnepropetrovsk. Pupils of 5-10th grades, who were divided into 6 experimental and 6 control groups, took part in it. Results: Tactile analyser functional state indicators of 10-16 year old children with visual impairment were analysed before the use of specially directed exercises and outdoor games. Changes of the studied indicators in gender and age aspects were considered. A positive influence of specially directed exercises and outdoor games on the functional state of the tactile analyser was revealed. Conclusions: 1. It was established that tactile sensitivity spatial threshold indicators of the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm were below the line in middle-school pupils with visual impairment before carrying out the experiment. 2. Inclusion of 10-16 year old pupils with visual impairment in the context of physical education classes containing specially directed exercises and outdoor games positively affected the functional state of the tactile analyser ($p<0.05$). 3. The most significant changes in the results related to the sense of touch for the 3rd phalanx pertaining to the middle finger of a hand were observed in 5th grade boys and 6th grade girls, and for the middle of a palm in 10th grade boys and 7th grade girls.

Keywords: Psychological characteristics, karate competitors and representatives, factor analysis.

INTRODUCTION

Successful functioning of sensory systems is caused by their interaction that is shown in obtaining such information by the individual, which can't be received without joint activity of analysers (Iermakov, Yakunin, 2000; Rodin, 2015). Therefore, the compensatory mechanisms connected with the functioning of other sense organs, which promote implementation of the different types of activity necessary for adaptation of visually impaired to new living conditions, take part in children with visual impairment (Iermakov, Yakunin, 2000; Bolonov, 2003; Wickremasinghe, Foster, Uranchimeg et al., 2004; Magno, Silva, Bilzon, Duarte et al., 2013; Rodin, 2015). The tactile sensory system plays an important role in ensuring protection of the person against harmful external effects, gives the chance to distinguish touches, pressure, vibrations, heat and cold and also pain (Pokrovskyi, Korotko, 2003; Shoshina, Gershkoron, Inzhevatkin, 2008; Filimonov, 2010; Markova, Repsh, 2013). It gives him the chance to learn objects, to define their

form, sizes, texture, deformation of bodies, character of the material from which they are made, to establish proportions and their ratios (Sapin, Sivoglazov, 2002; Nazarova, 2005; Antonik, Antonik, Andrianov, 2009). The use of all types of tactile analyser sensitivity expands and enriches the volume of representations and their figurativeness (Tinkova, Kozlovskaya, 2009). Big requirements when performing difficult movements of coordination are imposed to the tactile sensory system. It gives information on the amplitude of movements, collision of a body with apparatuses and stock, plays an important role in spatial orientation, and helps to precisely determine the run speed (Fomin, 1995).

The tactile analyser, when using the visual one, helps children with visual impairment in the process of training to create a full-fledged image, to be guided in space and to familiarise themselves with the world around them. The sense of touch is a powerful means of compensation for not only blindness, but also visual impairment. In this regard, experts consider the tactile analyser dominating in children with visual impairment. Reading and writing can be carried out by means of a relief font for visually impaired children. Functioning of the tactile analyser is the cornerstone of this activity (Iermakov, Yakunin, 2000).

The impact of mechanical, thermal, chemical, tactile and other irritants on skin can lead to the feeling of pain which is a protective reaction of an organism. It has the alarm value warning about danger for the visually impaired (Iermakov, Yakunin, 2000).
The works of Shesterova, 2002, 2004, 2008; Kuzmenko, Shesterova, 2011, 2012; Maslyak, Shesterova, Kuzmenko, Bala et al., 2016; Shesterova, Kuzmenko, Maslyak, 2017 are devoted questioning the influence of specially directed exercises on the functional state of middle-school pupils' sensory systems.

Moiseienko, 2014 investigated the influence of special exercises and outdoor games on the functioning of the tactile analyser in healthy preschool-aged children; Maslyak, 2007, 2008, 2015 investigated it in children of younger school age; Kuzmenko, 2013 investigated it in children of middle school age; Rovnyi, 2001; Abdulaiev, Moiseienko, 2017 investigated it in sportsmen - volleyball players. The authors established their positive influence on the functional state of the tactile sensory system.

Osipova, 2010; Sedova, Shesterova, 2013 dealt with issues related to the influence of physical exercises on the functional state of sensory systems in preschool-aged children with visual impairment; younger school-aged children – Myasnikova, 2005; middle school-aged children – Shesterova, 2015; Riadovaya, 2015. At the same time, the works which are devoted to the change of the tactile analyser functional state in middle school-aged children with visual impairment through the introduction in the context of physical education classes containing specially directed exercises aren't revealed in the literature available to us.

All of the above mentioned has also caused the choice of the studied problem.

MATERIALS AND METHODS

The purpose of the research - to define the influence of specially directed exercises and outdoor games on tactile analyser functional state indicators of 10-16 year old pupils with visual impairment.

Research methods: analysis and generalization of scientific and methodical literature, aesthesiometry method, pedagogical experiment and methods of mathematical statistics.

Tactile sensitivity spatial threshold indicators were determined with the help of an aesthesiometer (Weber's compass). The examinee was offered to sit down on a chair and close their eyes. The researcher, at the same time, placed the legs of the Weber's compass consistently to the palmar surface of the third phalanx pertaining to the middle finger of a hand, and then to the middle of the right-hand palm. The smallest distance between the legs of the compass (mm), at which the examinee felt their touch as two separate feelings, was noted.

The touch was repeated, gradually moving apart the branch of the aesthesiometer (increasing it by 1 mm every time), and the minimum distance at which there is a feeling of two separate touches was present. The smallest distance between the legs of the compass (mm), at which the examinee felt their touch as two separate feelings, was noted. The norms of tactile sensitivity indicators related to the 3rd phalanx of the middle finger of a hand are 2.2 mm; the middle of a palm – 8.9 mm (Degterev, Kushnariova, Fenkina, 1988).

The tactile analyser functional state indicators of middle school-aged children with visual impairment belonging to the experimental and control groups were determined before carrying out the experiment and investigated at the same time in identical conditions before performing the physical activity.

The research was conducted on the basis of general education boarding schools for children with visual impairment of Kharkov and Dnepropetrovsk. Middle-school pupils, who were divided into 6 experimental

and 6 control groups, took part in it. The pedagogical experiment was made during the academic year. The special exercises and outdoor games, which are directed to increase the functional state of the tactile analyser, were added during the process of carrying out the context of physical education classes for pupils belonging to experimental groups. Pupils belonging to control groups were engaged according to the Program of physical culture for pupils of 5-10th grades with reduced sight, developed by Sermeiev, Pavlov, 1995.

The children participating in the experiment were under observation of the school doctor. For assessing the impact on the functional state of the tactile analyser we used: finger movements of one or both hands at the same time, exercises using the principle of finger-to-thumb opposition, fingers of one hand to fingers of the other, palms of one or both hands, definition of figures, figures and letters "written" on the right and left hand, definition of objects, figures, figures to the touch by the right and then by the left hand, definition of forms, sizes and character of the surface of various sports equipment, outdoor games "See who it is", "Hand", etc. The number of repetitions for each exercise fluctuated from 6-8 to 8-12 times, on average. Duration of outdoor games was 5–10 minutes.

Specially directed exercises were joined with the preparatory, main and final parts of a lesson, outdoor games were added to the main part of variable modules track and field athletics, football, basketball, volleyball, gymnastics, and were selected taking into account their contents and problems encountered during a lesson. The exercises were carried out by game and strictly regulated methods. The above listed exercises were added to the pupils' homework, with subsequent checks regarding their performance.

RESEARCH RESULTS

The analysis of tactile sensitivity related to the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm for middle-school students with visual impairment belonging to the experimental and control groups before the experiment revealed a lack of reliability for distinctions ($p>0.05$) between them.

The analysis of results allowed establishing that tactile sensitivity indicators related to the 3rd phalanx of the middle finger for boys belonging to the experimental groups are higher, than for girls. Indicators for pupils attending the 7th and 8th grades which are higher in girls are an exception.

Tactile sensitivity of the middle of a palm is higher in girls, except for pupils attending the 6th and 7th grades where these indicators are higher for boys. It should be noted that the reliability of distinctions was observed only between indicators related to pupils attending the 9th and 10th grades ($p<0.05$). Indicators for boys are higher, than those pertaining to girls. The research on tactile sensitivity indicators related to the 3rd phalanx of the middle finger of a hand and the middle of a palm for pupils belonging to experimental groups, before the experiment, in the age aspect, showed that, with age, they change in different directions. Authentically, the best tactile sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand ($p<0.05$) were observed in 9th grade boys in comparison with pupils attending the 5th, 6th and 7th grades, and in 10th grade boys in comparison with pupils attending the 6th and 7th grades. 7th grade girls had authentically higher rates of tactile sensitivity spatial threshold related to the 3rd phalanx of the middle finger of a hand than schoolgirls attending the 6th and 10th grades ($p<0.05$).

Reliability of differences in the sense of touch indicators for the middle of a palm were observed only in girls attending the 5th and 10th grades ($p<0.05$) where the results of 5th grade schoolgirls prevailed.

Considering the initial results related to tactile sensitivity pertaining to the 3rd phalanx of the middle finger of a hand and the middle of a palm in pupils belonging to control groups, in the gender aspect, it should be noted that, in general, girls had better indicators than boys. The results related to tactile sensitivity pertaining to the 3rd phalanx of the middle finger of a hand in boys attending the 9th and 10th grades, and the middle of a palm in 6th grade boys are an exception. The reliability of differences in indicators wasn't observed ($p>0.05$).

The age dynamics of tactile sensitivity indicators related to the 3rd phalanx of the middle finger of a hand and the middle of a palm in pupils belonging to control groups before the experiment had a wavy character. Distinctions are reliable ($p<0.05$) only in the results obtained for boys attending the 7th and 9th grades where higher rates were observed in 9th grade pupils.

A comparison of the initial results for tactile sensitivity pertaining to the 3rd phalanx of the middle finger of a hand and the middle of a palm in middle-school pupils with visual impairment belonging to the experimental and control groups with standard indicators has allowed establishing that they are lower standard (Degterev, Kushnariova, Fenkina, etc., 1988).

The results for tactile sensitivity pertaining to the 3rd phalanx of the middle finger of a hand and the middle of a palm in middle-school pupils with visual impairment belonging to experimental groups considerably improved after the use of special exercises and outdoor games which are directed to change the functional state of the tactile analyser.

Comparing tactile sensitivity indicators of the 3rd phalanx pertaining to the middle finger of a hand in pupils belonging to experimental groups, before and after the experiment, it should be noted that they improved by 34.8% and 34.4% for boys and girls attending the 5th grade, respectively; for those attending the 6th grade, they improved by 29.2% and 35.2%, respectively; for the 7th grade, they improved by 33.7% and 28.7%, respectively; for the 8th, they improved by 33.0% and 29.8%, respectively; the 9th grade indicators improved by 30.9% and 33.0%, respectively, and the 10th grade indicators improved by 23.3% and 31.7, respectively.

The gain of results related to skin sensitivity for the middle of a palm was: boys have 6.3% and girls attending the 5th grade have 5.3%, respectively; 6th grade pupils have 5.6% and 6.3%, respectively; pupils attending the 7th grade have 6.3% and 8.1%, respectively; 8th grade pupils have 8.4% and 5.2%, respectively; pupils attending the 9th grade have 6.2% and 5.4%, with 10.3% and 6.1%, respectively, for pupils of the 10th grade (fig. 1).

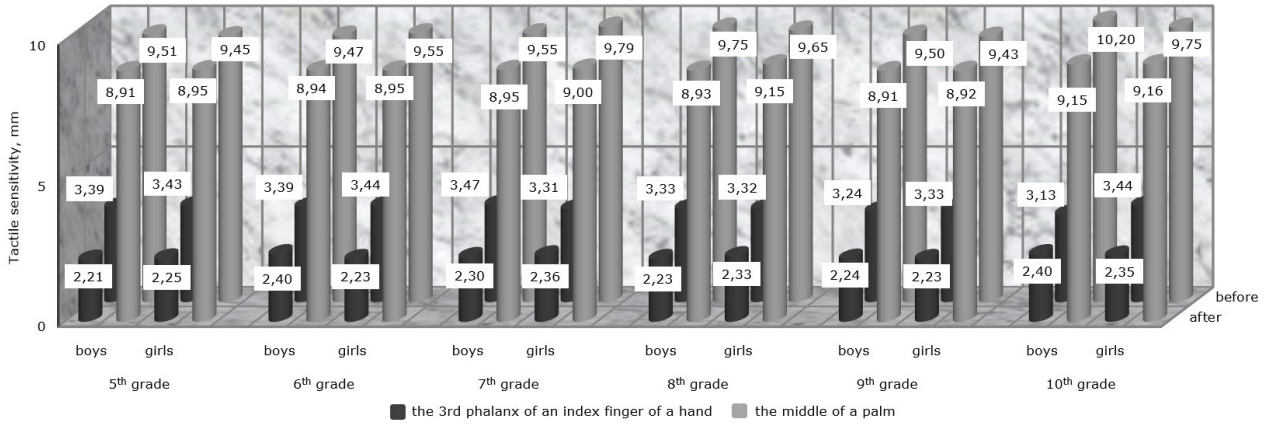


Figure 1: Tactile sensitivity indicators of the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm in middle school-aged children with visual impairment belonging to experimental groups before and after the experiment

The most significant gain of tactile sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand was observed in 5th grade boys and 6th grade girls and, for the middle of a palm, in 10th grade boys and 7th grade girls. Analysing tactile sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand in pupils belonging to experimental groups after the experiment, in the gender aspect, it should be noted that they almost don't differ for boys and girls. At the same time, the reliability of distinctions ($p<0.05$) is observed in tactile sensitivity spatial threshold indicators for the 3rd phalanx pertaining to the middle finger of a hand in 6th grade pupils where they are higher for girls. A comparison of results for tactile sensitivity related to the middle of a palm depending on sex showed that it is generally better for boys than for girls. The results obtained for 6th grade girls are an exception. At the same time, the reliability of distinctions ($p<0.05$) is observed only in indicators of boys and girls attending the 8th grade. A comparison of results for tactile sensitivity spatial threshold related to the 3rd phalanx of the middle finger of a hand and the middle of a palm for the studied experimental groups after the use of specially directed exercises and outdoor games, in the age aspect, demonstrates their multidirectional change. The reliability of distinctions ($p<0.05$) is observed in results obtained for boys attending the 5th, 6th and 10th grades. The best indicators were noted in fifth-graders. Pupils attending the 8th and 9th grades had authentically higher rates ($p<0.05$) than boys of the 6th and 10th grades. Better results ($p<0.05$) were recorded authentically for girls attending the 6th and 9th grades than for 7th grade schoolgirls. Differences in the sense of touch indicators for the middle of a palm have a reliable character ($p<0.05$) in schoolgirls attending the 5th, 7th, 8th, and 10th grades where they are higher for girls of the 5th and 7th grades.

Authentically, the best results for the tactile sensitivity spatial threshold were recorded in girls attending the 6th and 9th grades, while for schoolgirls of the 7th, 8th and 10th grades ($p<0.05$). A comparison of tactile sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm after the use of specially directed exercises and outdoor games with the standards showed that they almost meet the standards in middle school-aged children with visual impairment belonging to experimental groups. Tactile sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm in the studied control groups also changed after the experiment, however, these changes are less essential, aren't reliable ($p>0.05$) and don't correspond to the standard. So, the gain of skin sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand in boys attending the 5th, 6th, 7th, 8th, 9th and 10th grades was:

4.7%; 4.9%; 4.9%; 5.0%; 3.0% and 5.1%, respectively. For 5th grade girls, the tactile analyser sensitivity related to the sense of touch indicators for the third phalanx pertaining to the middle finger of a hand after the experiment has increased by 3.0%; for girls attending the 6th grade, it increased by 2.7%; for the 7th grade, it increased by 1.8%; the 8th grade girls' sensitivity increased by 3.6%; the 9th grade by 2.4% and the 10th grade by 4.4%. Results for the sense of touch pertaining to the middle of a palm in boys and girls attending the 5th grade improved by 1.3% and 0.7%, respectively; in the 6th grade, they improved by 1.1% and 0.6%, respectively; in the 7th, they improved by 0.8% and 1.1%, respectively; in the 8th grade, they improved by 0.9% and 0.9%, respectively; in the 9th, they improved by 0.6% and 1.5%, respectively; and in the 10th grade, they improved by 1.5% and 1.0%, respectively (fig. 2).

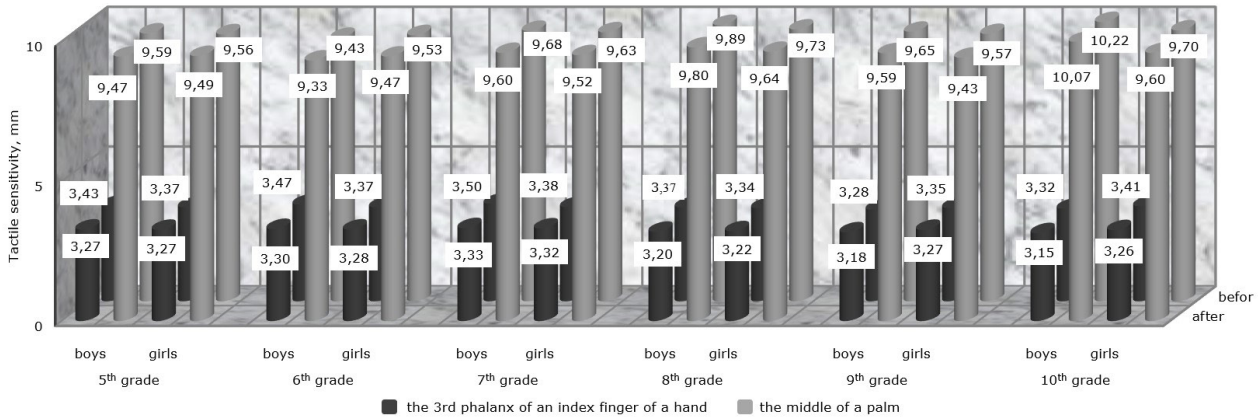


Figure 2: Tactile sensitivity indicators of the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm in middle school-aged children with visual impairment belonging to control groups before and after the experiment

The most considerable improvement of tactile sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand was revealed in 10th grade pupils, and, for the middle of a palm, in 10th grade boys and 9th grade girls. Considerable changes of initial results weren't revealed, investigating the repeated indicators of tactile sensitivity spatial threshold for the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm in pupils belonging to control groups, in the gender aspect.

A comparative analysis of results for tactile sensitivity related to the researched sections of skin in the studied control groups after the experiment, in the age aspect, gives the opportunity to say that tactile sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm, both in boys, and in girls, change in a wave-like character with age.

Differences in indicators are statistically unreliable ($p>0.05$). Thus, the specially directed exercises and outdoor games we offered positively affected the functional state of the tactile analyser – tactile sensitivity indicators for the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm in the overall studied experimental groups considerably improved. At the same time, the greatest gain of results for tactile sensitivity related to the 3rd phalanx of the middle finger of a hand was observed in girls, and for the middle of a palm in boys. It was revealed that the optimal period for training the tactile analyser is the age of 10-13 and 15–16 years.

DISCUSSION

According to experts, the optimal functional condition of the tactile analyser can compensate for disruptions of visual perception and play an important role in the course of perception and analysis of different types of external and internal irritants, as well as in the formation of movements (Iermakov, Yakunin, 2000; Tolmachev, 2004). Differences in results obtained for pupils' tactile sensitivity are caused by the fact that sensitivity thresholds are individual for each person (Zavarzina, Koziakov, Coro, Orlova, Ryshlyakova, 2015). A hand can reflect a form, a spatial arrangement of objects due to the touch, and in this regard, by the definition of I.M. Sechenov, it is the feeling parallel to sight (Nozhkina, Pivovarova, Prusova, 2017).

Analysing tactile sensitivity indicators of the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm, it should be noted that the reliable ($p<0.05$) improvement of the studied indicators was observed after the use of special exercises and outdoor games directed to change the functional state of the tactile analyser. It supplements the results obtained by research conducted by Riadovaya, 2015, stating a rather positive influence of specially directed exercises and outdoor games on the functional state of sensory

systems in middle school-aged children with visual impairment, and the results of research conducted by Shesterova, 2002, 2004, 2008; Shesterova, Kuzmenko, 2011; Kuzmenko, Shesterova, 2012; Kuzmenko, 2013; Abdulaiev, Moiseienko, 2017, which were carried out with participation of the pupils attending middle school who don't have deviations in their health status. Tactile analyser functional state indicators for pupils belonging to control groups also improved, but these changes are insignificant and unreliable ($p>0.05$). It is caused by the fact that the development of tactile feelings depends on specific requirements of the activity performed by children with visual impairment which is shown by training, life and work. All this proves that a person's feelings develop under the influence of their living conditions and the requirements of practical activities (Strizhak, 2000).

CONCLUSIONS

1. The analysis of scientific and methodical literature confirms an important role of the tactile analyser in the development and activity of children with visual impairment. At the same time, insufficient attention is paid to the problem of an increase in the functional state of tactile sensory system for middle-school pupils with the above specified nosology in the literature available to us.

2. The research on tactile sensitivity spatial threshold indicators of the 3rd phalanx pertaining to the middle finger of a hand and the middle of a palm for middle-school pupils with visual impairment before the experiment allowed establishing that they are lower standard at the studied contingent.

3. The use of specially directed exercises and outdoor games promoted a reliable increase in the functional state of the tactile analyser during physical education classes for middle-school pupils with visual impairment belonging to experimental groups ($p<0.05$). The most significant changes of tactile sensitivity indicators related to the 3rd phalanx of a middle finger of a hand were noted in 10–11 year old boys and 11-12 year old girls; changes for the middle of a palm were observed in 15–16 year old boys and 12-13 year old girls.

4. The tactile sensory system functional state indicators of pupils belonging to control groups during the experiment didn't change significantly, and had an unreliability of distinctions ($p>0.05$).

The prospects of further scientific research lie in defining the influence of specially directed exercises and outdoor games on functional state indicators of other sensory systems in middle school-aged children with visual impairment.

ACKNOWLEDGEMENTS

Communication of the work with scientific programs, plans, subjects. The research was carried out according to the thematic plan of the research work of Kharkov Sate Academy of Physical Culture for 2013-2015 on the subject 3.5.29.

"Theoretical and applied bases of monitoring creation of physical development, physical fitness and physical condition of various groups of the population" and for 2016-2020 on the subject "Improvement of process of physical education in educational institutions of various profile" (the state registration number is 0115U006754).

REFERENCES

1. Abdulaiev A. & Moiseienko Ye.K. (2017). Change of indicators of technical preparedness and functional state of the tactile analyzer of 12-13 year old volleyball players during a year macrocycle [Izmenenie pokazateley tekhnicheskoy podgotovlennosti i funktsionalnogo sostoyaniya taktilnogo analizatora voleybolistov 12–13 let na protyazhenii godichnogo makrotsikla]. Sports, 3, 4–7. (In Russian).
2. Antonik V.I., Antonik I.P. & Andrianov V.Ye. (2009). Anatomy, physiology of children with bases of hygiene and physical culture: manual [Anatomiia, fiziolohiia ditei z osnovamy hihiieny ta fizychnoi kultury: navchalnyi posibnyk], Publishing house «Professional, Center of educational literature, Kyiv. (In Ukrainian).
3. Bolonov G.P. (2003). Physical education in the system of correctional-developing training: program of hardening, improvement, organization of games, groups, leisure [Fizicheskoe vospitanie v sisteme korrektsionno-razvivayushchego obucheniya: programma zakalivaniya, ozdorovleniya, organizatsii igr, sektsiy, dosuga], Sfera, Moskov. (In Russian).
4. Degterev V.P., Kushnariova G.V., Fenkina R.P. et al. (1988). The manual to practical training on physiology: manual [Rukovodstvo k prakticheskim zanyatiyam po fiziologii: ucheb. posobie]. Under ed. of G.I. Kositskyi, V.A. Poliantsev, Meditsina, Moscow. (In Russian).
5. Filimonov V.I. (2010). Human physiology: textbook [Fiziolohiia liudyny: pidruchnyk], VSV «Meditsina», Kyiv. (In Ukrainian).
6. Fomin N.A. (1995). Human physiology. – 3rd edit. [Fiziologiya cheloveka. – 3-e izdanie], Prosveshchenie, Moskov. (In Russian).
7. Human physiology: textbook (2003). – 2nd edit., rew. and ad., Under edition of. V.M. Pokrovskiy, G.F. Korotko [Fiziologiya cheloveka: uchebnik. – 2-e izd., pererab. i dop., Pod red. V. M. Pokrovskogo, G. F. Korotko], Meditsina, Moscow. (In Russian).
8. Iermakov V.P. & Yakunin G.A. (2000). Fundamentals of tiflopedagogics: development, training and education of children with visual impairment: manual for students of HEI [Osnovy tiflopedagogiki: razvitie, obuchenie i vospitanie detey s narusheniyami zreniya : ucheb. posobie dlya stud. vyssh. ucheb. zavedeniy], Tumanit, pub. center VLADOS, Moskov. (In Russian).

9. Kuzmenko I.A. & Shesterova L.Ye. (2011). Changes of functional state of sensory systems of pupils of middle school under the influence of specially directed exercises [Izmeneniya funktsionalnogo sostoyaniya sensornykh sistem shkolnikov srednikh klassov pod vliyaniem spetsialno napravlennykh uprazhneniy]. High technologies, basic and applied researches in physiology, pharmacology and medicine: col. of art. the II Internat. scient.-pract. conf., Edit. of Polytechnic university, St-Petersburg, 1, 48–50. (In Russian).

10. Kuzmenko I.A. & Shesterova L.Ye. (2012). Development of coordination abilities of pupils of the 5-9th grades taking into account functional state of analyzers [Razvitie koordinatsionnykh sposobnostey shkolnikov 5–9-kh klassov s uchetom funktsionalnogo sostoyaniya analizatorov]. Materiály VIII mezinárodní vědecko–praktická conference «Dny vědy – 2012». – D íl 95. Tělovýchova a sport: Praha. Publishing House «Education and Science» s.r.o. (in Russian).

11. Kuzmenko I.O. (2013). Development of coordination abilities of pupils of middle school taking into account functional state of sensory functions: abstr. diss. on receiving the scientific degree of cand. of sciences on physical. educ. and sport [Rozvytok koordynatsiinykh zdibnostei shkoliariv serednikh klasiv z urakhuvanniam funktsionalnoho stanu sensornykh funktsii: avtoref. dys. na zdobuttia naukovoho stupenia kand. nauk z fiz. vykh. ta sportu], KhDAFK, Kharkiv. (In Ukrainian).

12. Magno E., Silva M., Bilzon J, Duarte E., Gorla J. & Vital R. (2013). Sport injuries in elite paralympic swimmers with visual impairment. Journal of Athletic Training, 48 (4), 493–498.

13. Markova T.O. & Repsh N.V. (2013) Sensory systems of the person: manual [Sensornye sistemy cheloveka: uchebnoe posobie], FGAOU VPO DVFU (School of pedagogy), Ussuriysk. (In Russian).

14. Masliak I.P. (2007). Change of level of physical fitness of younger pupils as a result of special exercises which are directed to improvement of functional state of analyzers: abstr. diss. on receiving scientific degree of cand. of sciences on physical. educ. and sport [Zmina rivnia fizychnoi pidhotovlenosti molodshykh shkoliariv pid vplyvom spetsialnykh vprav, spriamovanykh na pokrashchennia funktsionalnoho stanu analizatoriv: avtoref. dys. na zdobuttia naukovoho stupenia kand. nauk z fiz. vykh. ta sportu], HDAFK, Kharkiv. (In Ukrainian).

15. Masliak I.P. (2008). Dynamics of level of physical fitness of younger pupils as a result of special exercises which are directed to improvement of functional state of analyzers [Dynamika rivnia fizychnoi pidhotovlenosti molodshykh shkoliariv pid vplyvom spetsialnykh vprav, spriamovanykh na polipshennia funktsionalnoho stanu analizatoriv]. Theory and technique of physical education and sport, 4, 47–51. (In Ukrainian).

16. Maslyak I. (2015). Influence of specially directed exercises on separate functions of sensor-based systems of pupils of junior classes. Slobozhanskyi herald of science and sport: scien.-theor. journ., 5 (49), 48–51.

17. Maslyak I.P., Shesterova L.Ye., Kuzmenko I.A., Bala T.M., Mameshina M.A., Krivoruchko N.V. & Zhuk V.O. (2016). The influence of the vestibular analyzer functional condition on the physical fitness of school-age children. Sport science: International scientific journal of kinesiology, Travnik, Bosnia and Herzegovina, Vol. 9, Issue 2, 20–27.

18. Miasnikova L.V. (2005). Development of touch and small motility in younger pupils with visual impairment in the course of their correctional training: diss. cand. ped. scien [Razvitie osyazaniya i melkoy motoriki u mladshikh shkolnikov s narusheniem zreniya v protsesse ikh korrektsionnogo obucheniya: dis. kand. ped. nauk], Moscow. (In Russian).

19. Moiseienko Ye.K. (2014). Influence of specially directed exercises on functional state of sensory systems and motive preparedness of children of preschool age [Vliyanie spetsialno napravlennykh uprazhneniy na funktsionalnoe sostoyanie sensornykh sistem i dvigatelnuyu podgotovlennost detey doshkolnogo vozrasta]. Sports, 10, 91–97. (In Russian).

20. Nazarova N.M., Aksenova L.I., Arkhipov B.A., Beliakova L.I. et al. (2005). Special pedagogy: manual for students of HEI. – 4th ed., ster. [Spetsialnaya pedagogika : ucheb. posobie dlya stud. vyssh. ucheb. zavedeniy. – 4-e izd., ster.], Ender ed. N.M. Nazarova, Publishing center «Akademia», Moscow. (In Russian).

21. Nozhkina T.V., Pivovarova I.A. & Prusova N.V. (2017). General psychology: manual [Obshchaya psikhologiya: uchebnoe posobie]. (In Russian).

22. Osipova L.B. (2010). Development of touch and small motility as means of compensation of visual insufficiency at younger preschool children with visual impairment: diss. cand. ped. scien [Razvitie osyazaniya i melkoy motoriki kak sredstva kompensatsii zritelnoy nedostatochnosti u mladshikh doshkolnikov s narusheniyami zreniya: dis. kand. ped. nauk], Chelyabinsk. (In Russian).

23. Rovnyi A.S. (2001). Mechanism of sensory control of exact movements of sportsmen during a training [Mekhanizm sensornoho kontroliu tochnykh rukhiv sportsmeniv protiahom trenuvalnoho zaniattia]. Theory and technique of physical education and sport, 1, 31–34. (In Ukrainian).

24. Rodin M.V. (2015). Features of psychology and pedagogical accompaniment of children with weakened sight at comprehensive school: diss. cand. psyc. [Osobennosti psikhologo-pedagogicheskogo soprovozhdeniya detey s oslablennym zreniem v obshcheobrazovatelnoy shkole: dis. kand. psikhol.], Nizhny Novgorod. (In Russian).

25. Riadova L.O. (2015). Change of indicators of functional state of the acoustic analyzer of children of middle school age with defects of sight under the influence of specially directed exercises and outdoor games [Zmina pokaznykiv funktsionalnoho stanu slukhovoho analizatora ditei serednoho shkilnoho viku z vadamy zoru pid vplyvom spetsialno spriamovanykh vprav i rukhlyvykh ihor]. Herald of Chernihiv national pedagogical university. Ed. 129, ChNPU, Chernihiv, III, 282–286. (In Ukrainian).

26. Sapin M.R. & Sivoglazov V.I. (2002). Anatomy and human physiology (with age features of a children's organism): manual for stud. of sec. ped. ed. inst. – 3rd ed., stereotype. [Anatomiya i fiziologiya cheloveka (s vozrastnymi osobennostyami detskogo organizma): ucheb. posobie dlya stud. sred. ped. ucheb. zavedeniy. – 3-e izd., stereotip.], Publishing center «Akademia», Moscow. (In Russian).

27. Sedova O. & Shesterova L. (2013). Research of indicators of functional state of sensory systems of children with defects of sight [Doslidzhennia pokaznykiv funktsionalnoho stanu sensornykh system ditei z vadamy zoru]. Slobozhanskyi herald of science and sport: scien.-theor. journ., HDAFK, Kharkiv, 3, 72–75.

28. Shesterova L.Ye. (2002). Research of influence of functional state of sensory systems on the level of development of high-speed and power abilities of 11-15 year old pupils [Issledovanie vliyaniya funktsionalnogo sostoyaniya sensornykh sistem na uroven razvitiya skorostno-silovykh sposobnostey shkolnikov 11-15 let]. Slobozhanskyi herald of science and sport: scien.-theor. journ., HDAFK, Kharkiv, 5, 16–18. (In Russian).

29. Shesterova L.Ye. (2004). Influence of level of activity of sensory functions on improvement of motive abilities of pupils of middle school: abst. diss. on receiving scientific degree of cand. of sciences on physical. educ. and sport [Vplyv rivnia aktyvnosti sensornykh funktsii na udoskonalennia rukhovykh zdibnostei shkoliariv serednikh klasiv: avtoref. dys. na zdobuttia nauk. stupenia kand. nauk z fiz. vykh. ta sportu], HDAFK, Kharkiv. (In Ukrainian).

30. Shesterova L.Ye. (2008). Influence of specially-directed exercises on the level of activity of separate sensory systems [Vliyanie spetsialno-napravlennykh uprazhneniy na uroven aktivnosti otdelnykh sensornikh sistem]. Modern Olympic and Paralympic sport and sport for everybody: thes. rep. XII International scientific congress, Moscow,3, 162–163. (In Russian).

31. Shesterova L. (2015). Influence of paropsiss is on the separate indexes of the functional state of sensory systems of schoolboys of middle classes. Slobozhanskyi herald of science and sport: scien.-theor. journ., HDAFK, Kharkiv, 4, 46–51.

32. Shesterova L., Kuzmenko I. & Masliak I. (2017). Motive preparedness of school-age children under the influence of special exercises affecting the state of the acoustic analyser. Sport science: International scientific journal of kinesiology. Travnik, Bosnia and Herzegovina, Vol. 10, Issue 2, 96–104.

33. Shoshina I.I., Gershkoron F.A. & Inzhevatkin Ye.V. (2008). Physiology: lecture notes [Fiziologiya: konspekt lektsiy], IPK SFU, Krasnoyarsk. (In Russian).

34. Strizhak L.N. (2000). Psychology and pedagogics: manual [Psikhologiya i pedagogika: uchebnoe posobie], MGIU, Moscow. (In Russian).

35. The program of physical culture for pupils with reduced sight: 5–10 grades (1995). Ukl. B.V. Sermeiev, Yu.V. Pavlov et al. [Prohrama z fizychnoi kultury dlia uchniv zi znyzhenym zorom: 5–10 klasy, Ukl. B.V. Sermieiev, Yu.V. Pavlov ta in.], ISDO, Kyiv. (In Ukrainian).

36. Tinkova Ye.L. & Kozlovskaya G.Yu. (2009). Anatomic-physiological and neuropsychological bases of training and education of children with visual impairment: manual [Anatomo-fiziologicheskie i neyropsikhologicheskie osnovy obucheniya i vospitaniya detey s narusheniyami zreniya : uchebnoe posobie], Ed. SGPI, Stavropol. (In Russian).

37. Tolmachev R.A. (2004). Adaptive physical culture and rehabilitation for blind and visually impaired [Adaptivnaya fizicheskaya kultura i reabilitatsiya slepykh i slabovidyashchikh], Sovetskyi sport, Moscow. (In Russian).

38. Wickremasinghe S., Foster P. J., Uranchimeg D., Lee P.S., Devereux J.G., Alsbirk P.H., Machin D., Johnson G.J. & Baasanhu J. (2004). Ocular biometry and refraction in Mongolian adults. Investigative Ophthalmology and Visual Science, 45 (3), 776–783.

39. Zavarzina O.O., Koziakov R.V., Koro N.R., Orlova Ye.A. & Ryshliakova N.V. (2015). Psychophysiology of professional activity: textbook and practical work for an applied bachelor degree [Psikhofiziologiya professionalnoy deyatelnosti: uchebnik i praktikum dlya prikladnogo bakalavriata], Direkt-Media, Moscow-Berlin. (In Russian).

PROMJENA INDIKATORA FUNKCIONALNOG STANJA OSJETNOG ANALIZATORA UČENIKA SA OŠTEĆENJIMA VIDA U DOBI OD 10-16 GODINA POD UTICAJEM POSEBNO USMJERENIH VJEŽBI I IGARA NA OTVORENOM PROSTORU

Svrha: definisati uticaj posebno usmjerenih vježbi i igara na otvorenom prostoru na indikatore funkcionalnog stanja osjetnog analizatora djece sa oštećenjima vida koja pohađaju osnovnu školu. Materijal: istraživanje je provedeno na osnovu posebnih internata za opće obrazovanje u Harkovu i Dnjepropetrovskom. Učenici od 5. do 10. razreda, koji su bili podijeljeni u 6 eksperimentalnih i 6 kontrolnih grupa, su učestvovali u istraživanju. Rezultati: Indikatori funkcionalnog stanja osjetnog analizatora djece sa oštećenjima vida u dobi od 10 do 16 godina su analizirani prije upotrebe posebno usmjerenih vježbi i igara na otvorenom prostoru. Uzete su u obzir promjene u istraženim indikatorima po pitanju dobi i pola. Otkriven je pozitivan uticaj posebno usmjerenih vježbi i igara na otvorenom na funkcionalno stanje osjetnog analizatora. Zaključci: 1. Ustanovljeno je da su, prije provođenja eksperimenta, indikatori prostornog praga osjetljivosti na dodir treće falange srednjeg prsta ruke i sredine dlana ispod granice kod učenika sa oštećenjima vida koji pohađaju osnovnu školu. 2. Uključivanje učenika sa oštećenjima vida u dobi od 10 do 16 godina u kontekst časova fizičkog obrazovanja koji sadrže posebno usmjerene vježbe i igre na otvorenom prostoru je uticalo na funkcionalno stanje osjetnog analizatora ($p<0,05$). 3. Najznačajnije promjene u rezultatima koji se tiču čula dodira treće falange srednjeg prsta ruke su zabilježene kod dječaka koji pohađaju 5. razred i djevojčica koje pohađaju 6. razred, a za sredinu dlana kod dječaka koji pohađaju 10. razred i djevojčica koje pohađaju 7. razred.

Ključne riječi: Učenici sa oštećenjima vida, osjetni analizator, sredina dlana, falanga srednjeg prsta ruke.

Received: December 02, 2018 / Accepted: December 15, 2018
Correspondence to: Liliana Riadova, Kharkov state academy of physical culture, Ukraine
E-mail: lil1ana@mail.ru

THE EFFECT OF 12-WEEK REBOUND (TRAMPOLINE) EXERCISE ON CORE MUSCLE STRENGTH IN SPINAL CORD INJURY PATIENTS

Sadeghi M[1], Ghasemi GH[2], Karimi MT[3]

1. PhD candidate of Sport Injuries and Corrective Exercise, Faculty of Sports Sciences, University of Isfahan, Isfahan, Iran
2. Associate professor of Corrective Exercise and Sport Injuries, Faculty of Sports Sciences, University of Isfahan, Isfahan, Iran
3. Musculoskeletal Research Center, Shiraz University of Medical Sciences, Faculty of Rehabilitation Sciences, Shiraz, Iran

ABSTRACT

Introduction: Different methods of physical rehabilitation, such as a non-invasive method, apply pressure on the injured region in spinal cord injury patients. The aim of this study was to perform 12-week Rebound Therapy exercise on core muscle strength in spinal cord injury patients.

Method: 16 members of Isfahan Spinal Cord Injury Association participated in this semi-experimental study by way of a convenience sampling method. Participants were allocated to 2 groups, the control group (8 subjects) and the rebound group (8 subjects), through a randomized matching method. Consent forms were signed after a briefing session. Core muscle strength was measured by an Abdominal Pressure Cuff and Curl-Up Test before and after the 12-week Rebound Therapy exercise (three sessions each week, with a session lasting from 10 to 30 minutes). Data were analysed by repeated measures ANOVA in SPSS software. Significance level was considered to be $P<0.05$.

Results: Both measured variables showed a significant interaction ($P<0.05$). It means that Rebound Therapy exercise training has had a positive effect on the patients' core muscle strength.

Conclusion: These results suggest that Rebound Therapy could be used as a non-invasive, low cost, and complementary intervention for spinal cord injury patients.

Keywords: Rebound Therapy, core, Abdominal Pressure Cuff, trampoline, spinal cord injury.

INTRODUCTION

The core region connects the upper and lower limbs together, and transfers strength from the central section to the limbs; hence, a reduction in the strength of the core muscles increases the pressure on the organs and the injury, and ultimately decreases body balance (Huxel Bliven & Anderson, 2013). The stability of the core region points to muscular control around the lumbo-pelvic area aimed at keeping functional stability in the neutral position, and aiding the production and transfer of energy from the body to the organs (Shirey et al., 2012). Stability of the core region is a general description about the exercises of the abdomen and lumbo-pelvic muscles (Kibler, Press, & Sciascia, 2006). This section includes the trunk, the pelvis, the hip joint, and the active and passive structures that generate or limit movements in this area (Okada, Huxel, & Nesser, 2011). Spinal cord injury (SCI) is an injury to the spinal cord that causes a temporary

or permanent change in the functioning of the motor, sensory, or automated systems (Prieto et al., 2016). The most common causes of spinal cord damage are (in the following sequence): trauma to the spinal cord due to accident (48%); falls (23 %); sports injuries (9%); violence (14%); spinal infections, viruses, or tumours, and surgery side effects (6%) (Moore, Durstine, Painter, & Medicine, 2016). SCI is often revealed through a variety of physical and mental signs, and based on the location of the injury, it can cause sensory and motor function disorders in patients. This damage impacts all physical, social, and mental aspects of an individual's life, and is accompanied with various difficulties in this regard (Zampa et al., 2003). The most common difficulties are: motor disorders, sensory disorders, bladder and intestine disorders, reduced blood pressure, pain, muscle spasms, osteoporosis and ... (that are different depending on age, sex, cause of injury and many other factors) (Gitkin, Ganulette, Friedman, Durstine, & Moore, 2003). According to the level of damage, the core muscles in the central section of the body are the most important muscles affected in SCI patients (especially above the waist), and naturally, they affect the stability of the central section. Therefore, a disorder in this section of the body in patients with spinal cord injury, carries many consequences. Hence, special attention to this section in rehabilitation programs is very important (Okada et al., 2011; Oliver, Stone, Wyman, & Blazquez, 2012).

Various physical rehabilitation methods, including sports exercises, are non-invasive treatment methods that enable the SCI patient to stimulate and affect the damaged area, by involvement in performing movements, actively or passively (Sandrow-Feinberg & Houlé, 2015). Research show that exercise helps protect the muscular mass (Hubel & Wiesel, 1963; Sandrow-Feinberg, Izzi, Shumsky, Zhukareva, & Houle, 2009), returns the sensory-motor function (Sandrow-Feinberg et al., 2009), increases the accumulation of neurotrophic factors in the spinal cord and the muscular tissue (Ying, Roy, Edgerton, & Gómez-Pinilla, 2005), and reduces the inflammation around the site of injury. One of the relatively new methods is performing exercises on a trampoline, referred to as rebound exercises or Rebound Therapy. In rehabilitation processes, Rebound Therapy is used in exercise and rehabilitation programs, since Rebound Therapy is considered a beneficial method for increasing muscular strength, body balance, the mechanical ability of bones, improving health levels, and even improving damages (Graham, 2006; Ross & Hudson, 1997). Because of the unstable (flexible) surface of the trampoline, and for keeping balance and the body position in space and against gravity, during Rebound Therapy exercises, more muscles are involved (Smith & Cook, 2007). For keeping balance in space, the muscles in the core section of the body are involved in a special way. The objective of the current study is to investigate the effect of 12-week Rebound Therapy exercises on the core muscle strength in SCI patients.

METHOD

Study design

This is a semi-experimental study with pre and post-testing of experimental (rebound) and control groups. The statistical population is all SCI patients who were members of the Isfahan SCI Association. From the members of this association, 30 patients, possessing the requirements for participating in this study, were selected using the convenience sampling method and divided into two groups, 1 - rebound (experimental) and 2 - control groups. The study was approved by the Isfahan University Research Council and the Ethics Committee of the Isfahan Medical Sciences University, and a written consent form for participating in the study was taken from all patients.

Inclusion criteria for participating in this study were: the age between 20 and 45, spinal cord injury at the thoracic level, ability to sit without aid, and not having other chronic or severe physical disorders (such as dermal, cardio, liver, and musculoskeletal diseases) that interfere with performing exercises. Exclusion criteria include: absence in more than a third of the exercise sessions, not completing the forms in the pre or post-test, and not wanting to participate in the study. Considering these criteria, 16 patients (8 patients in each group), out of the 30 patients, completed the study, and final statistical analysis was performed on these individuals. Before starting the interference, the qualification of the patients for participating in sports activities was approved by a specialized physician.

An Abdominal Pressure Cuff was used to examine the strength of the core muscles and the transverse abdominal (TVA) muscle. Since the Abdominal Pressure Cuff is a standard global tool, its validity and reliability is high. For examining the strength of the TVA muscle, the individual lies prone or supine (lying prone is preferred), and the cuff is placed under the body (in line with the ASIS appendage) [figure 1]. Then, the pressure in the cuff is increased to 70 mm Hg, and the individual is asked to reduce the pressure in the cuff by contracting the abdominal wall towards the spine, as much as possible for ten seconds. The amount of reduction is recorded as his score (Izraelski, 2012). This test is repeated ten times, and the average score is recorded. The above test is similarly used for examining the strength of the core muscles during strong exhaling, with the difference that, after placing the cuff under the stomach, the individual is asked to push the stomach out and perform active exhaling. The obtained difference

in this manoeuvre is recorded as the individual's score. This test is designed and executed knowing that, during active exhaling, in addition to respiratory muscles, rectus abdominis, TVA, external and internal oblique muscles are involved actively (Ratnovsky, Elad, & Halpern, 2008).

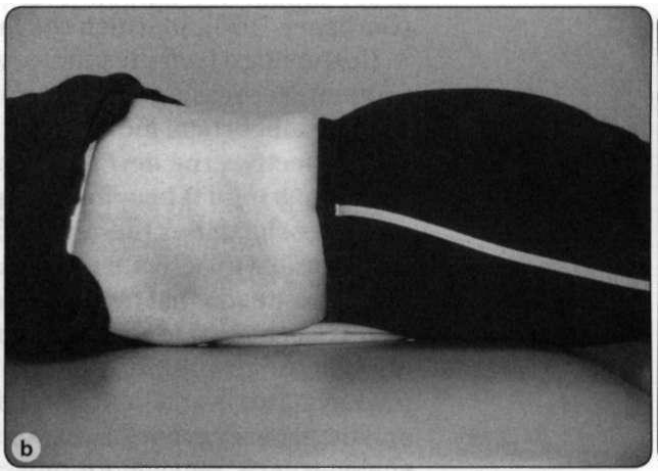


Figure 1: Abdominal Pressure Cuff Test

The other test used in this study is the modified curl-ups performed during one minute for examining the strength of abdominal muscles. In this test, the patient's legs are kept still by the coach and the test is performed according to the Canadian method. In the Canadian method, the individual places his hands next to the body, and, at every rising of 10 cm, moves his hands forward relative to the first point (Stathokostas, Speechley, Little, Doerksen, & Paterson, 2016).

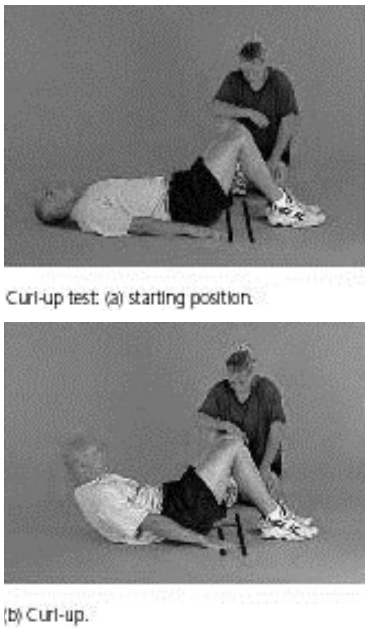


Figure 2: Canadian Curl-Up Test

REBOUND THERAPY EXERCISE PROTOCOL

A trampoline with suitable size and dimensions was designed and constructed such that it could be used easily by individuals with spinal cord injuries. All exercise programs were executed while sitting or lying down on the trampoline. In every session, the exercises were chosen by the researcher such that, in addition to being attractive, they consisted of movements that strengthen the core system. For increasing the variations in the exercises, tools such as Swiss Balls, Thera-Bands, rods, etc. were used. Exercises took place, for 12 weeks, with three sessions per week, at the Isfahan Spinal Cord Injury Association. Intensity of the exercises was controlled by the Polar System (pulse metre) and blood pressure monitor. Fatigue, weakness, and excessive sweating were also taken into account.

DATA ANALYSES

Data was analysed by using a repeated measure analysis of variance [RM ANOVA] in the SPSS software [version 21]. For all variables, the Mauchly's sphericity test showed the sphericity of the data, and the BOX test ensured the homogeneity ($P>0.05$) of the covariance matrix in the two groups. These tests enabled the usage of the RM ANOVA for all variables. $P<0.05$ was used as the level of significance for the data.

RESULTS

Information regarding the demographic data of the samples is shown in Table 1.

Table 1: Participant demographics data [mean± standard deviation]

	Age [year]	Weight [kg]	Height [m]	TPI*
Rebound [N=8]	37.6±8.3	72.1±12.4	1.73±0.92	5.8±2.3
Control [N=8]	34.7±3.8	70.1±8.3	1.75±0.89	4.5±1.9
Sig	0.06	0.70	0.64	0.21

*time post injury

As the information in Table 1. shows, the difference between the two groups is not statistically significant (P>0.05), and the groups are homogeneous in this regard. Table 2. demonstrates that interactions are significant for all four dependent variables. It means that, during the study, groups have different changes procedure. Detailed comparisons are illustrated in Figures 3-5. They demonstrate that, during the study, the control group had no progress, while the experimental groups made significant improvements. In other words, the slope of the line in the rebound group is different from the control group, which shows an improvement in strength of the abdominal muscles and core stability of the patients in the rebound group, compared to the control group. It also signifies the superiority of this exercise method.

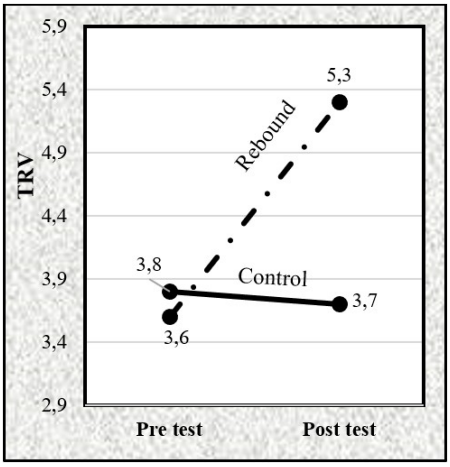


Figure 3: Chart line of transverse abdominal strength

Table 2: Results of the descriptive and RM-ANOVA test

Criteria	Group	Pre-test	Post-test	Mean difference	Group Interaction df [1,14]
		Mean±SD	Mean±SD		
Transvers abdominal muscle	Rebound	3.6±0.6	5.3±0.6	1.7	F=18.1 P≤0.001*
	Control	3.8±0.7	3.7±0.7	-0.1	
Core muscles	Rebound	8.6±2.1	12.3±3.2	3.7	F=33.1 P≤0.001*
	Control	7.8±1.8	8.0±1.9	0.2	
Curl-Up	Rebound	34.2±4.2	38.8±3.7	4.6	F=23.4 P≤0.001*
	Control	33.8±3.7	34.1±3.8	0.13	

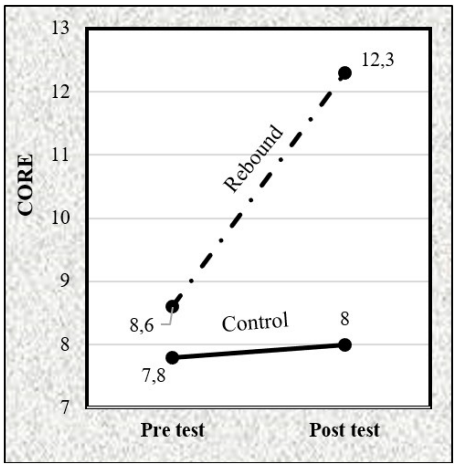


Figure 4: Chart line of core muscle strength

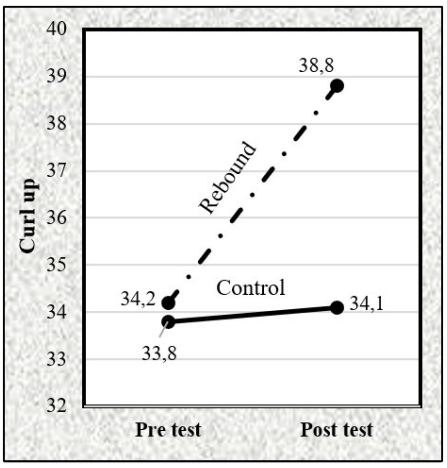


Figure 5: Chart line of the Curl-Up Test

DISCUSSION

Disability is a natural and social phenomenon that is viewed differently in different societies. Statistics show that a considerable percentage of individuals in any society are handicapped. Nowadays, with the many advancements in various sciences (including medicine, psychology, sociology, physical education, etc.), attempts are made to help these people to continue their daily lives independently, without any help from others, without feeling like a burden to the society, or being outcast. The present study was performed to determine the effect of 12-week Rebound Therapy exercises on core muscle strength in SCI patients. The results showed that there is a significant interaction in all criteria in both groups ($P \leq 0.05$). This signifies the effectiveness of Rebound Therapy exercises on improving the strength of core muscles in SCI patients. Graham showed the benefit of Rebound Therapy exercises on improving muscle tone (Graham, 2006). The results of the current study match that study.

In modern approaches, the core region is very important in improvement and prevention of disorders, the improvement of the quality of function, etc. This region can be considered a box or a cylinder, with abdominal muscles in its anterior section, the iliac and gluteal muscles in the posterior section, the diaphragm at its top, and the pelvic floor and the pelvic girdle forming its bottom. Many experts consider stability of the core section a key component in the improvement of performance. In individuals with spinal cord injuries, the abdominal muscles (rectus abdominis, TVA, and oblique muscles) and diaphragm are the active muscles in the core section, and the other muscles in this area are less involved, due to the injury. Hence, strengthening and involving these muscles seems necessary (McGill, 2001; Mok et al., 2015).

The main component of trampoline exercise is jumping. In intermittent jumps, the body is constantly suspended in space, which causes the involvement of all muscles in the body. The role and involvement of core muscles is considerable due to keeping balance during landing and the next jump. Another characteristic of the trampoline is creating a shake in the muscle spindle that causes improvement of muscle tone. The improvement is such that the shake in the muscle spindle causes an increase in length and the elasticity of muscles with increased tone, and results in the contractibility of muscle fibres in muscles with reduced tone. In other words, the springing movements can increase the natural muscle tone by stimulating the sensory system, and light jumping can reduce natural muscle tone by effectively shaking the muscle ducts (Graham, 2006). Furthermore, some exercise sources on the trampoline are referred to as cellular exercises, since it is believed that trampoline exercises involve every single cell in the body and can have a positive effect on muscle strength (Zolaktaf, Ghasemi, & Sadeghi, 2013). It is noteworthy that many of the movements in the exercise protocol of this study are specialized exercises for core stability, and considering the unstable surface of the trampoline, double the involvement of core muscles. The issues discussed describe the effectiveness of Rebound Therapy exercises on the core muscles.

CONCLUSION

Treatment approaches involving the use of physical activity and exercises as a rehabilitation method are increasing. The reason for this is the reduction in costs and side effects of medicinal treatments (Carter, 1988).

One of these methods is Rebound Therapy. These exercises are simple ways to attain physical fitness. Advantages of Rebound Therapy compared to other forms of exercises are due to the unstable (flexible) surface of the trampoline on which the exercises are performed. This flexible surface, in addition to helping the vertical movements, enables the body to experience weightlessness all the way to 5 times the body weight. The amount of pressure exerted to the body can be adjusted by the patient (Eager, Chapman, & Bondoc, 2012). The expansive and unstable surface enables the coach to perform the intended movements in the original form, but on an unstable surface in all directions. These characteristics of this exercise method have caused it to conform to the requirements of a standard exercise, and function for a wide range of individuals (from patients to professional athletes).

Other positive characteristics of rebound exercises are the capability of the flexible surface in absorbing force, which, as a result, reduces the impact on the body and the joints on that surface, compared to solid surfaces. Hence, these exercises are safe in this regard [30].

Furthermore, the attraction and the pleasure of these exercises (due to high mobility) and less exhaustion (due to affecting the lymphatic system) result in longer duration of these exercises by users (especially beginners and patients), and result in motivation and a positive outlook on them (Hill, Tatum, & cops Jenko, 1993). Therefore, considering the results of the current study, Rebound Therapy exercises can be suggested to SCI patients as a complementary method to treatment under the supervision of a specialist.

ACKNOWLEDGMENTS

Valuable contributions of many people in the Spinal Cord Injury Association, Isfahan, Iran enabled us to accomplish this study. We would particularly like to extend our appreciation to the thoughtful participants who volunteered for the study.

REFERENCES

1. Carter, Albert Earl. (1988). The new miracles of rebound exercise: ALM Publishers.
2. Eager, David, Chapman, Chris, & Bondoc, Kenneth. (2012). Characterisation of trampoline bounce using acceleration. Paper presented at the Proceedings: the 7th Australasian Congress on Applied Mechanics (ACAM 7), 9-12 December 2012, the University of Adelaide, North Terrace Campus/National Committee on Applied Mechanics of Engineers Australia.
3. Gitkin, A, Ganulette, M, Friedman, D, Durstine, JL, & Moore, GE. (2003). American College of Sports Medicine's Exercise Management for Persons with Chronic Disease and Disabilities.
4. Graham, Elisabeth. (2006). The effect of rebound therapy on muscle tone. Unpublished Master Thesis. Leeds Metrop Univ, 4, 1-57.
5. Hill, Susan, Tatum, Channing, & cops Jenko, Undercover. (1993). Jump for Joy: Peguis Publishing Ltd.
6. Hubel, David H, & Wiesel, Torsten N. (1963). Receptive fields of cells in striate cortex of very young, visually inexperienced kittens. Journal of neurophysiology, 26(6), 994-1002.
7. Huxel Bliven, Kellie C, & Anderson, Barton E. (2013). Core stability training for injury prevention. Sports Health, 5(6), 514-522.
8. Izraelski, Jason. (2012). Assessment and treatment of muscle imbalance: The janda approach. The Journal of the Canadian Chiropractic Association, 56(2), 158.
9. Kibler, W Ben, Press, Joel, & Sciascia, Aaron. (2006). The role of core stability in athletic function. Sports medicine, 36(3), 189-198.
10. McGill, Stuart M. (2001). Low back stability: from formal description to issues for performance and rehabilitation. Exercise and sport sciences reviews, 29(1), 26-31.
11. Mok, Nicola W, Yeung, Ella W, Cho, Jeran C, Hui, Samson C, Liu, Kimee C, & Pang, Coleman H. (2015). Core muscle activity during suspension exercises. Journal of science and medicine in sport, 18(2), 189-194.
12. Moore, Geoffrey, Durstine, J Larry, Painter, Patricia, & Medicine, American College of Sports. (2016). ACSM's Exercise Management for Persons With Chronic Diseases and Disabilities, 4E: Human Kinetics.
13. Okada, Tomoko, Huxel, Kellie C, & Nesser, Thomas W. (2011). Relationship between core stability, functional movement, and performance. The Journal of Strength & Conditioning Research, 25(1), 252-261.
14. Oliver, Gretchen D, Stone, Audrey J, Wyman, James W, & Blazquez, Ivan N. (2012). Muscle activation of the torso during the modified razor curl hamstring exercise. International journal of sports physical therapy, 7(1), 49.
15. Prieto, Guillermo Asín, Andrés, Amaia Ilzarbe, Venkatakrishnan, Anusha, Malik, Wasim Q, Dietz, Volker, & Rymer, William Zev. (2016). Rehabilitation Technologies for Spinal Injury Emerging Therapies in Neurorehabilitation II (pp. 65-85): Springer.
16. Ratnovsky, Anat, Elad, David, & Halpern, Pinchas. (2008). Mechanics of respiratory muscles. Respiratory physiology & neurobiology, 163(1), 82-89.
17. Ross, Andrea L, & Hudson, Jackie L. (1997). Efficacy of a mini-trampoline program for improving the vertical jump. Biomechanics in Sports XV, 63-69.
18. Sandrow-Feinberg, Harra R, & Houlé, John D. (2015). Exercise after spinal cord injury as an agent for neuroprotection, regeneration and rehabilitation. Brain research, 1619, 12-21.
19. Sandrow-Feinberg, Harra R, Izzi, Jessica, Shumsky, Jed S, Zhukareva, Victoria, & Houle, John D. (2009). Forced exercise as a rehabilitation strategy after unilateral cervical spinal cord contusion injury. Journal of neurotrauma, 26(5), 721-731.
20. Shirey, Matthew, Hurlbutt, Matthew, Johansen, Nicole, King, Gregory W, Wilkinson, Steven G, & Hoover, Donald L. (2012). The influence of core musculature engagement on hip and knee kinematics in women during a single leg squat. International journal of sports physical therapy, 7(1), 1.
21. Smith, S, & Cook, D. (2007). Rebound therapy. Learning Disability: Physical Therapy Treatment and Management-A collaborative approach. 2nd ed. Hoboken: John Wiley and Sons, 249-262.
22. Stathokostas, Liza, Speechley, M, Little, RMD, Doerksen, S, & Paterson, DH. (2016). The Get Fit for Active Living demonstration project: Evaluation of a Canadian older adult physical activity education program. Evaluation Report.
23. Ying, Zhe, Roy, Roland R, Edgerton, V Reggie, & Gómez-Pinilla, Fernando. (2005). Exercise restores levels of neurotrophins and synaptic plasticity following spinal cord injury. Experimental neurology, 193(2), 411-419.

24. Zampa, A, Zacquini, S, Rosin, C, Bizzarini, E, Magrin, P, & Saccavini, M. (2003). Relationship between neurological level and functional recovery in spinal cord injury patients after rehabilitation. Europa Medicophysica, 39(2), 69-78.

25. Zolaktaf, Vahid, Ghasemi, Gholam A, & Sadeghi, Morteza. (2013). Effects of exercise rehab on male asthmatic patients: aerobic verses rebound training. International journal of preventive medicine, 4(Suppl 1), S126.

EFEKAT VJEŽBI ODSKOKA NA TRAMPOLINU U TRAJANJU OD 12 SEDMICA NA SNAGU MIŠIĆA TRUPA KOD PACIJENATA SA POVREDOM KIČMENE MOŽDINE

Uvod: Različite metode fizičke rehabilitacije, poput neinvazivne metode, primjenjuju pritisak na povrijeđenu regiju kod pacijenata sa povredom kičmene moždine. Cilj ovog istraživanja je bio izvršiti terapiju putem vježbi odskoka na trampolinu u trajanju od 12 sedmica za snagu mišića trupa kod pacijenata sa povredom kičmene moždine.

Metoda: 16 članova Udruženja osoba sa povredom kičmene moždine iz Isfahana je učestvovalo u ovom polu-eksperimentalnom istraživanju primjenom metode odabira pogodnih uzoraka. Učesnici su podijeljeni u dvije grupe, kontrolnu grupu (8 ispitanika) i grupu koja je vršila vježbe odskoka na trampolinu (8 ispitanika) putem metode slučajnog podudaranja. Obrasci za saglasnost su potpisani nakon informisanja. Snaga mišića trupa je mjerena putem uređaja za mjerenje snage abdominalnih mišića i Curl-Up testa prije i poslije terapije putem vježbi odskoka na trampolinu u trajanju od 12 sedmica (3 puta sedmično u trajanju od 10 do 30 minuta). Podaci su analizirani primjenom testova ANOVA za ponovljena mjerenja u programu SPSS. Nivo značaja je bio P<0,05.

Rezultati: Obje izmjerene varijable su pokazale značajnu interakciju (P<0,05). To znači da je terapija putem vježbi odskoka na trampolinu imala pozitivan efekat na snagu mišića trupa pacijenata.

Zaključak: Ovi rezultati ukazuju da terapija putem vježbi odskoka na trampolinu može biti korištena kao neinvazivna, jeftina i komplementarna intervencija za pacijente sa povredom kičmene moždine.

Ključne riječi: Terapija putem vježbi odskoka na trampolinu, mišići trupa, uređaj za mjerenje snage abdominalnih mišića, trampolin, povreda kičmene moždine.

Received: July 01, 2017 / Accepted: September 06, 2018
Correspondence to: Morteza Sadeghi, Faculty of Sports Sciences, University of Isfahan, Iran
E-mail: morteza67sadeghi@yahoo.com

THE SIGNIFICANCE OF DIFFERENTIATED MOTOR HAND MOVEMENTS IN DEVELOPMENT OF SPEECH IN CHILDREN

Jadranka Otašević[1], Dragana Kljajić[2], Vera Rajović[3], Zoran Mašić[4], Vesna Bratovčić[5]

1. Faculty of Special Education and Rehabilitation, University of Belgrade, Serbia
2. High Health School of Professional Studies in Belgrade, Serbia
3. Faculty of Philosophy, University of Belgrade, Serbia
4. Academy of Football, Belgrade, Serbia
5. Educational rehabilitation Faculty of University of Tuzla

ABSTRACT

Refined and coordinated hand movements have impact on sensomotoric development of the central nervous sustem, including speech, which requires higher level of sensomotoric coordination. Aim of this study is to determine the dynamics and levels of development of the differentiated hand movements and its impact on the developing of the articulation in preschool children. A basic organization method of research is quasi experimental design, with two observed groups, the experimental and the control group. Research population comprised 60 children (30+30) of both genders, age from 5.5 to 7. We used the Lafaye I, II and III test for the assessment of manipulative dexterity of hands. This testing method includes three tests. On execution of tests, we monitored hands preference, level of grip evolution, manner of choosing materials, speed of execution, presence of associated movements of the extremities and the facial musculature. The results of this research indicate that the manipulative dexterity of hands is better in children without present articulation disorders, which may be used for convenient prevention of disorders and inclusion of children into adequate therapy.

Keywords: Differentiated motor movements, hand grip, articulation.

INTRODUCTION

The development of motor functions from simple to complex ones is being repeated in the process of maturing during the life of a human. Motor development evolves in a chronological order and includes parallel maturing of the nervous system. Besides, there is an entire system of learning through trials and errors, aiming at adopting adequate motor pattern, i.e. scheme (Cisek, Kalaska, 2005). Besides the genetic predisposition, the development also includes the component of individuality, which is of great importance in the process of correction certain motor patterns along with the stimulation applied (Eraković, 1987; Bonacin, D., Zečić. S., 2015). At birth and in period of early development, the cephalocaudal pattern prevails, while at later stage it evolves in favor of extremities, i.e. proximodistal development pattern prevails. The development of differentiated active movements includes development of a hand grip. Hand grip enables both everyday human functioning as well as achieving results in sports (Khasawneh, A., Taifour, 2015). The first step in hand grip development is a grip with whole hand, which is a reflex grip. In the sixth month, the position of grip is radial-medial. In the seventh month of life, the child willingly and intentionally grabs objects, which is a palmar-radial grip. In the ninth month, the grip is three-point pinch (thumb, index fingerand middle finger). At the age of ten months, grip evolves to a Pincer grip (thumb and index finger extended, thumb adducted). Child continues to practice grip's dexterity. By the age of twelve months the development of grip reaches its highest stage, evolving into neat Pincer grip (index finger is used in flexion of interphalangeal joints and thumb is in flexion and opposition).

The experience from practice show that normal development of differentiated active movements of a hand and improving of so called neat Pincer grip which is characterized by the opposition of a thumb (m.opponens pollicis, innervated with n.medianus) significantly improves proper development of logomotorics and subsequently the articulation itself.

PROBLEM AND AIM OF RESEARCH

Due to increased number of children with articulation impairments, the experts increasingly recognize the need to improve early detection methods (Popović, at al., 2010). The aim of this paper is to determine the dynamics and level of development of differentiated motor hand movements and its impact on the development of articulation in preschool children. In accordance with this aim, the following research hypothesis was set: Development of the articulation in the context of given neurological development will correlate with the development of differentiated active hand movements.

METHODS

Basic organization method of research is quasi experimental design, with two observed groups. Research population comprised 60 children of both genders. The election criterion was the age of children, from 5.5 to 7 years of age. The research sample was divided into two groups. The experimental group (E) consisted of 30 children with diagnosed articulation disorders. The second, control group (C) consisted of 30 children from general population who did not have any impairment in expressive speech. We used a method of individual testing, both in E and in C group. In order to establish the level and quality of differentiated active hand movements, we used the Lafaye I, II and III test for the assessment of manipulative hands dexterity.

This testing method includes three tests. On execution of tests, we monitored the dominance of hand, level of grip evolution, manner of choosing materials, speed of execution, presence of associated movements of the extremities and the facial musculature. The research was performed in the Children's Outpatient Department at the Community Health Center Voždovac - Belgrade. It lasted from February 2015 till May 2016. The approval from the research institutions has been obtained, as well as the approval from the Ethic Committee.

Statistical process and analysis was done using a computer program SPSS ver. 20 (Statistical Package for the Social Sciences). As a descriptive statistics tool, we used the arithmetic mean with accompanying standard deviation, along with minimum and maximum. Frequency and percentage were also used. Chi-squared test was used for survey of correlation between two category variables. We have also used the t test for large, independent samples.

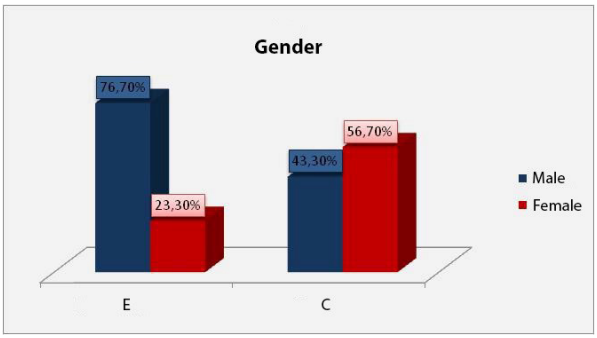
RESULTS

Table 1: Sample structure according to average age of the respondents

	N	Min	Max	M	SD
E	30	5,5	7	6,07	0,50729
C	30	5,5	7	6,3433	0,46065
	60	5,5	7	6,2067	0,49979

Average age of the experimental group was M=6,07±0,5 years of age, while average age of the control group was M=6,34±0,46 years of age.

Chart 1: Sample structure according to gender of the respondents



Control group comprised more respondents of male gender (76,7%), while the control group comprised more female gender respondents (56,7%).

Table 2: Manipulative hands dexterity test – (Lafay) – difference between the experimental and control group on categorical items

			GROUP						
			E		C				
				%		%	x^2	df	p
I TEST	Hand preference	Left hand	7	23,30%	12	40,00%	6,316	2	0,043
		Right hand	18	60,00%	18	60,00%			
		Ambidexter	5	16,70%	0	0,00%			
	Level of hand grip development	whole hand grip	5	16,70%	1	3,30%	21,4	3	0
		four fingers grip	11	36,70%	0	0,00%			
		three fingers grip	11	36,70%	15	50,00%			
		Pincer grip	3	10,00%	14	46,70%			
	Presence of associated movements	Yes	9	30,00%	0	0,00%	10,588	1	0,001
		No	21	70,00%	30	100,00%			
II TEST	Hand preference	Left	8	26,70%	12	40,00%	3,827	2	0,148
		Right	19	63,30%	18	60,00%			
		Ambidexter	3	10,00%	0	0,00%			
	Level of hand grip development	whole hand grip	5	16,70%	1	3,30%	21,4	3	0
		four fingers grip	11	36,70%	0	0,00%			
		three fingers grip	11	36,70%	15	50,00%			
		Pincer grip	3	10,00%	14	46,70%			
	Presence of associated movements	Yes	9	30,00%	0	0,00%	10,588	1	0,001
		No	21	70,00%	30	100,00%			
	Manner of choosing materials	Yes	30	100,00%	30	100,00%	/	/	/
		No	0	0,00%	0	0,00%			
III TEST	Hand preference	Left	5	16,70%	7	23,30%	1,054	2	0,59
		Right	17	56,70%	18	60,00%			
		Ambidexter	8	26,70%	5	16,70%			
	Level of hand grip development	whole hand grip	1	3,30%	0	0,00%	19,467	3	0
		four fingers grip	11	36,70%	1	3,30%			
		three fingers grip	15	50,00%	12	40,00%			
		Pincer grip	3	10,00%	17	56,70%			
	Presence of associated movements	Yes	10	33,30%	0	0,00%	12	1	0,001
		No	20	66,70%	30	100,00%			

In the first test of hand Preference, right-handed respondents were dominant in both groups at 60% rate, C group comprised 40% of left-handed respondents, while the E group comprised 23.3% . Level of grip development is statistically significantly different between the E and the C group (x^2=21,40, df=3, p<0,01). C group comprised 50% of the respondents with three fingers grip and Pincer grip (46,7%), while the E group comprised respondents with four and three fingers grip (36,7%). Presence of associated movements is statistically different in respondents of the E and the C group (x^2=10,58, df=1, p<0,01). They were not present in the C group, but were present in 30% of the respondents in the E group. The second test also revealed statistically significant difference in the level of grip development (x^2=21,40, df=3, p<0,01) and associated movements test (x^2=10,58, df=1, p<0,01). In the third test, level of grip development remains statistically significantly different (x^2=19,46df=3, p<0,01), along with the presence of associated movements (x^2=12, df=1, p<0,01).

Chart 2: Differences between the experimental and control group in all three tests

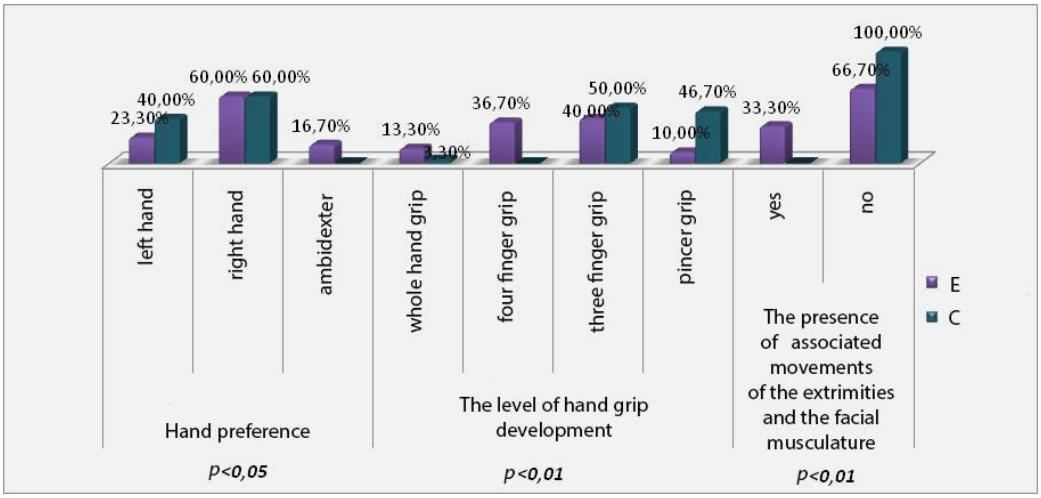


Chart no 2. shows statistically significant differences in all three tests: hand preference (x^2=6,31, df=2, p<0,05), hand grip development (x^2=20,25, df=3, p<0,01) and presence of associated movements (x^2=12,00, df=1, p<0,01). The E group comprised of 16% of ambidexters while the C group did not comprise any. Whole hand grip was present at 13.3% of the respondents in the E group, while there were none in the C group. Four fingers grip was present in respondents of the E group (36,7%), while there were none in the C group. Grip with three fingers was present in 40% of the respondents in the E group, while there were 50% of the respondents with the same grip in the C group. Pincer grip was present in 46.7% of the respondents in the C group and only in 10% of the respondents in the E group. Presence of associated movements in the E group was found in 33.3% of the respondents, while there were none in the C group.

Chart 3: Hands Manipulative Dexterity Test – difference between the experimental and the control group in numerical items (speed of task execution)

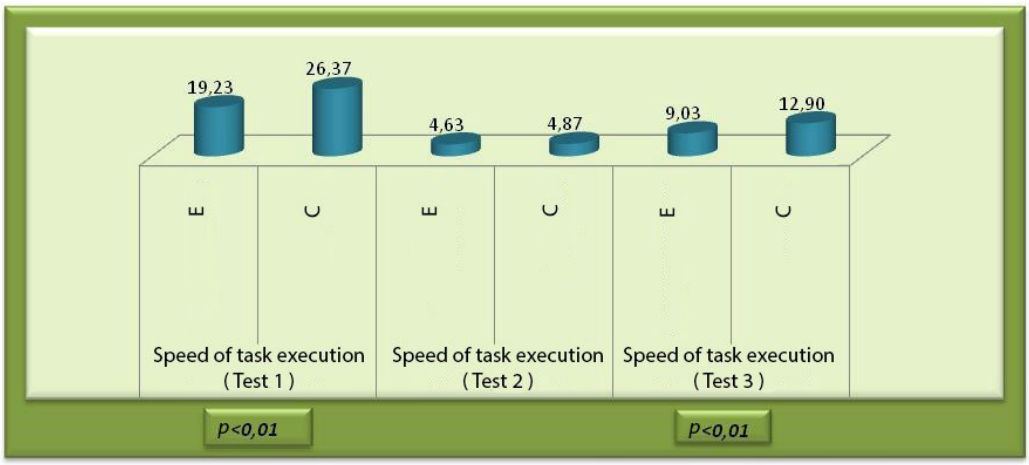


Chart no 3. Speed of execution in the E and the C group is statistically significantly different in the first test (t=3,95, p<0,01). The E group has slower execution speed (M=19,2) in comparison to the C group (M=26,3). In the third test, the respondents of the E group had lower execution speed (M=9,03) in comparison to the respondents of the C group (M=12,90), that speed is statistically significantly different (t=4,78, p<0,01).

DISCUSSION AND CONCLUSION

The research comprised children between 5.5 to 7 years of age (Table 1). This specific age was selected because it is considered that the development of articulation completes at the age of 5.5. The sample was divided into three subgroups, each half year older than the other.

Percentage of children per subgroups: 60% of children in the E group was 5.5-6 years old, 13,3% was 6,1 to 6,5 years old and 26,7% is 6,6 – 7 years old. In the C group 23,3% children belonged to age group of 5,5 – 6, 46,7% to age groupof 6,1-6,5 and 30,0% to age group of 6,6-7. We believe that the differentiated motor skills and speech (articulation) were developmental categories which are being

adopted through learning process and have been intensively evolving in preschool period. There is a hierarchy order in the development, where initially differentiated hand movements emerge, then the speech follows. Likewise, simple motor patterns emerge initially, followed by more complex ones, which are being perfected by practicing and repeating. (Hanakawa, et al., 2008).

Gender results analysis (Chart no.1) has shown that the E group consisted of larger number of boys (76,7%) compared to girls (23,30%), while the C group consisted of larger number of girls (56,7%) compared to boys (43,30%). As this is a prospective cross-sectional study, sample structure according to gender transliterates to groups numerical strength in the population.

Having obtained the results from all three tests, they were summarized and the respective analyses of differences in all three items between the E and the C group was conducted (Chart no.2) There were statistically significant differences in all three items: hand preference (x^2=6,31, df=2, p<0,05), grip development level (x^2=20,25, df=3, p<0,01) and presence of associated movements (x^2=12,00, df=1, p<0,01), as well in Speed of execution (Chart no.3). Predominantly, both groups included right-handed respondents, but the C group included more left-handers (40%). There were 16,7% of ambidexters in the E group, which indicated that the respondents in the C group were lacking differentiated laterality, which was the indicator of slower maturing of structures and functions responsible for lateralization of movements. Around 40% of children between the age of 4 and 5 were poorly lateralized, while this percent decreased to 30% between the age of 5 to 7 (Heitger, 2012). Four-fingers (36,7%) and three-fingers grip (40%) were dominant in the E group, while the whole hand grip was detected in 13,3% of the respondents. In the C group, grip with three fingers (50%) and the Pincer grip (46,7%) prevailed. Better results of the C group is shown in the larger number of respondents in the category of Pincer grip in total, which comprises the ability of proper gripping characterized by the opposition of a thumb and the intended coordination of the hand segments movements while performing manipulative activities (De Smet, Vercammen, 2001; Bear-Lehman, et.al., 2002; Agostino, et.al., 2008; Boschi, Frère, 2013; Wilmut, Byrne, 2014). Presence of associated movements is more frequent in the E group (33,3%) in comparison to the C group (0%), as expected. Associated movements or synkinesis represent the sign of immature neuro-muscle connections and relations. Neuro-muscle maturing can be followed-up by monitoring the suspension of additional movements (as remains of mass reaction from the newborn period) and "refining" of movements till they become fully autonomous (Galea, Celnik, 2009; Censor, Cohen, 2011; Dietz, et.al., 2015). Speed of execution in both groups showed statistically significant differences (t=3,95, p<0,01). The speed represents the main characteristic, being an integral part of each active movement. This research examined the speed of movements' execution, which is closely tied to anatomic and physiological characteristics of the muscles.

Close correlation between hands dexterity and speech is well-known for years (Davidović, et.al., 2018). Neurological diagnosis are widely based solely on evaluation of dexterity movements of hands and fingers. Results of this study show that the hand manipulative dexterity (hand preference, level of grip development and presence of associated movements) is better in children without the accompanied articulation disorders than in the children with the disorders. These results may contribute to timely evaluation of possible irregularities in the development of expressive speech and consequently lead to preventive organization of the stimulative threatment.

REFERENCES

1. Agostino, R., Iezzi, E., Dinapoli, L., Suppa, A., Conte, A., & Berardelli, A. (2008). Effects of intermittent theta-burst stimulation on practice-related changes in fast finger movements in healthy subjects. European Journal of Neuroscience, 28(4), 822-828.

2. Bear-Lehman, J., Kafko, M., Mah, L., Mosquera, L., & Reilly, B. B. (2002). An exploratory look at hand strength and hand size among preschoolers. Journal of Hand Therapy, 15(4), 340-346.

3. Bonacin, Da., & Zečić. S. (2015). Monitoring capabilities of biomotor dimensions in seven year olds for the purpose of selection of gifted. Sport Science 8 Suppl 1: 81-86

4. Boschi, S. R., & Frère, A. F. (2013). Grip and pinch capability assessment system for children. Medical engineering & physics, 35(5), 626-635.

5. Censor, N., & Cohen, L. G. (2011). Using repetitive transcranial magnetic stimulation to study the underlying neural mechanisms of human motor learning and memory. The Journal of physiology, 589(1), 21-28.

6. Cisek, P., & Kalaska, J.F. (2005). Neural correlates of reaching decisions in dorsal premotor cortex: specification of multiple direction choices and final selection of action. Neuron, 45(5), 801-814.

7. Davidović, M, Otašević, J., Dobrota Davidović, N., Petronić, I., Davidović, D., & Jerkić, L. The effect of dynamic and levels of cortical function for the development of speech in children, Srpski arhiv, Srpsko lekarsko društvo, Online First July 4, 2018 DOI: https://doi.org/10.2298/SARH180510046D

8. De, L. S., & Vercammen, A. (2001). Grip strength in children. Journal of pediatric orthopedics. Part B, 10(4), 352-354.

9. Dietz, V., Macauda, G., Schrafl-Altermatt, M., Wirz, M., Kloter, E., & Michels, L. (2013). Neural coupling of cooperative hand movements: a reflex and FMRI study. Cerebral Cortex, 25(4), 948-958.

10. Galea, J. M., & Celnik, P. (2009). Brain polarization enhances the formation and retention of motor memories. Journal of neurophysiology, 102(1), 294-301.

11. Hanakawa, T., Dimyan, M. A., & Hallett, M. (2008). Motor planning, imagery, and execution in the distributed motor network: a time-course study with functional MRI. Cerebral cortex, 18(12), 2775-2788.

12. Heitger, M. H., Macé, M. J. M., Jastorff, J., Swinnen, S. P., & Orban, G. A. (2012). Cortical regions involved in the observation of bimanual actions. Journal of neurophysiology, 108(9), 2594-2611.

13. Khasawneh, A., & Taifour, A. (2015). Predicting handgrip strength based on some anthropometric measures, hand volume, and handprint area. Sport Science, 8(1), 103-7.

14. Popovic,L., Dobrota-Davidovic,N., & Stevovic-Otasevic,J. (2010). Prevention of Articulation Disorders Caused by Teeth and Jaw Anomalies, In: Special education and rehabilitation - science and/or

15. practice: Thematic collection of papers, p.255-273.

16. Wilmut, K., & Byrne, M. (2014). Grip selection for sequential movements in children and adults with and without Developmental Coordination Disorder. Human movement science, 36, 272-284.

17. Eraković, T. (1987) The personality of the child and psychomotor activity (In Serbian, Ličnost deteta i psihomotorika) Novi Sad, Dailynews (In Serbian Dnevnik).

ZNAČAJ DIFERENCIRANIH MOTORNIH POKRETA ŠAKE ZA RAZVOJ GOVORA KOD DJECE

Profinjeni i koordinirani pokreti ruku imaju utjecaj na senzomotorni razvoj središnjeg živčanog sustava, a preko njega i na razvoj govora, što zahtijeva viši stupanj senzomotorne koordinacije. Cilj ovog istraživanja bio je utvrditi razinu i dinamiku razvoja diferenciranih motoričkih pokreta ruku i njihov utjecaj na razvoj artikulacije kod djece predškolske dobi. Istraživanje je kvazieksperimentalni dizajn sa dvije grupe, eksperimentalnom i kontrolnom. Uzorak uključuje 60 djece (30 + 30), oba spola, dobi od 5,5 do 7 godina starosti. Kao instrument smo koristili Lafaye (Lafaye) I, II i III test za procjenu manipulativnih vještina ruku. Ovaj test ispituje se kroz tri probe. Pri izvođenju proba posmatra se dominacija ruke, razina razvijenosti hvata, način odabira materijala, brzina izvođenja i prisustvo nuzkretnji udova i mišića lica. Rezultati ovog istraživanja ukazuju na to da je manipulativna spretnost ruku bolja u djece bez poremećaja artikulacije, što može biti iskorišteno za pravodobno sprječavanje i uključivanje djece u tretman.

Ključne riječi: Diferencirani motorički pokreti, hvat, artikulacija.

Received: December 03, 2018 / Accepted: December 15, 2018
Correspondence to: Jadranka Otašević, Faculty of Special Education and Rehabilitation, University of Belgrade, Serbia
E-mail: jadrankastevovic@yahoo.com

"BREATHING ROOM" FOR BOWLERS: ON SCRAPPING OF BATTING POWERPLAY FROM 50 OVERS CRICKET

Dibyojyoti Bhattacharjee[1], Abhishek Chakraborty[2]

1. Department of Statistics, Assam University, Silchar, India
2. XLRI Xavier School of Management, Jamshedpur, Jharkhand, India

ABSTRACT

Modifications in the rules of a game at the international level are done by the governing bodies of the concerned sports with a definite goal in mind. International Cricket Council (ICC), governing cricket at the international level has made several changes in the powerplay rules since its introduction. In 2015, the batting powerplay was withdrawn from cricket for providing 'breathing room' to the bowlers. This study tries to analyse if the bowlers are now better placed after the withdrawal of the batting powerplay. Based on traditional measures of bowling performance like the economy rate, bowling strike rate, the bowling average and the combined bowling rate, this study tries to find out if bowlers are better placed after the withdrawal of the batting powerplay from cricket. The findings of our study suggest that the bowlers' condition has not improved largely with the withdrawal of the batting powerplay, instead, it has deteriorated significantly on an aggregate. With the change, on the one hand, the game has become dull during the middle overs, and on the other hand, it has done no good to the bowlers. The paper concludes that modification in the rules of a game without proper planning and experimentation may lead to further modifications without achieving the purpose for which the change is made.

Keywords: Sports analytics, performance measurement in sports, statistical graphics, sports management.

INTRODUCTION

The rules governing different sports are often open to modifications at the international level. Common reasons for such amendment of rules in sports include improving players' performance, attracting more spectators, simplifying the game, attending to commercial pressure, adapting sports to children's needs and interests and preventing injuries (Aris, Argudo and Alonso, 2011). Rules are also modified if teams/players are found to take undue advantage of the existing ones. A change in Cricket rules at the international level is often done by the International Cricket Council (ICC). In the words of Silva, Manage and Swartz (2015) - "Rules in cricket, at the international level are changed more frequently compared to the other major sports like football, baseball, etc." But cricket has three different versions played at the international level that can be broadly classified as unlimited overs cricket (Test matches) and limited overs cricket (One-day and Twenty20). In test cricket, each team bats for two innings and the team with more aggregate runs scored in their two innings wins the test match. In test matches, there is no restriction on the number of overs played in an innings. Thus, taking wickets is more vital than conceding runs by bowlers in test cricket. Test cricket has a fixed viewer base that comprises of quality cricket enthusiasts.

One-day International Cricket (ODI) and Twenty20 cricket are limited overs cricket. While ODI's are generally restricted to 50 overs a side Twenty20 as the name indicates comprises of 20 overs per innings. But with the launching of Twenty20 cricket in the international format, in 2005, it became very popular among the mass compared to ODIs. Thus, for the continued existence of ODI, onus came on the ICC to bring the necessary modifications.

Accordingly, ICC responded with the introduction of 'Power Play' in ODI matches played from July 2005 (Aashish, 2005). Before that, in ODI, each innings used to start with a fielding restriction for the first 15 overs. During those overs, the fielding team could place only two players outside the 30-yard circle, guarding the boundary. This was done to encourage high scoring shots, i.e. fours and sixes by the batsmen. Following the end of fielding restrictions, i.e. at the end of 15 overs, the field was spread out (a maximum of five fielders guarding the boundary) making lofted shots from a batsman carrying a risk of getting out, caught at the boundary. At this stage (16th to 40th over), batsmen try to keep the scorecard moving, scoring ones and twos, taking advantage of the spread-out field and hardly taking any risk.

Generally, this part of the innings is dull to watch as chances of dramatic things to happen during the middle overs are lesser. Then, the 'death overs' (41st to 50th over) start, as it is often called, the last ten overs of ODI innings. This is the stage when the ball gets old, the bowlers are tired and it is the last opportunity for the batsmen to score runs. The batsmen played risk-free cricket during the middle overs to store their best for the last, when scoring runs matters and preserving wickets does not. During this stage, the ODI innings becomes exciting again. To introduce some excitement in the middle overs, ICC, from July 2015, introduced three sets of fielding restrictions and termed it as the powerplay.

The first powerplay comprised of the first ten overs of an innings, which are mandatory. This is followed by two further powerplay blocks, of five overs each, to be decided by the fielding team's captain. Also, both powerplays shall end before the start of the 41st over. It was perceived that this strategy made ODIs more exciting during the middle overs, but it did not happen the way it was expected. Captains of the bowling teams started taking the two blocks of powerplays consecutively between the 11th to the 20th over unless the batsmen are very ruthless on the bowlers. This strategy was planned, as bowlers in the remaining part of the innings can get an opportunity to make up for the losses during the powerplay which again made the middle overs (21st to 40th) dull and non-happening. Therefore, in October 2008, ICC introduced the batting powerplay. This comprises of a five-over block of fielding restriction to be decided by the batting team. This was in addition to the mandatory first ten overs of powerplay and a five-over block of powerplay to be decided by the fielding team's captain to be called as the bowling powerplay. As the batting powerplay is to be decided by the batting team, so it shall be chosen when the innings is poised towards the batting side, and the batsmen are well set and ready to score quick runs, taking advantage of the fielding restriction. ICC conceptualized that, as most of the fielding teams kept overs of their best bowlers for the death overs. Now, with batting powerplay coming in, teams need to employ their best bowlers in the batting powerplay overs, so they need to resort to a lesser bowler during the death overs (Chopra, 2011). This shall enhance runs scoring during the middle overs. Later in October 2012, ICC scrapped the bowling powerplay, keeping the mandatory powerplay of first ten overs and the batting powerplay (a block of five overs) at the desecration of the batting team but before the start of the 41st over. The batting powerplay, however, did not work the way it was expected. While it was believed that this powerplay should be a nightmare for the bowlers, it increased the possibility of wicket fall. Losing wickets during batting powerplay, in an attempt to accelerate the run rate tells on the batting side, which in turn, helped the bowlers to improve their performance figures. Several articles like Chopra, 2011; Aashish, 2011; Ramesh, 2011, with relevant analyses, supported that batting powerplay was not altogether a batsmen's paradise, but bowlers too had their share of the pie.

But, a committee formed by ICC for analysing the existing ODI rules headed by Indian bowler of yesteryears Anil Kumble, in May 2015, recommended the withdrawal of the batting powerplay along with some other changes. Consequently, ICC scrapped the batting powerplay from the ODI's played after 5th July, 2015. The reason cited was to provide a bit of 'breathing room' to bowlers in 50-overs cricket. The above discussion provides the platform for the research question of the current study. Has the withdrawal of the batting powerplay benefitted the bowlers?

PROBLEM STATEMENT

For works that offer an overview of the literature centring on rule modification in sports, one may look into the works of Aris, Argudo, and Alonso (2011) and Wright (2014). The former presented a comprehensive analysis of the available bibliography about the rule modification in sports.

Covering as many as 21 sports, including cricket, the work of Wright (2014) reviews the literature on analytical papers on sports that have addressed the issue with the existing rules of different sports or frequency in the modification of sports rules or consequences of such modifications in the rules. In volleyball, Giatsis (2003) studied the impact of the change in the scoring system from 'side outscoring' to 'rally scoring' and found that the new scoring system made the game more wavering and spectacular as more sets finished with the minimum difference of points. Another study in volleyball about the change in the scoring system is that of Kovacs (2009). Brocas and Carrillo (2004), studying the change in the rule of awarding 'three-points for victory' in football instead of the 'traditional two-points for victory', aimed at making teams more offensive and found that it was not

achieved in reality. Lybbert, Lybbert, and Smith (2011) studied the impact of a 2005 rule change in cycling that moved the red flag from one kilometre to three kilometres from finish to moderate the chaos at the finishing zone. But, it was found that, after the change, both the incidence and size of crashes nearly doubled in the 1-3 kilometres from the finishing zone. Studying the effect of the change in rules in field hockey, related to allowing a 'self-pass' in case of the free hit (a change initiated by the International Hockey Federation in 2009), Tromp and Holmes (2011) found that the change has helped in reducing time wastage significantly for engaging free hits. To increase the safety of players, improve competitiveness and reduce wastage of time during the match, the International Rugby Board introduced some rule changes in 1999. Williams, Hughes, and O'Donoghue (2017), with the data spanning over five years from 1999 to 2003, investigated the impact of the changed rules. They found that, after the revised rules, the ball-in-play time and continuity of the game increased significantly. Taking data from professional rugby league football in the United States over four-time periods, Evans, Huges and Lamb (2017) showed that the change in rules implemented between 1992 and 2000 had little impact on the playing patterns of professional rugby league teams.

Regarding the rules in cricket, a considering amount of literature is available on the laws related to target rescheduling in case of rain truncated limited over matches. Some of them are Duckworth and Lewis (1998), Jayadevan (2002), Preston and Thomas (2002), Carter and Guthrie (2004), Schall and Weatherall (2013) and Stern (2009). Regarding powerplay rule changes and its impact, Silva, Manage and Swartz (2015) make a comprehensive study. They stated that, in contrast to the stability of the rules involving many major sports, one-day cricket has tinkered continuously with its powerplay rule. The paper then investigated the effect of teams as well as players' performance on the various forms of powerplay that has been adopted over the years. Using a 'what-if' approach, the authors substituted the powerplay outcomes with what might have happened had there been no powerplay. The work through published in 2015 is based on available data till December 2013. Thus, the study could not include the effect of withdrawing the batting powerplay, which was affected from July 2015. The scrapping of the batting powerplay was done with the logic of giving a benefit to the bowlers (cricket is believed to be tilted towards the advantage of the batsmen in general). Three years have passed after the said scrapping, sufficient amount of cricket has been played in between, and a considerable amount of statistics is also accumulated. Also, from the review of the literature on other sports, related to the impact of the change in rules, it is perceived that not all changes meet the goal for which they are implemented. All these provide an opportunity for the current researchers to test to what extent the goal underlying the scrapping of batting powerplay is attained in cricket.

AIM OF THE STUDY

The batting powerplay was withdrawn with an objective of creating a situation which better suits the bowlers. It is, thus, expected that the bowlers must have improved the performance post-withdrawal of the batting powerplay. The aim of the study is to test the following hypothesis.

- The bowlers performed equally well when the batting powerplay was in existence and after the withdrawal of the batting powerplay.

The literature review indicated the research gap and that no previous study was done to explore the implication of the said withdrawal. The method described in the following section is designed with the perspective of attaining the above objective.

METHOD

The methodology to understand the implication of withdrawing the batting powerplay on the performance of bowlers is designed through the following few steps.

Performance Statistics of Bowlers

Bowlers' performance is traditionally quantified using the Bowling Strike Rate (BSR), the Economy Rate (ER) and the Bowling Average (BA). If B represents the number of balls bowled by a bowler, W the number of wickets taken by a bowler and R the runs conceded by the bowler in a match or a series of matches then:

$$BSR = \frac{B}{W}, \quad ER = \frac{R}{B} \times 6 \quad \text{and} \quad BA = \frac{R}{W}$$

The three measures have different purposes. BSR indicates the average number of balls bowled by a bowler to take a wicket and BA measures the average number of runs conceded by the bowler between wickets. Both measures quantify the wicket-taking ability of bowlers, but concerning two different criteria viz. the number of balls delivered and the runs conceded. However, both measures do not define clearly as for how easier scoring of runs is against the bowler. Thus comes ER, it provides the average number of runs conceded by the bowler per over. This statistic is very important and specific to limited overs cricket, where bowlers are expected to concede fewer runs along with their ability to take wickets. Thus, it is necessary that the performance of the bowlers through a pair-wise test be compared for

the three statistics above while the batting powerplay was in existence and after the withdrawal of the batting powerplay. It may be noted that all the three measures are negative in dimension, i.e. the lower the value, the better the performance.

Another performance statistic for bowlers called the Combined Bowling Rate (CBR#) developed by Lemmer (2012) takes into consideration the match conditions into account. It is a combined statistics as it compiles both the wicket-taking capability, and run restricting the ability of a bowler. This is a harmonic mean of the above three traditional measures of bowling performance. As the harmonic mean of participating ratios needs to have parity in the numerator, so the following adjustment is proposed in BSR by Lemmer (2002).

$$BSR = \frac{B}{W} = \frac{B}{W} \times \frac{R}{R} = \frac{RB}{RW} = \frac{R}{RW/B} \quad \ldots (1)$$

Thus, the combined bowling rate (CBR) defined by Lemmer (2002) as

$$CBR = \frac{3}{\frac{1}{BA} + \frac{1}{ER} + \frac{1}{BSR}} = \frac{3R}{W + (B/6) + W \times \frac{R}{B}} \quad \ldots(2)$$

Later, Lemmer (2005) improved the CBR to an adjusted measure called CBR* which is more appropriate for quantifying bowling performance for a small number of matches giving the formula as:

$$CBR^{\#} = \frac{3R}{W^{*} + (B/6) + W^{*}(R/B)} \quad \ldots(3)$$

W *= the sum of weights of the wickets taken by the i^{th} bowler. The weights of the wickets taken by the bowler are related to the batting positions of the batsmen dismissed by the bowler (cf. Lemmer (2005)).

$$CBR^{\#} = \frac{3R'}{W^{*} + (B/6) + W^{*}(R'/B)} \quad \ldots(4)$$

R'= the sum of adjusted runs conceded by the bowler in all the innings of the series/matches under consideration

$$= \sum_{j-1}^{n} RA_j \text{ with, } RA_j = R_j \left(RPB_j / RPBM_j\right)^{0.5}$$

where, RPB_j = the runs conceded by the bowler in the j^{th} match/balls bowled by the bowler in the j^{th} match and $RPBM_j$ = Total runs scored in the j^{th} match/ Total balls bowled in the j^{th} match. The measure is noteworthy because of the following two inherent issues. The factor $(RPB_{ij} / RPBM_j)$ considers the match situation in which the bowler delivered and the factor W* which refuses to give equal importance to all the wickets taken by the bowler but weights them differently based on their batting position. It may be noted that, like BSR, ER and BA, CBR# is also a negative measure. The lower the value, the better the performance.

Selection of Bowlers

To measure the performance, it is necessary that players' statistics for a large number of games should be considered. One or two games may not properly judge the real quality of a player. The effects of outstanding or poor, single performances are smoothed over the larger number of games (Lewis, 2005). The nature of the professional sport ensures that the majority of individuals will experience sufficient match-play to enable this type of methodology to be deployed (Bracewell and Ruggiero, 2009).

Thus, proper selection criterion needs to be set up which will help to identify changes in the bowlers' performance. Firstly, the bowlers who have bowling experience in ODI matches, both in the pre, and post-withdrawal of the batting powerplay shall be considered. Secondly, only those bowlers who bowled during the batting powerplay shall be considered. Thirdly, considering the comments mentioned above by Lewis and Bracewell, the restrictions imposed shall be such that the selected bowler must have bowled in a considerable number of matches both pre, and post-withdrawal of the batting powerplay. After experimentation, the following criteria for selection of the bowlers for analysis are decided.

- (a) Bowlers who had bowled at least one over each in batting powerplay during the period when batting powerplay was in existence in 10 or more ODIs shall be considered
- (b) Bowlers who have bowled at least in 10 ODIs after batting powerplay was withdrawn by the ICC in 2015.

A bowler who satisfies both (a) and (b) is selected for analysis. While measuring the performance of a bowler (included in the analysis), only those matches where the bowler has bowled at least one over in the batting powerplay shall be taken into consideration.

This is done so that the influence of batting powerplay in the bowling performance is included. However, after the withdrawal of the batting powerplay, all the innings, in which

the bowler has bowled at least one over, are considered for performance measurement.

Data Source and Data Type

At the very selection stage of the bowlers for analysis, the researchers need to know if a bowler under consideration has bowled in the batting powerplay of a match in which he played (apparently when the batting powerplay was in existence).

This information (which bowlers bowled during the powerplay) is not available in the scorecard of the matches. So, some reliable source which stores the commentary of ODI matches along with information about the powerplays is required. The website www.espncricinfo.com keeps such commentary in their archives and is the data source.

Regarding the data types, if the bowler has bowled in the batting powerplay, innings-wise number of balls bowled by the bowler, innings-wise runs conceded by the bowler, innings-wise number of wickets dismissed by the bowler and the batting positions of those wickets are taken into consideration. Also, the total runs scored in the match, and the total number of balls bowled in the game are necessary to compute the different measures of bowling performance.

Statistical Tools

For each of the bowler selected for analysis, the values of BSR, ER, BA and CBR# are computed based on the aggregate values of B, R, R' and W from all matches in which the bowlers bowled during batting powerplay. The same exercise is repeated for the selected bowlers, for the matches played after the withdrawal of batting powerplay.

Thus, for each bowler, we shall get values of BSR, ER, BA and CBR# in pairs, one while batting powerplay was in existence, and the other after its withdrawal. This calls for the application of Wilcoxon matched pair signed rank test separately for BSR, ER, BA and CBR# values to test if the withdrawal of batting powerplay has improved the bowlers' performance.

The tests shall be done for all the bowlers taken together as well as separately for spinners and pace bowlers included in the sample. Normal approximation of the statistic can be applied for sample sizes of more than 25 and is used here only for all bowlers with a sample size of 27. For the other two samples of spinners and pace bowlers, the Wilcoxon matched pair signed rank test without normal approximation is conducted. It may be recalled here that, unlike others in the case of this test, if the value of the test statistic is less than the critical value, than the null hypothesis is rejected.

It shall be noted here that the alternative hypotheses of the tests shall be one-tailed hypothesizing that the average values of BSR, ER, BA and CBR# across all the bowlers have decreased significantly after the withdrawal of the batting powerplay.

As CBR# is successful in providing match specific bowling performance of a bowler, appropriate for a single match or fewer number of matches, and it combines all the other rates, so it is more comprehensive compared to the other measures.

RESULTS

Following the conditions of bowler selection (mentioned in Section 4.2), 27 bowlers are selected for analysis. Out of these, there are eight spinners and 19 pace bowlers. The details regarding the bowlers, along with their performance statistics, can be seen in Appendix I. The Wilcoxon matched pair signed rank test is used to compare the performance related statistics of bowlers (BSR, ER, BA and CBR#) when the batting powerplay was in existence (October 2008 to July 2015) and after its withdrawal (July 2015 to July 2018). The analysis is done initially, taking all the bowlers together and then separately for the spinners and the pacers. The results of the tests are provided in Table 1.

Table 1 shows that the median values of BSR, ER, BA and CBR# have shown an increase after the withdrawal of the batting powerplay when the performance of all the bowlers is taken together. This means that the bowlers' performance, in aggregate, in terms of their wicket-taking ability and the ability to restrict runs, has gone down significantly after the withdrawal. When only spinners are considered, the values of BSR, ER, BA and CBR# have remained same on an average (statistically). In the case of pace bowlers too, all the three factors viz. BSR, BA and CBR# are statistically the same on an average, both when the batting powerplay was in existence, and after the withdrawal of the batting powerplay. Thus, in no way (in terms of the wicket-taking ability or restricting of runs) bowlers of any expertise (spin or pace) have benefitted by the withdrawal of batting powerplay from one-day matches, rather in certain cases, it has become worse viz. economy rate of fast bowlers and BSR, ER, BA and CBR# for all the bowlers taken together.

Table 1: The results of the Wilcoxon matched pair signed rank test to compare the Bowling Strike Rate, Economy Rate, Bowling Average and Combined Bowling Rate for bowlers during and after the withdrawal of the batting powerplay

		Bowling Strike Rate		Economy Rate		Bowling Average		CBR#	
		During	After	During	After	During	After	During	After
All Bowlers (n = 27)	Median	35.28	38.19	5.21	5.28	31.28	35.31	12.22	12.62
	Variance	469.74	540.75	0.45	0.33	358.69	462.99	3.463	4.212
	Test-statistic	- 1.7778		- 2.3064		- 1.7298		- 2.1863	
	p- value	0.0377 (< 0.05)		0.0105 (< 0.05)		0.0418 (<0.05)		0.0144 (< 0.05)	
	Conclusion	Median BSR increased significantly after the withdrawal of batting powerplay		Median ER increased significantly after the withdrawal of batting powerplay		Median BA increased significantly after the withdrawal of batting powerplay		Median CBR# increased significantly after the withdrawal of batting powerplay	
Spinners (n = 8)	Median	40.71	47.5	4.59	5.04	31.83	36.18	10.33	11.26
	Variance	1426.3	1246.8	0.59	0.26	1101.1	849.9	3.576	2.674
	Test-statistic	5		9		6		6	
	Critical value (5%)	5		5		5		5	
	Conclusion	No significant difference in Median BSR during and after the withdrawal of batting powerplay		No significant difference in Median ER during and after the withdrawal of batting powerplay		No significant difference in Median BA during and after the withdrawal of batting powerplay		No significant difference in Median CBR# during and after the withdrawal of batting powerplay	
Pacers (n = 19)	Median	33.63	37.79	5.55	5.56	29.18	35.31	12.32	12.7
	Variance	60.24	190.29	0.24	0.25	67.84	325.57	2.553	4.354
	Test-statistic	74		46		67		57	
	Critical value (5%)	53		53		53		53	
	Conclusion	No significant difference in Median BSR during and after the withdrawal of batting powerplay		Median ER increased significantly after the withdrawal of batting powerplay		No significant difference in Median BA during and after the withdrawal of batting powerplay		No significant difference in Median CBR# during and after the withdrawal of batting powerplay	

DISCUSSION AND CONCLUSION

The sport's governing body initiates every rule modification process with a definite goal in mind. It is necessary to revisit it after a fair amount of time and clarify to what extent the goals underlying the modification are attained. This work attends the same issue for cricket, i.e. analysing the change made in the powerplay rules in ODI in 2015. The international cricket governing body - ICC made the change with an aim to improve the performance of the bowlers. But, the exercise finds that the change did not go in favour of the bowlers. Modification in rules of any sports at the highest level should be investigated through a reflective process at domestic levels or lower levels before their final introduction. Nothing of this type happened before the withdrawal of the batting powerplay, and so the change ended up in a reverse outcome. Aris, Argudo, and Alonso (2011), in their review work on papers related to changes in rules concerning different sports, stated that eighty percent of the studies do not report the outcome of the modification of rules. Analysis of matches played post modification shall be done to test if the goal of rule modification was attained at the highest level. This was the motivation behind the work, and the researchers feel that the outcome of the rule change in cricket related to batting powerplay is precisely attended.

Appendix 1: Bowling Strike Rate, Economy Rate and Bowling Average of the selected players during and after the withdrawal of powerplay

The name of the bowler	Type	Innings		Bowling Strike Rate		Economy Rate		Bowling Average		CBR#	
		During*	After	During*	After	During*	After	During*	After	During*	After
S Benn	Spin	12	13	141.6	138	5.15	4.96	121.6	114.2	13.61	13.16
C Anderson	Spin	13	10	23.64	30.6	6.29	5.11	24.8	26.1	12.69	10.94
R Ashwin	Spin	47	11	39.75	53.81	4.88	5.79	32.38	52	10.72	13.67
T Chatara	Pace	16	14	47.26	39	5.31	5.43	41.89	35.31	12.81	12.70
J Fulkner	Pace	27	24	29.66	34.58	5.79	5.52	28.64	31.86	12.32	11.87
Mohd. Hafeez	Spin	27	19	48.08	65.76	3.95	4.36	42.71	47.84	9.11	10.46
Mohd. Irfan	Pace	23	15	35.31	43	4.96	5.09	29.18	36.5	10.95	12.88
RA Jadeja	Spin	53	15	42.07	76.36	4.67	5.27	32.75	37.09	10.54	12.72
K Jarvis	Pace	13	10	50.57	42.5	6.15	5.28	51.85	37.4	15.84	12.61
N Kulasekhara	Pace	48	15	48.1	34.06	5.21	5.66	41.76	32.12	12.26	12.62
S Lakmal	Pace	14	40	32.17	37.79	4.95	5.18	26.54	32.67	10.42	11.32
L Malinga	Pace	76	20	31.59	54.17	5.46	6	28.81	54.17	12.23	14.60
M Morkel	Pace	51	17	28.78	42.42	4.99	5.27	23.95	37.26	10.64	11.60
M Mortaza	Pace	13	44	41.96	36.75	4.94	5.12	34.53	31.41	11.61	11.48
C Mpofu	Pace	19	13	47.66	38.19	5.63	5.87	44.71	37.38	14.25	14.26
W Parnell	Pace	24	18	29.93	27.93	5.77	5.79	28.8	26.93	12.71	11.51
NLTC Perera	Pace	18	28	30.19	33.07	5.64	5.95	28.42	32.8	12.61	13.46
R Hussain	Pace	21	21	35.28	33.17	5.55	5.73	32.66	31.69	12.67	13.14
S A Hasan	Spin	52	29	41.67	41.19	4.5	5.14	31.28	35.27	10.12	11.57
T Southee	Pace	36	35	33.63	45.63	5.61	5.56	31.5	42.32	12.37	13.11
M Starc	Pace	22	29	27.14	28.98	4.73	5.14	21.38	24.82	9.60	10.66
D Steyn	Pace	50	12	33.89	36.78	4.69	5.89	26.52	36.11	10.21	13.05
S Narine	Spin	35	13	37.98	38	3.83	4.16	24.26	26.37	8.09	8.74
I Tahir	Spin	12	46	27.33	35.46	4.45	4.94	20.29	29.17	8.87	10.63
J Taylor	Pace	13	10	32.36	88.5	6.27	7.17	33.86	105.8	13.30	19.96
W Riaz	Pace	26	19	26.51	58.88	5.73	5.97	25.33	58.56	12.01	14.89
C Woaks	Pace	14	41	42.12	33	6.26	5.12	43.89	28.15	15.07	10.73

*Considering only those matches in which the bowler has bowled at least one over in batting powerplay, when batting powerplay was in existence. "After"- means statistics for the matches after the withdrawal of the batting powerplay.

REFERENCES

1. Aashish (2011). Game Changer Rules like Power Play, UDRS, Free hit in ODI Cricket!, http://blogcricketlovers.blogspot.com/2011/02/game-changer-rules-in-odi-cricket.html#.W-FnctUzblU

2. Arias, J. L., Argudo, F. M., and Alonso, J. I. (2011). Review of Rule Modification in Sport. Journal of Sports Science and Medicine, Vol. 1, pp. 1-8.

3. Bracewell, P. J., and Ruggiero, K. (2009). A Parametric Control Chart for Monitoring Individual Batting Performance in Cricket. Journal of Quantitative Analysis in Sports, Vol. 5, No. 3, pp. 1 - 19.

4. Brocas, I., and Carrillo, J. D. (2004). Do the "Three-Point Victory" and "Golden Goal" Rules Make Soccer More Exciting? Journal of Sports

Economics, Vol. 5, No. 2, pp. 169-185.

5. Carter, M. and Guthrie, G. (2004). Cricket interruptus: fairness and incentive in limited overs cricket matches. Journal of the Operational Research Society, Vol. 55, No. 8, pp. 822-829.
6. Chopra, A. (2011) Timing the powerplays right, http://www.espncricinfo.com/story/_/id/22460850/powerplays-foxing-teams (Accessed on 12th September, 2018).
7. Duckworth, F. C. and Lewis, A. J. (1998). A fair method for resetting the target in interrupted one-day cricket matches. Journal of the Operational Research Society, Vol. 49, No. 3, pp. 220-227.
8. Giatsis, G. (2003). The effect of changing the rules on score fluctuation and match duration in the FIVB women's beach volleyball. International Journal of Performance Analysis in Sport, Vol. 3, No. 1, pp. 57-64.
9. Jayadevan, V. (2002). A new method for the computation of target scores in interrupted, limited-over cricket matches. Current Science, Vol. 83, No. 5, pp. 577-586.
10. Kovacs, B. (2009). The Effect of the Scoring System Changes in Volleyball: A Model and an Empirical Test. Journal of Quantitative Analysis in Sports, Vol. 5, No. 3, DOI: 10.2202/1559-0410.1182.
11. Lemmer, H. H. (2002). The Combined Bowling Rate as a Measure of Bowling Performance in Cricket, South African Journal for Research in Sport, Physical Education and Recreation, Vol. 24, pp. 37 – 44.
12. Lemmer, H. H. (2005). A Method for the Comparison of the Bowling Performances of Bowlers in a Match or a Series of Matches. South African Journal for Research in Sport, Physical Education and Recreation, Vol. 27, pp. 91 – 103.
13. Lemmer, H.H. (2012). Individual Match Approach to Bowling Performance Measures in Cricket, South African Journal for Research in Sport, Physical Education and Recreation, Vol. 34, No. 2, pp. 95-103.
14. Lybbert, T. J., Lybbert, T. C., Smith, A., and Warren, S. (2011). Does the Red Flag Rule Induce Risk Taking in Sprint Finishes? Moral Hazard Crashes in Cycling's Grand Tours. Journal of Sports Economics, DOI: 10.1177/1527002511412077.
15. Preston, I. and Thomas, J. (2002). Rain rules for limited overs cricket and probabilities of victory. Journal of the Royal Statistical Society: Series D (The Statistician), Vol. 51, No. 2, pp. 189-202.
16. Schall, R. and Weatherall, D. (2013). Accuracy and fairness of rain rules for interrupted one-day cricket matches. Journal of Applied Statistics, Vol. 40, No. 11, pp. 2462-2479.
17. Silva, R. M., Manage, A. B. W. and Swartz, T. B. (2015) A study of the powerplay in one-day cricket, European Journal of Operational Research, Vol. 244, pp. 931-938.
18. Stern, S. (2009). An adjusted Duckworth-Lewis target in shortened limited overs cricket matches. Journal of the Operational Research Society, Vol. 60, No. 2, pp. 236-251.
19. Tromp, M., and Holmes, L. (2011). The effect of free-hit rule changes on match variables and patterns of play in international standard women's field hockey. International Journal of Performance Analysis in Sport, Vol.11, No. 2, 376-391.
20. Williams, J., Hughes, M., and O'Donoghue, P. (2005). The effect of rule changes on match and ball in play time in rugby union. International Journal of Performance Analysis in Sport, Vol. 5, No. 3, pp. 1-11.
21. Wright, M. (2014). OR analysis of sporting rules - A survey. European Journal of Operational Research, Vol. 232, pp. 1-8.

"PREDAH" ZA BACAČE: O ODBACIVANJU POWERPLAY OGRANIČENJA ZA UDARAČE U 50 OVERS KRIKETU

Izmjene u pravilima igre na međunarodnom nivou se vrše od strane upravljačkih tijela sporta u pitanju, imajući na umu konkretni cilj. Međunarodno vijeće za kriket (ICC) koje upravlja kriketom na međunarodnom nivou je, od svog uvođenja, izvršilo nekoliko promjena pravila powerplay ograničenja. U 2015. godini, powerplay ograničenja za udarače su povučena iz kriketa iz razloga što pružaju 'predah' bacačima. Ova studija nastoji analizirati da li su bacači sada u boljem položaju nakon povlačenja powerplay ograničenja za udarače. Na osnovu uobičajenih mjera za izvedbu bacanja puput economy rate, bowling strike rate, bowling average i combined bowling rate, ova studija nastoji otkriti da li su bacači u boljem položaju nakon povlačenja powerplay ograničenja za udarače u kriketu. Nalazi naše studije ukazuju da se položaj bacača nije bitno poboljšao povlačenjem powerplay ograničenja za udarače nego se sveukupno značajno pogoršao. S jedne strane, sa promjenom je igra postala nezanimljiva tokom middle overa, a sa druge, nije ništa doprinijela bacačima. Ovaj rad zaključuje da izmjene u pravilima igre bez odgovarajućeg planiranja i ispitivanja mogu dovesti do daljih promjena, bez postizanja krajnje svrhe izmjene.

Ključne riječi: Sportska analitika, mjerenje izvedbe u sportu, statistička grafika, sportski menadžment.

Received: December 01, 2018 / Accepted: December 15, 2018
Correspondence to: Dibyojyoti Bhattacharjee, Department of Statistics, Assam University
E-mail: djb.stat@gmail.com

THE IMPACT OF CULTURE ON OLYMPIC HERITAGE

Dino Mujkić[1] ,Jana Čarkadžić[2], Dejana Sadžak[3], Amna Tuzović[1], Dijana Rađo[1], Maya Djuric[4]

1. University of Sarajevo, Bosnia and Hercegovina
2. Sarajevo Meeting of Cultures
3. Olympic Committee of Bosnia and Herzegovina
4. Faculty of sport and Physical Education, University of Travnik

ABSTRACT

The sports and culture sectors play a significant role in generating better values for the society. Olympic Heritage belongs to cultural values, especially in countries where the Olympic Games took place. Over three decades ago, Bosnia and Herzegovina (BiH) was a leader in promoting Olympic values during the 1984 Winter Olympic Games. Through questionnaires addressed to the sports federations that are members of the Olympic Committee of Bosnia and Herzegovina (over 30 sports organizations), this paper was used to inspect the value and direction of the cultural dimension related to the Olympic Heritage in Bosnia and Herzegovina. Through the Likert scale consisting of 13 items which were used, important values and the potential development of cultural activities within the Olympic Movement were used and considered in order to provide recommendations for promoting the country's cultural values in the future. The significance of differences and examinations was determined using the chi-square test (x^2).

Considering the fact that there is little research on the topic, the authors approach the work by highlighting the elements of culture that are closely connected with the importance of preserving the Olympic Heritage, as well as promotion of culture through sport in Bosnia and Herzegovina. In the future, universities, together with the Olympic Committee and NGOs, could offer new cultural platforms emphasising the Olympic values by spreading awareness and educating the youth through sport and culture. The research results may also be applicable to the Sports Development Strategy of BiH.

Keywords: Olympic values, Olympic Heritage, cultural activities, cultural awareness, cultural impact .

INTRODUCTION

Within the new initiatives of the programmes and strategies of the European Union, 2018 has been declared the "European Year of Cultural Heritage[1]". The ideals, principles and values embedded in Europe's cultural heritage constitute a shared source of remembrance, understanding, identity, dialogue, cohesion and creativity for Europe. Cultural heritage plays a role in the European Union and the preamble to the Treaty on European Union (TEU) states that the signatories drew inspiration from the cultural, religious and humanist inheritance of Europe[2]. Sport and the organization of international sporting events is a supreme platform for the promotion of national cultural heritage. In the case of Bosnia and Herzegovina, sports international events are an excellent platform for the promotion of Olympic heritage considering that the city of Sarajevo was the organizer of the 1984 Winter Olympics. The organization of sporting events represents a platform for the promotion of the country and the city, its historical and cultural values.

Despite the fact that Bosnia and Herzegovina and the city of Sarajevo hosted the Olympic Games, a set of relevant skills and experiences has been lost and forgotten. However, this is not only the case in Bosnia and Herzegovina, but a matter that has already been explored in other cities across the world that have hosted the Olympics. Olympic Heritage belongs to large-scale effects, especially in countries where the Olympic Games took place.

1 DECISION (EU) 2017/864 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on a European Year of Cultural Heritage (2018), Official Journal of the European Union, 25.05.2017

2 http://europa.eu/cultural-heritage/ (10TH May 2018)

With that in mind, if there were no cultural awareness of this important matter, what would be the consequences of forgetting the importance of the Olympic values? Over three decades ago, Bosnia and Herzegovina took part in the Olympic spirit. Nonetheless, how and in what way did it continue to maintain and nurture the Heritage of the Olympic ideal after the post-war devastations and during the transitional period? This paper attempts to examine the impact of culture and the importance of preserving the Olympic Heritage by promoting the IOC's cultural plan in Bosnia and Herzegovina. Additionally, the aim of the paper is to examine the best possible ways of using sports resources in order to create an atmosphere for promoting the culture within the country. The sports and culture sectors play a significant role in generating benefits for the society. Most benefits, however, are quite difficult to measure and can therefore become neglected or entirely disregarded in discussions that concern the allocation of scarce resources. The characteristics of culture assume nurturing, cultivation and protection of important values it embraces (Fujiwara, Kudrna & Dolan, 2014).

The necessity for promoting new approaches and linking sport and culture is one of the reasons why the authors of this paper were determined to conduct this research. In communication with various organizations, but also through literary consultancy, we are able to obtain an overview of the situation, enabling us to clearly see the needs for development and action in practice. Awareness raising about the approach to the sociological spheres of culture and sports opens up space for new operations. The link between culture and sports also applies to joint action at mutual benefit. In his research on social and cultural impacts, Konstantaki (2009) states that the majority of respondents thought that the 2012 Olympic Games would provide a wide range of opportunities for cultural interaction and integration. Representative themes showed that respondents view the 2012 Olympics as an opportunity to extend their understanding of other cultures and celebrate cultural diversity while bringing people together and promoting cultural activity and especially youth culture.

METHODS

Through questionnaires addressed to the sports federations that are members of the Olympic Committee of Bosnia and Herzegovina (over 30 sports organizations), this paper was used to inspect the value and direction of the cultural dimension related to the Olympic Heritage in Bosnia and Herzegovina.

Through the Likert scale consisting of 13 items which were used, important values and the potential development of cultural activities within the Olympic Movement were used and considered in order to provide recommendations for promoting the country's cultural values in the future. The significance of differences and examinations was determined using the chi-square test (x^2). The correlation of questionnaires in this study was conducted by verifying the measures of the Spearman's rank correlation coefficient.

RESULTS

Through this research, management structure in sports organizations and the lack of good communication confirm that sports organizations, trade unions and clubs are not interested in participating in various forms of research. Less than 60% of the questionnaires used for this research are considered valid and complete in order to clearly interpret the results. 11 questionnaires were received and analysed, and 50% of them come from organizations that account for winter sports, based on which the findings reveal relevant results (Table 1).

Linking sports and culture is often neglected, although organizations state that the necessity is high. In over 63% of opinions, the surveyed club representatives believe that the need for organizing sports competitions is existent. It is noticed that there is not enough experience in organizing cultural activities, considering that 36% of organizations did not organize cultural events. The concepts that are increasingly used and connected with practice today speak of the need for a multidisciplinary approach and correlations between culture and sport that imply sports tourism and the Olympic heritage. 72% of the organizations share an opinion that there is a strong link between culture and sport. The responsibilities of the Culture and Olympic Heritage Commission are also to help facilitate synergies between the various cultural platforms, communities and bodies within the Olympic Movement: academies, museums, the NOC and OCOG culture sections, research centres and universities, and recognised organisations, with a view to achieving a better overall impact.

81% of the organizations consider that one of the prerequisites for acquiring candidature for international competitions is more likely to be successful if a demonstration of actual synergic work between the organizations of culture and sports exists. Olympic heritage and promotion of heritage are an important segment of work within sports organizations. In 81% of the organizations, there is a good climate for the development of sports tourism and an interest in organizing a vast number of international competitions.

Disappointedly, the research conducted demonstrates that in 90% of cases, organizations consider that public administrative bodies must be more involved in strengthening the international sports competitions. This act would greatly influence the rise of public interest that, for the time being, has a considerably low rate of 54%. The overall result which is the core of this research, concerned with the promotion of

Olympic identity by the city of Sarajevo, has an exceptionally low rate of 20%. However, the reason for this does not solely rest in the low rates of engagement by administrative bodies, but, likewise, the insufficient awareness about the richness of the Olympic values and the evident inconsistent collaborative links between sports and cultural organizations. Promotion of authentic national cultures has its own platform in sports. Authenticity has been widely discussed in tourist literature and, over the years, authors in the field of tourism have provided studies and definitions of authenticity, with authenticity being attached to artefacts, touristic activities and events. Many cultural events are, in effect, an adoption of past rituals and traditional forms created by destination managers in order to improve tourism development. However, to be successful, cultural events need to be authentic. (Mccartney & Osti, 2007).

Table 1: Participant demographics data [mean± standard deviation]

Research Summary	**Positive thinking**
Do you have opportunities to organize international sports competitions? (OIC)	63%
Have you ever organized cultural events while sporting events have taken place? (OSE)	36%
Do you think that the notions 'sports tourism' and 'the culture of Olympic heritage' are in high correlation? (STOH)	72%
Do you believe that culture plays a significant role in acquiring candidature of certain competitions? (IMPO)	81%
Do you believe that you promote Bosnia and Herzegovina through your competitions? (PROM)	81%
Do you think that the overall activities of your association are focused on the promotion of Olympic heritage? (PROH)	90%
Do you think that your city should be more involved in the promotion of sports tourism? (PROT)	90%
Do you believe that your association creates a good environment for sports tourism awareness raising? (AWST)	81%
Do you think that the public is interested in sporting events in general? (PUBE)	54%
Do you think that the city of Sarajevo amply utilizes the identity of Olympic heritage? (CITY)	20%
Do you think that your members (sportspersons) are adequately aware about the importance of Olympic heritage that we use? (WHE)	50%
Are you in constant contact with organizations that work in the field of cultural development? (COMU)	38%
Do you think that we cultivate Olympic heritage appropriately and are aware of its importance? (OHVAL)	45%

By analysing and using the chi-square test (Table 2.), the obtained results indicate that the most influential variables are the variables related to national promotion and involvement of the city structures in the organization and promotion of sports competitions. Today, sport represents the most important platform for the promotion of cities and countries, and, as such, they ought to be in close correlation in order to support both spheres, sport and the promotion of culture. Through the promotion of heritage and diverse cultures, we raise awareness of all participants about the necessity of getting to know others and those who are different in order to recognize and respect more, which ultimately leads to better intercultural dialogue as a precondition for peace in the world. One of the basic principles of the Olympic Charter (1908) is that the goal of Olympism is to place sport at the service of the harmonious development of man, with a view to promoting a peaceful society concerned with the preservation of human dignity. All of the attained results indicate that there is a necessity for the promotion of culture and specific heritage of one nation as a platform for intercultural dialogue and cultural exchange. In the textbook Rađo & Sadžak (2009), the phenomenon of diversity and the need to distinguish different cultures is explained. Furthermore, they explain the project Globe[3] and the notion of culture which is founded on the belief in the general sense - people's way of life.

3 Global Leadership & Organizational Behavior Effectiveness (1993), http://globeproject.com/ (25th May 2018)

Table 2

	OIC	OSE	STOH	IMPO	PROM	PROH	PROT	AWST	PUBE	CITY	AWHE	OHVAL	COMU
Chi-Square	4.545a	3.091b	4.909b	6.091c	4.455d	3.455a	7.364d	4.636c	3.455a	2.182b	3.182c	1.727c	3.091b
df	2	4	4	3	1	2	1	3	2	4	3	3	4
Asymp. Sig.	.103	.543	.297	.107	.035	.178	.007	.200	.178	.702	.364	.631	.543

Considering the fact that there is little research on the topic, the authors shall approach the work with a wider horizon of the overall situation, highlighting the elements of culture that are closely connected with the importance of preserving the Olympic Heritage, as well as promotion of culture through sport in Bosnia and Herzegovina. In the future, universities, together with the Olympic Committee and NGOs, could offer new cultural platforms emphasising the Olympic values by spreading awareness and educating the youth through sport and culture. The research results may also be applicable to the Sports Development Strategy of BiH.

CONCLUSION

"The challenge is to create the appropriate conditions in which event stakeholders can reach a consensus in formulating leveraging initiatives that embed sport and cultural Olympic legacies in the tourism development of the host city. Therefore, it is important to introduce leveraging programs for jointly harnessing a sport and cultural tourism legacy and enriching as well as diversifying a host city's post-Olympic tourism product." (Ziakas & Boukas, 2014)

This type of approach mirrors the work of the Olympic Heritage Commission[4] whose mission encompasses the following: "The Culture and Olympic Heritage Commission advises the IOC Session, the IOC Executive Board and the IOC President on all the activities of the Olympic Movement that are related to culture in the broadest sense of the term - art, history, focus on values, academic research and patrimonial collections – with a view to promoting the Olympic ideals as widely as possible, especially among young people all over the world."

The relationship between sport, heritage, and tourism is strong, and the breadth and depth of research that explores this relationship is significant (Ramshaw, 2014). Bearing in mind the current research and efforts to strongly link sport and culture with an aim to promote national heritage, the authors have confirmed the state and the need to promote national values, the values of the Olympic heritage of Bosnia and Herzegovina.

The potential for the promotion of cultural and Olympic values in Bosnia and Herzegovina is boundless. Regrettably, there are no clearly defined strategies nor awareness of the potential possibilities for linking sports and cultural heritage to the promotion of Bosnia and Herzegovina at a national level. With this approach, we open a new chapter that focuses on linking sport and culture as inseparable and closely connected values, as an assertion of promoting national values. The new approach presents sport as a platform for intercultural dialogue and promotion of different cultures.

4 https://www.olympic.org/culture-and-olympic-heritage-commission (19th March 2017)

REFERENCES

1. Camy J. & Robinson L. (2007).Managing Olympic Sport Organizations, Edited under the leadership of the International Olympic Committee, Olympic Solidarity.

2. Fujiwara D., Kudrna L. & Dolan P. (2014). "Quantifying the Social Impacts of Culture and Sport", (scientific paper) department for Culture, Media & Sport., UK.

3. European Commission (2017). DECISION (EU) 2017/864 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2017 on a European Year of Cultural Heritage (2018), Official Journal of the European Union, 25.05.2017, http://europa.eu/cultural-heritage/. 10th May 2018

4. Konstantaki, M. (2009). Social and cultural impact of the London 2012 Olympic Games: a lecturers' and students' perspective. In: International Tourism Conference 2008: 05-09 November 2008, Alanya, Turkey.

5. Mccartney, G. & Osti, L. (2007). From Cultural Events to Sport Events: A Case Study of Cultural Authenticity in the Dragon Boat Races, Journal of Sport Tourism, 12:1, 25-40.

6. Olympic Committee, https://www.olympic.org/culture-and-olympic-heritage-commission - 19th March 2017.

7. Olympic Charter. (1908). https://www.olympic.org/olympic-studies-centre/collections/official-publications/olympic-charters - 19th March 2017

8. Rađo, I. & Sadžak, M. (2009). Globalno liderstvo, Sarajevo, "Svjetlost" Fojnica,

9. Ramshaw, G. (2014). Sport, heritage, and tourism, Journal of Heritage Tourism, 9:3, 191-196.

10. Spaaii R. (2012). "The Social Impact of Sport: Cross-Cultural Perspectives (Sport in the Global Society - Contemporary Perspectives)", Routledge.

11. Ziakas, V. & Boukas, N. (2014). Post-Event Leverage and Olympic Legacy: A Strategic Framework for the development of Sport and Cultural Tourism in Post-Olympic Athens, Journal of Sport.

UTICAJ KULTURE NA OLIMPIJSKU BAŠTINU

Područja sporta i kulture imaju značajnu ulogu u stvaranju boljih vrijednosti u društvu. Olimpijska baština pripada kulturnim vrijednostima, posebno u zemljama gdje su se održavale olimpijske igre. Prije trideset godina, Bosna i Hercegovina (BiH) je bila nosioc promocije olimpijskih vrijednosti tokom Zimskih olimpijskih igara 1984. godine. Kroz upitnike upućene sportskim savezima koji su članovi Olimpijskog komiteta Bosne i Hercegovine (više od 30 sportskih organizacija), ovaj rad se bavi provjerom vrijednosti i smjerom kretanja kulturalne dimenzije olimpijske baštine u Bosni i Hercegovini. Likertovom skalom od 13 elemenata koji su se koristili, koristile su se i razmatrale važne vrijednosti i potencijalni razvoj kulturnih aktivnosti unutar olimpijskog pokreta kako bi se u budućnosti davale preporuke za promociju kulturnih vrijednosti zemlje. Značaj razlika i provjera utvrđen je pomoću chi-square testa (x2).

Imajući u vidu činjenicu da postoji veoma malo istraživanja na ovu temu, autori pristupaju radu ističući elemente kulture koji su usko povezani s važnosti očuvanja olimpijske baštine, kao i promociju kulture kroz sport u Bosni i Hercegovini. U budućnosti, univerziteti, zajedno s Olimpijskim komitetom i nevladinim organizacijama, mogu ponuditi nove kulturne platforme koje ističu olimpijske vrijednosti, širenjem svijesti i educiranjem mladih kroz sport i kulturu. Rezultati istraživanja također mogu biti primjenjivi na Strategiju razvoja sporta BiH.

Ključne riječi: Olimpijske vrijednosti, olimpijska baština, kulturne aktivnosti, kulturna svijest, utjecaj kulture.

Received: December 03, 2018 / Accepted: December 15, 2018
Correspondence to: Dr. Dino Mujkić, Sarajevo Meeting of Cultures, Sarajevo, Bosnia and Herzegovina
E-mail: dino.mujkic@smoc.ba

DIFFICULTIES FACED BY PHYSICAL EDUCATION STUDENTS IN PRACTICAL COURSES

Mo'een Ahmad Oudat[1], Majed Abu Eisha[2], Mohammad Khalaf Thiyabat[3]

1. The Hashemite University
2. The University of Jordan
3. Yarmouk University

ABSTRACT

This study aimed at identifying the difficulties that students attending the faculties of physical education face during practical courses at the University of Jordan and the Hashemite University. The researchers utilized the descriptive method, and the study sample consisted of (200) students who were registered in practical courses during the 2015/2016 academic year, at the rate of (0.50) of the total study population. The study sample was chosen by using a stratified random method. The researchers developed a special questionnaire about the difficulties that students attending the faculties of physical education face during practical courses - (32) items which consisted of four main domains (teaching method, curriculum, psychosocial factors, and safety factors). The validity of the instrument was verified by presenting it to arbitrators, whereas the reliability coefficient was calculated using Cronbach's alpha (0.92). The researchers calculated the means, standard deviations, percentages, conducted a t-test, and the One-Way Analysis of Variance (ANOVA) test to answer the study questions.

The results showed that the level of difficulties that students attending the faculties of physical education face during practical courses is moderate in all main domains in the following order: psychosocial factors, curriculum, safety factors and teaching method. The overall mean is 3.32, and percentage scores are 66.40. The results also indicated a presence of statistically significant differences in the teaching method and the field of safety factors on the gender variable. Statistically significant differences depending on the study year variable were found in curriculum and safety factors among first-year students and fourth-year students, and they were in favour of the fourth-year students. Additionally, differences were found between the first-year students and the third-year students, favouring the third-year students in the field of safety. The results also showed no statistically significant differences between the averages of all the difficulties that students attending the faculties of physical education face during practical courses, depending on the variables of appreciation and the university.

Keywords: Difficulties, physical education students, practical courses.

INTRODUCTION

Teaching in our times depends on many scientific and educational bases which aim at developing and preparing the students in all the physical, psychological, social and educational areas. Physical education is one of the humanities disciplines that works towards developing the students' physical, mental, psychological, social and educational experiences by learning the sports skills. Therefore, the instructors of the practical courses should be aware of all the factors that affect the teaching process in order to guarantee bringing it to success. The educational curricula and their different programmes are among the most important factors that help in achieving

peoples' hopes and ambitions. Physical education is a feature and a vital component of modern education. As such, it is quite necessary to keep pace with the rapid developments, in order to continue the building and progress track, using new methods and teaching styles (Al-Wedyan, 2012; Oudat, 2006).

Employing the scientific method to encounter the difficulties faced by the sportsmen working in the sports field is the pillar to develop their performance level in all the health, psychological, manner, social and intellectual trends and prepare them to be effective factors in the society and its development (Yassin, 2012).

Physical education is a complementary, integral and inseparable part of general education. It aims at developing the students' physical, intellectual, emotional and social aspects through the practice of multiple kinds of physical activities which should be selected according to well-studied scientific bases. Such activities are set to achieve the optimal growth of the human, in terms of all the aspects, in a manner assuring the formation of an integrated and yet balanced personality (Al-Wedyan, 2012; Yassin, 2012; and Hands & Larkin, 2006).

The importance of practical courses in the physical education plan lies in introducing the students with the importance of skills, their types, performance manner and teaching styles. All these are based on the major activities given to the students in the physical education colleges, which are among the compulsory and optional requirements of the major, specified for the obtainment of the BA degree in physical education (theoretical teaching and practical training) (Idrees, 2014). Difficulties faced by the students attending physical education colleges, throughout the study stages, are present in any physical or moral difficulty that may prevent the student to achieve his/her goals, and/or performance of the required assignments, which will be negatively reflected on the student's practical performance level or psychological state. The researchers, being university instructors specialised in physical education, through teaching the courses of this major, noticed a poor student performance, and sometimes their reluctance to enrol in the practical courses, especially the optional ones; a situation that made them feel the existence of a problem. Therefore, the researchers intended to conduct this study to identify the difficulties faced by students in certain practical courses as an attempt to propose some relevant solutions.

The importance of the study lies in finding the most prominent difficulties that the students attending physical education colleges face during practical courses. It also contributes to give a clear image to the teachers about these difficulties, in order to solve them, so that they do not negatively reflect on the students' psyche and abilities. The study further aimed at identifying the extent of the effect of each of the (gender, academic year, rating and university) variables on the difficulties faced by these students.

STUDY OBJECTIVES

The primary objectives of this study are to:
1- Identify the major difficulties that students attending the faculties of physical education face during practical courses, which are related to the teaching method, curriculum, psychosocial factors and safety factors.

2- Identify the differences in difficulties that students attending the faculties of physical education face during practical courses, which are related to the variables of gender, the study year, appreciation and university.

STUDY QUESTIONS

1- What are the major difficulties that students attending the faculties of physical education face during practical courses, which are related to the teaching method, curriculum, psychosocial factors and safety factors?
2- Are there significant differences at the level of significance $\alpha \leq 0.05$ in difficulties that students attending the faculties of physical education face during practical courses, which are related to the variables of gender, the study year, appreciation and university?

METHODOLOGY

Study Design

The researchers used a descriptive design, applying survey methodology due to its relevance to the nature of this study.

Study Population and Sample

The study population consisted of all the physical education students attending practical courses at the University of Jordan and the Hashemite University (N=400). The study sample was chosen by using a stratified random method, and the sample consisted of (200) participants (i.e. 50% of the total study population).

Study variables

Independent variables are: gender (male, female), the study year (the first, second, third, fourth), appreciation (excellent, very good, good, acceptable), university (the University of Jordan and the Hashemite University). The dependent variables are: the difficulties faced by students (teaching method, curriculum, psychosocial factors and safety factors).

Study Instrument

A special questionnaire was developed to identify the difficulties that students attending the faculties of physical education face during practical courses at the University of Jordan and the Hashemite University. The questionnaire included (32) items distributed over the following four domains: the teaching method, curriculum, psychosocial factors and safety factors. The questionnaire was administered after obtaining the participants' consent in advance. To determine the problem degree, the researchers used the Likert-type scale, which is one of the most famous types and most commonly used for developing the measurements and psychological tests. Several studies (e.g. Wedyan, 2012; Makhamreh, 2012; Saleh, 2012; & Khamis, 2007) were addressed. The questionnaire was distributed and collected in the period between 28/2/2016 - 20/4/2016 with the help of teachers of practical courses at the universities. The difficulties faced by students were reviewed in order to determine the following percentages related to the degree of difficulties:

80% and more: very high degree
70%-79.9%: high degree
60%-69.9%: medium degree
50%-59.9%: low degree
49.9% and less: very low degree

Psychometric Properties

The validity of the instrument was verified by presenting it to five teachers at Jordan universities, specialists in the methods of teaching physical education, who approved the validity of the study instrument items. The reliability coefficient was calculated using the Cronbach's alpha equation; the reliability coefficient value was (0.92).

Statistical Analyses

Data analyses were performed by using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics (i.e. means, standard deviations, and percentages), a t-test and One-Way ANOVA were used to answer the questions.

RESULTS AND DISCUSSION

First question: What are the difficulties that the students attending physical education colleges face during practical courses concerning the teaching method, curriculum, psychological and social problems and the security and safety factors? For answering this question, the means (M's), standard deviations (SD's) and relative significance were calculated for every area of the difficulties that the students attending physical education colleges face during practical courses. Tables (1, 2, 3, 4, and 5) illustrate them.

Table 1: Participant demographics data [mean± standard deviation]

No.	Item	M	SD	Sign.	Level
1	Poor physical abilities are a reason of the students' reluctance to enrol in practical courses	3.71	1.10	74.20	High
2	Insufficient incentives to join practical courses	3.67	1.30	73.40	High
3	Fear of injuries when using the equipment and devices	3.60	1.28	72.00	High
4	Skill difficulties are a reason of the students' reluctance to enrol in practical courses	3.45	1.14	69.00	Medium
5	Poor performance is a reason of the students' reluctance to enrol in practical courses	3.40	1.20	68.00	Medium
6	The use of the traditional method is a reason for feeling boredom during the lecture	3.38	1.25	67.60	Medium
7	Repeated failure generates a feeling of embarrassment	3.23	1.31	64.60	Medium
8	In mixed lectures, males hinder the females' effective performance	3.20	1.02	64.00	Medium
	Overall	3.46	0.73	69.20	Medium

The results in Table (1) indicate that the overall mean of the difficulties concerning the psychosocial factors was medium (3.46). Items reading "Poor physical abilities are a reason of the students' reluctance to enrol in practical courses", "Insufficient incentives to join practical courses" and "Fear of injuries when using the equipment and devices" were high. The researchers attribute this result to the generally noted poor physical fitness of the students and their fear of being injured due to the difficulty of the skill. They also ascribe it to the existence of sports equipment and devices that they never knew or had training on them. Shyness in females hinders them from properly performing in the mixed (males and females) sections. Finally, most of these courses are not a prerequisite for other courses. The researchers are in agreement with Oudat, 2016 and Ali, 2010, on the fact that the repeated failure in performance frustrates the students and makes them reluctant to enrol in practical courses.

Table 2: Means and standard deviations of the difficulties related to the curriculum domains

No.	Item	M	SD	Sign.	Level
1	The number of students in one lecture is high	3.70	1.30	74.00	High
2	Insufficient teaching aids	3.69	1.25	73.80	High
3	Insufficient educational references about the courses	3.45	1.29	69.00	Medium
4	Unclear students' performance standards	3.40	1.17	68.00	Medium
5	The curriculum did not take into account the individuals' differences	3.36	1.16	67.20	Medium
6	The curriculum does not match the allocated time	3.33	1.25	66.60	Medium
7	The curriculum overlooked the self-abilities challenge principle	3.24	1.26	64.80	Medium
8	Lack of gradation in skill presentation	2.81	1.19	56.20	Medium
	Overall	3.37	0.76	67.40	Medium

Table (2) illustrates that the overall mean of the curriculum-related difficulties was medium (3.37). On the other hand, items reading "The number of students in one lecture is high" and "Insufficient teaching aids" had high means (3.70, 3.69, respectively). The researchers are consistent with Al-Haliq et al., 2014 and Idrees, 2014, on the fact that the curriculum does not take into consideration the individual differences of the students and that it lacks standards for the students' performance evaluation. Moreover, the curriculum focuses more on the theoretical aspect than the practical one, especially with the increasing numbers of students in one classroom in addition to the lack of sufficient teaching aids.

All these factors lead to presenting the content in an inadequate way, and subsequently, decreasing the learning opportunities.

Table 3: Means and standard deviations of the difficulties related to the security and safety factors

No.	Item	M	SD	Sign.	Level
1	Inadequate areas devoted to teaching and application	3.76	1.31	75.20	High
2	Lack of a specialized paramedic in emergency cases	3.42	1.40	68.40	Medium
3	Uncertain validity of the devices and instruments before use	3.40	1.26	68.00	Medium
4	The grounds of the training halls are not suitable	3.37	1.42	67.40	Medium
5	Practical application halls are unsuitable	3.31	1.31	66.20	Medium
6	Devices and instruments are unsafe for practical application	3.24	1.33	64.80	Medium
7	Warming up is inadequate and improper	3.18	1.28	63.60	Medium
8	Non-compliance with appropriate sports dress	2.77	1.47	55.40	Medium
	Overall	3.31	0.83	66.20	Medium

The results in Table (3) indicate that the overall mean of the security and safety-related difficulties was medium (3.31). The item reading "Inadequate areas devoted for teaching and application" was the only one with a high mean (3.76). The researchers impute this result to the lack of comprehensive health aspects in the practical teaching halls. They are in agreement with Oudat and Al-Zboon, 2013, and Khamis, 2007, on the fact that the playgrounds and halls allocated for practical courses are not adequately equipped, so that they are proportional to the number of students.

In addition, many instruments are not sufficient as compared with the number of students, and most of the devices are not fit for use, due to poor storage and lack of periodical maintenance.

Table 4: Means and standard deviations of the difficulties related to the teaching method domains

No.	Item	M	SD	Sign.	Level
1	The teaching method does not observe individual differences among the students	3.67	1.14	73.40	High
2	Time allocated for application is insufficient	3.45	1.29	69.00	Medium
3	The teaching method does not match with the number of the students	3.40	1.19	68.00	Medium
4	The practical part and the theoretical explanation of the skill is unfairly distributed	3.21	1.26	66.20	Medium
5	Lack of teaching aids in skill teaching	3.09	1.30	61.80	Medium
6	The teaching method does not fit the skill	2.90	1.02	58.45	Medium
7	Student performance is not corrected during application	2.71	1.27	54.20	Medium
8	Lack of a practical model of the skill before application	2.60	1.30	52.00	Medium
	Overall	3.13	0.75	62.60	Medium

The results in Table (4) indicate that the overall mean of the teaching method-related difficulties was medium (3.13). Meanwhile, the item reading "The teaching method does not observe individual differences among the students" came with a high mean (3.67), and the item reading "Lack of a practical model of the skill before application" came last with a (2.60) mean. The researchers ascribe the result to the fact that the traditional method does not take into account the students' individual differences and needs, and does not fit the large number of students in one classroom.

Finally, there is insufficient time allocated (for skill explanation, providing the model, application and play). The researchers are consistent with Oudat, 2015, Saleh, 2012, Susan et al., 2011, and Abed Rabbo, 2006, on the fact that the traditional teaching methods lack the use of education technology, such as cinema, video, pictures and computers. It is well established that the use of technological means is vital in learning, as these means simulate the students' eagerness and abilities in using and dealing with the modern technology methods, which will positively reflect on the students' performance and learning.

Table 5: Means and standard deviations of the areas related to the difficulties that the students in physical education colleges face during practical courses, by descending order

No.	Difficulty	M	SD	Sign.	Level
1	Difficulties related to psychosocial factors	3.46	0.73	69.20	Medium
2	Method-related difficulties	3.37	0.76	67.40	Medium
3	Security and safety-related difficulties	3.31	0.83	66.20	Medium
4	Teaching method-related difficulties	3.13	0.75	62.60	Medium
	Overall	3.32	0.63	66.40	Medium

Table (5) shows that the level of difficulties that students attending physical education colleges face in practical courses was medium in all areas with (3.32) mean, (66.40%) relative significance, and a medium level.

The means ranged between 3.46 and 3.13, with the difficulties related to the psychosocial factors being first (3.46 mean and 62.60% relative significance), and teaching method-related difficulties being last (3.13 mean and 62.60% relative significance). The researchers ascribe this result to the volume of the psychosocial pressures the students suffer from, such as coordination between the practical and theoretical courses, exam pressures, and the short intervals between the practical and theoretical lectures. In addition, large distances between the buildings lead to students being late for lectures due to the need for changing clothes and taking a bath.

Finally, the use of a traditional teaching method leads to boredom and fits neither the sports skills nor the students themselves; and it does not accomplish the education purposes. The researchers are consistent with Al-Wedyan, 2012, on the fact that those adequate teaching methods should be chosen.
Second Question: Are there statistically significant differences at the significance level $\alpha \geq 0.05$ in the difficulties that the students attending physical education colleges face during practical courses, attributed to the gender, academic year, rating, or university variables? Tables (6, 7, 8, 9, 10, 11, and 12) illustrate that.

Table 6: T-test among the M's of the difficulties that students attending the faculties of physical education face in practical courses by the gender variable

Difficulties	Gender	No.	M	SD	T	Sign.
Difficulties related to psychosocial factors	Male	109	3.47	0.76	0.38	0.700
	Female	91	3.45	0.70		
Curriculum-related difficulties	Male	109	3.39	0.76	1.40	0.162
	Female	91	3.34	0.74		
Difficulties related to safety factors	Male	109	3.37	0.79	2.42	0.016
	Female	91	3.24	0.87		
Teaching method-related difficulties	Male	109	3.29	0.76	2.81	0.005
	Female	91	2.97	0.71		
Overall	Male	109	3.38	0.63	1.93	0.054
	Female	91	3.25	0.63		

Table (6) results indicate that there are no statistically significant differences in the psychosocial and method areas, according to the gender variable. Additionally, the curriculum focuses on teaching the basic skills for both genders, and the use of the basic teaching principles that provide suitable teaching opportunities, which contribute in encouraging the students to learn. The results further show that there are statistically significant differences in the two areas of security and safety factors on the one hand, and the teaching method on the other, according to the gender variable, which was in favour of the males. This result is consistent with the results of Yassin, 2012, on the fact that some teachers employ traditional ways that do not fit some students of both genders, especially the females, such as participation in displaying a model, and application time.

Furthermore, the fear degree with females is higher than that of the males, such as fear of injuries and shyness during the application in front of others.

Table 7: M's and SD's of the difficulties that students attending the faculties of physical education face in practical courses by the year variable

Difficulties	Study year	No.	M	SD
Difficulties related to psychosocial factors	First	47	3.47	0.77
	Second	55	3.52	0.72
	Third	45	3.44	0.72
	Fourth	53	3.40	0.69
Curriculum-related difficulties	First	47	3.17	0.71
	Second	55	3.42	0.70
	Third	45	3.40	0.86
	Fourth	53	3.50	0.72
Difficulties related to safety factors	First	47	3.12	0.95
	Second	55	3.35	0.68
	Third	45	3.39	0.87
	Fourth	53	3.37	0.78
Teaching method-related difficulties	First	47	2.95	0.65
	Second	55	3.17	0.76
	Third	45	3.15	0.81
	Fourth	53	3.24	0.76
Overall	First	47	3.18	0.66
	Second	55	3.37	0.57
	Third	45	3.35	0.65
	Fourth	53	3.38	0.63

Table (7) shows the means and standard deviations of the difficulties that the students attending physical education colleges face in practical courses according to the study year variable.

Revision of the means shows that there are (apparent) differences between them. To further determine the importance and statistical significance, the ANOVA method was employed. Table (8) illustrates this.

Table 8: The results of One-Way ANOVA on the differences in the difficulties that students attending the faculties of physical education face during practical courses by the study year variable

Difficulties	Source of Variance	Total Squares	Freedom Degree	Squares Mean	F	Sign.
Difficulties related to psychosocial factors	Inter-Groups	1.89	3	0.63	1.20	0.311
	Intra-Groups	102.84	196	0.52		
	Overall	104.73	199			
Curriculum-related difficulties	Inter-Groups	5.14	3	1.71	3.09	0.028
	Intra-Groups	108.64	196	0.55		
	Overall	113.78	199			
Difficulties related to safety factors	Inter-Groups	6.46	3	2.15	3.20	0.025
	Intra-Groups	132.03	196	0.67		
	Overall	138.49	199			
Teaching method-related difficulties	Inter-Groups	2.27	3	0.76	1.34	0.262
	Intra-Groups	110.27	196	0.56		
	Overall	112.53	199			
Overall	Inter-Groups	3.52	3	1.17	3.03	0.031
	Intra-Groups	76.00	196	0.39		
	Overall	79.52	199			

Table (8) indicates that there are statistically significant differences, at ($\alpha \geq 0.05$) level, between the means of the difficulties that the students attending physical education colleges face during practical courses, according to the study year variable. The overall F computed value amounted to (3.03), with a (0.031) significance level.

On the other hand, F computed value was statistically significant in both the method and the security and safety areas. Meanwhile, F computed value was not statistically significant in both the psychosocial and the teaching method areas. To determine the sources of differences, a Scheffe's Test for post-comparisons was employed. Table (9) illustrates this.

Table 9: Scheffe's t-test for post-comparisons to determine the source of differences in the domains of the difficulties that students attending the faculties of physical education face during practical courses

Domain	M	Year	Second	Third	Fourth
Teaching method-related difficulties	3.17	First			*
	3.42	Second			
	3.40	Third			
	3.50	Fourth			
Difficulties related to safety factors	3.12	First		*	*
	3.35	Second			
	3.39	Third			
	3.37	Fourth			
Overall	3.18	First			*
	3.37	Second			
	3.35	Third			
	3.38	Fourth			

The results of Table (9) indicate the existence of statistically significant differences at the ($\alpha \geq 0.05$) level, in the areas of the curriculum and the security and safety-related factors, as well as the overall difficulties among the first and fourth academic years, in favour of the fourth-year students. On the other hand, there are statistically significant differences in the area of security and safety-related factors among the first and third-year students, which are in favour of the latter.
The researchers attribute the result to the fact that the first-year students cannot easily cope with practical courses. They also ascribe it to the fear of failure and lack of experience in practical courses, because most of the courses they take are general, and of the compulsory and optional requirements of the university.

Table 10: M's and SD's of the difficulties that students attending the faculties of physical education face in practical courses by ranking

Difficulties	Ranking	No.	M	SD
Difficulties related to psychosocial factors	Excellent	33	3.32	0.84
	Very Good	79	3.67	0.62
	Good	75	3.69	0.76
	Acceptable	13	3.17	0.65
Curriculum-related difficulties	Excellent	33	3.39	0.87
	Very Good	79	3.44	0.84
	Good	75	3.48	0.82
	Acceptable	13	2.94	0.76
Difficulties related to safety factors	Excellent	33	2.92	0.77
	Very Good	79	3.38	0.75
	Good	75	3.19	0.74
	Acceptable	13	3.02	0.81
Teaching method-related difficulties	Excellent	33	3.29	0.83
	Very Good	79	3.41	0.77
	Good	75	3.45	0.74
	Acceptable	13	3.34	0.60
Overall	Excellent	33	3.23	0.70
	Very Good	79	3.48	0.61
	Good	75	3.45	0.64
	Acceptable	13	3.12	0.55

Table (10) shows the M's and SD's in the difficulties that the students attending physical education colleges face in practical courses according to the rating variable (excellent, very good, good or acceptable).

To identify the differences between these means and their statistical significance, the uni-variance analysis, and Table (11) were used as an explanation.

Table 11: Results of the ANOVA for the differences in the areas of difficulties that the students attending physical education colleges face in practical courses according to the rating variable

Difficulties	Source of Variance	Total Squares	Freedom Degree	Squares Mean	F	Sign.
Difficulties related to psychosocial factors	Inter-Groups	3.85	4	0.96	1.86	0.118
	Intra-Groups	100.87	195	0.52		
	Overall	104.73	199			
Curriculum-related difficulties	Inter-Groups	2.98	4	0.75	1.07	0.371
	Intra-Groups	135.51	195	0.69		
	Overall	138.49	199			
Difficulties related to safety factors	Inter-Groups	1.95	4	0.49	0.86	0.488
	Intra-Groups	110.58	195	0.57		
	Overall	112.53	199			
Teaching method-related difficulties	Inter-Groups	1.13	4	0.28	0.49	0.742
	Intra-Groups	112.64	195	0.58		
	Overall	113.78	199			
Overall	Inter-Groups	1.17	4	0.29	0.73	0.576
	Intra-Groups	78.35	195	0.40		
	Overall	79.52	199			

Table (11) shows no statistically significant difference at the ($\alpha \geq 0.05$) level, among the means of all the difficulties that the students attending physical education colleges face during practical courses, according to the rating variable. The total F computed value was (0.73), with a (0.576) significance level; and the difficulties concerning the psychosocial factors area had the highest value, as its total F computed value was (1.86), and a (0.118) significance level. On the other hand, the lowest value was found in the difficulties concerning the method, where F computed value was (0.49), and the significance level was (0.742). The researchers ascribe the result to the fact that the psychological factors have a significant impact on alleviating the difficulties faced by the students, regardless of their general rating.

Table 12: Results among the M's of the difficulties that students attending the faculties of physical education face in practical courses by the university variable

Difficulties	University	No.	M	SD	T	Sign.
Difficulties related to psychosocial factors	University of Jordan	98	3.19	0.76	1.08	0.280
	Hashemite University	102	3.07	0.74		
Curriculum-related difficulties	University of Jordan	98	3.55	0.71	1.03	0.304
	Hashemite University	102	3.37	0.74		
Difficulties related to safety factors	University of Jordan	98	3.44	0.80	0.19	0.846
	Hashemite University	102	3.30	0.72		
Teaching method-related difficulties	University of Jordan	98	3.32	0.84	0.15	0.877
	Hashemite University	102	3.31	0.83		
Overall	University of Jordan	98	3.38	0.65	0.03	0.974
	Hashemite University	102	3.26	0.62		

Table (12) shows no statistically significant difference at the ($\alpha \leq 0.05$) level, among the means of all the difficulties that the students attending physical education colleges face during practical courses, according to the university variable. In this concern, total T computed value amounted to (0.03) and a (0.974) significance; meanwhile, the highest value was in favour of the teaching method-related difficulties, with (1.08) T computed value and a (0.280) significance level. On the other hand, the lowest value of the difficulties was for those concerning the security and safety factors, with (0.15) T computed value, and a (0.877) significance level. The researchers attribute the result to the fact that the applied teaching method is the basis of learning, and has a great role in overcoming the challenges and difficulties that are encountered during the students' learning process.

CONCLUSIONS

1. The level of difficulties faced by the students during practical courses in the areas of the teaching method, curriculum, psychosocial factors, and security and safety factors was medium.
2. There are statistically significant differences in the areas of security and safety factors, and the teaching method, according to the gender variable.
3. There are no statistically significant differences in the areas of the curriculum and psychosocial factors, according to the gender variable.
4. There are statistically significant differences in the areas of the curriculum, and security and safety factors between the students attending the first and fourth academic years, in favour of the fourth-academic-year students, according to the academic year variable.
5. There are statistically significant differences in the area of the security and safety factors between the students attending the first and third academic years, in favour of the third-academic-year students, according to the academic year variable.
6. There are no statistically significant differences among the means of all the difficulties that the students attending physical education colleges face during practical courses, according to both the rating and university variables.

RECOMMENDATIONS

1. Physical education teachers should employ different teaching styles that meet the students' needs.
2. There is a necessity for using mechanisms and strategies that reduce the intensity of the difficulties faced by students at the university level.
3. The physical education curriculum should be modified to match the available capabilities, and face the problems hindering the implementation.
4. Holding continuous meetings among the faculty members of the physical education colleges and those working in the physical education field, to examine the results of the research and studies in this concern.

LIMITATIONS

The study has several limitations. First, bias existed due to the way the researchers chose the study sample, which was by using the stratified random method. Second, the results are generalisable only to the target population and to the same setting (i.e. physical education students at the University of Jordan and the Hashemite University). Finally, the results of the study were based on the perspective of the participants themselves.

REFERENCES

1. Abed Rabbo, A. (2006). The Effect of The Using of Multi-Media on Perform Some Gymnastics Skills For Preparatory School Students, Unpublished PhD Dissertation, Faculty of Physical Education, Alexandria.

2. Al -haliq, M. A., Oudat, M. A., & Abu Al-Taieb, M. (2014). The Effect of Using Video on Developing Physical Fitness of Physical Education Students at the Hashemite University, Asian Social Science, Canada, 10(1): 21-27.

3. Ali, A. S. (2010). The Impact of A Proposed Program to Perform Some Basketball Skills Level For People With Learning Difficulties Category (Dyspraxia), Unpublished Master Thesis, University of Helwan, Cairo.

4. Al-Wedyan, M. A. (2012). Difficulties that Faced Students in the Faculties of Physical Education in Yarmouk University in Courses for swimming, Unpublished Master Thesis, Yarmouk University, Jordan.

5. Hands, B. & Larkin, D. (2006). Physical fitness differences in children with and without motor learning difficulties, European Journal of Special Needs Education, 21(4): 447-456.

6. Idrees, H. M. R. (2014). The Obstacles Facing the Students of Physical Education of Al Quds University in Gymnastics Course (1,2) According to their Point of View, Dirasat: Educational sciences,41(2): 660-676.

7. Khamis, I. F. (2007). The Effectiveness of an Educational Program to Meet The Learning Difficulties Faced By Students While Teaching Basketball Skills, Unpublished PhD Dissertation, University of Helwan, Cairo.

8. Makhamreh, K. (2012). The Main Obstacles of Teaching Physical Education in Schools and Educational Directorate Hebron from the Teachers' Point. Journal of Al-Azhar University: Series of Humanities Sciences, 14 (1): 103-128.

9. Oudat, M. A. (2016). Challenges Facing Physical Education Teachers in the Jordanian Public Schools from Perspective of the Teachers Themselves, Advances in Physical Education, USA, 6(2): 43-51.

10. Oudat, M. A. (2015).The Effect of Using Visual Aids on Teaching Volleyball Skills to Physical Education Students. International journal of education research, USA, 10(2): 22-30.

11. Oudat, M. A. (2006). Effective Physical Educator's Use of Remedial Teaching Style to Those Motor Learning Disabilities in Physical Education Lesson. Unpublished PhD Dissertation, Helwan University, Cairo.

12. Oudat, M. & Al Zboon, M. (2013). The Effectiveness of Using the Instruction and Building Style and the Performance Level of some physical and Skill Variables for Hashemite University Students, Al Manara for Research and Studies, 19(3): 287-311.

13. Saleh, A. (2012). The Effectiveness Of A Proposal Program To Improve The Physical Capabilities To Smash Skill In Al Salam Club in The Gaza Strip, Al-Najah National University Journal, 26(3): 687 - 730.

14. Susan, O.; Melissa, L.; Brendan, L.; & Brian, B. (2011). Effects of Teaching Methods on Swimming Skill Acquisition in Children with Developmental Coordination Disorder, International Journal of Aquatic Research and Education, 5(1): 432-448.

15. Yassin, I. (2012). Difficulties That Faced Students in the Faculties of Physical Education and Sport in the Practical Aspects of Gymnastics Courses at the Islamic University, Unpublished Master Thesis, Islamic University of Gaza.

POTEŠKOĆE SA KOJIMA SE STUDENTI FIZIČKOG OBRAZOVANJA SUSREĆU TOKOM PRAKTIČNE NASTAVE

Ova studija je imala za cilj identifikovati poteškoće sa kojima se studenti koji pohađaju fakultete fizičkog obrazovanja susreću tokom praktične nastave na Univerzitetu u Jordanu i Univerzitetu Hashemite. Istraživači su koristili deskriptivnu metodu, a uzorak studije se sastojao od (200) studenata koji su bili prijavljeni za pohađanje praktične nastave tokom 2015./2016. akademske godine, uz stopu od (0,50) ukupne proučavane populacije. Uzorak studije je odabran koristeći metodu stratificiranog uzorkovanja. Istraživači su kreirali posebni upitnik o poteškoćama sa kojima se studenti koji pohađaju fakultete fizičkog obrazovanja susreću tokom praktične nastave - (32) stavke koje su obuhvatale četiri glavne oblasti (nastavna metoda, nastavni plan i program, psihosocijalni faktori i sigurnosni faktori). Ispravnost instrumenta je provjerena predstavljajući ga arbitrima, dok je koeficijent pouzdanosti izračunat koristeći Cronbach's alpha (0.92). Istraživači su izračunali srednje vrijednosti, standardne devijacije, postotke, proveli t-test i test Jednostruke analize varijanse (ANOVA) kako bi odgovorili na pitanja u studiji.

Rezultati su pokazali da je nivo poteškoća sa kojima se studenti koji pohađaju fakultete fizičkog obrazovanja susreću tokom praktičnih časova umjeren u svim oblastima, a prema sljedećem redoslijedu: psihosocijalni faktori, nastavni plan i program, sigurnosni faktori i nastavna metoda. Ukupna srednja vrijednost je 3,32, a postotak je 66,40. Rezultati su također ukazali na prisustvo statistički značajnih razlika u nastavnoj metodi i na području sigurnosnih faktora po pitanju varijable pola.

Statistički značajne razlike u zavisnosti od varijable koja se odnosi na studijsku godinu su pronađene u nastavnom planu i programu, kao i u sigurnosnim faktorima između studenata prve i studenata četvrte godine, a koje su išle u korist studenata četvrte godine. Nadalje, razlike su pronađene između studenata prve i studenata treće godine, a iste su išle u korist studenata treće godine kada je u pitanju područje sigurnosti.
Rezultati su također pokazali izostanak statistički značajnih razlika između prosjeka svih poteškoća sa kojima su se studenti koji pohađaju fakultete fizičkog obrazovanja susretali tokom praktične nastave, u zavisnosti od varijabli uvažavanja i univerziteta.

Ključne riječi: Poteškoće, studenti fizičkog obrazovanja, praktična nastava.

Received: November 22, 2017 / Accepted: December 27, 2018
Correspondence to: Mo'een. A. Oudat, Faculty of Physical Education and Sport Sciences, The Hashemite University, Jordan
E-mail: dr.moeenodat@gmail.com

THE INFLUENCE OF SPECIALLY DIRECTED EXERCISES ON THE FUNCTIONAL STATE OF THE TACTILE ANALYSER AND PHYSICAL FITNESS OF 7-15 YEAR OLD PUPILS

Alexandr Aghyppo[1],Irina Kuzmenko[1], Irina Masliak[1], Ludmula Shesterova[1], Tetiana Bala[1], Natalia Krivoruchko[1], Tatyana Dorofeeva[2]

1. Kharkov State Academy of Physical Culture, Ukraine
2. Kharkiv G. Skovoroda National Pedagogical University, Ukraine

ABSTRACT

Purpose: to determine the level of influence of specially directed exercises on the functional state of the tactile analyser and the level of physical fitness in 7-15 year old pupils. Material: research was conducted on the basis of comprehensive schools of Kharkov. More than 800 pupils, of whom 6 experimental and 6 control groups were made, took part in it. Results: the pupils' level of motive preparedness is determined; the functional state of the tactile analyser is investigated; differences of the studied indicators in age and sexual aspects are considered; interrelation between parameters of the functional state of the tactile sensory system and the pupils' motive abilities development level is defined; the extent of influence of specially directed exercises on the functional state of the tactile analyser and motive preparedness of the investigated subjects is revealed. Conclusions: 1. The analysis of initial research allowed to establish that the pupils' tactile sensitivity indicators of the middle of the palm and the 3rd phalanx are lower than the norm, and the results related to the back surface of the hand and the forearm are a little higher than the norm. 2. The correlation analysis showed the existence of a rather close interrelation between the tactile analyser and the development level of physical qualities. 3. The use of specially selected exercises positively influenced the functioning of the tactile analyser and, indirectly, affected the examinees' development of physical qualities.

Keywords: Physical education, school-age children, tactile analyser, motive qualities, special exercises.

INTRODUCTION

One of the most acute social issues is the health of the younger generation. The tendency to number reduction of the physically healthy youth is observed worldwide in recent years (Haskell, Lee, Pate, et al., 2007; Krivoruchko, et al., 2013; Maslyak, Mameshina, Zhuk, 2014; Bala, 2015; Aghyppo, Tkachov, Orlenko, 2016; Kuzmenko, 2017).

One of the main reasons for the negative dynamics of indicators related to the health status of the younger generation in Ukraine is sedentary lifestyle (Mameshina, 2016; Masliak, Bala, Krivoruchko, et al., 2018). Experts in the field of physical education and sport offer various solutions for the problem that has arisen (Filenko, Filenko, Martirosyan, 2013; Bala, 2012; Maslyak & Kryvoruchko, 2016). Special significance in physical education and sport belongs to sensory systems (visual, acoustic, vestibular, tactile) without whose involvement execution of any physical action is impossible (Aghyppo & Kuzmenko, 2015; Maslyak, Shesterova, et al., 2016; Podrigalo, Iermakov, Potop, et al., 2017; Pomeshchikova, 2010; Magomedova & Shesterova, 2013). A number of authors mark a special role of the tactile analyser in forming an integral

perception of the world around the person. In the case of loss of sight and hearing, the person can "hear" and "read" by means of the tactile analyser through the use of training and different technical devices, that is, work and be useful to the society. The tactile analyser plays a special role in the perception of movements, as execution of movements is accompanied by stretching skin and putting pressure upon its separate sections. Great demands in the case of executing physical actions, difficult on coordination, are imposed to the tactile sensory system; it gives information on the amplitude of movements and contact of the body with apparatuses and equipment (Smirnov & Budylina, 2003; Solodkov & Sologub, 2005).

An insignificant number of works is devoted to studying the question of the influence related to special exercises on the functional state of the tactile analyser and, indirectly, on the manifestation of some motive qualities at different contingents. So, Vasylenko & Mitova, 2011, claim about defining the influence of the tactile sensory system on the basketball players' technical training at the stage of specialized basic preparation.

It is established that the special exercises, which are aimed at the development of the tactile analyser, promote an increase in motive abilities of blind children (Mihaylik, 2001). Maslyak, 2006, 2008, 2015, found out that, as a result of carrying out his research, improving the indices of tactile sensitivity and, as a result, of motive preparedness of pupils attending elementary grades is under the influence of specially directed exercises.

Kuzmenko, 2011, defined a positive influence of specially directed exercises on the tactile analyser and the development level of coordination abilities in 10-14 year old children. However, the question of the influence of the tactile analyser activity on motive preparedness of school-age children remains relevant and requires further research.

The purpose of the research is to define the level of influence of specially directed exercises on the functional state of the tactile analyser and the development level pertaining to physical qualities in 7-15 year old pupils.

MATERIALS AND METHODS

Research was conducted on the basis of general education institutions of Kharkov. More than 800 pupils, of whom experimental and control groups were made, took part in the research: the I age group – 7-year-old pupils, the II age group – 8-year-old pupils, III age group – 9-year-old pupils (pupils of elementary grades), IV age group– 10-11 year old pupils, V age group – 12-13 year old pupils, VI age group – 14-15 year old pupils (middle-school pupils). All the children, who participated in the research, belonged to main and preparatory medical groups, and were under observation of the school doctor. During the academic year, the contents of physical education classes for pupils belonging to experimental groups were complemented with specially selected physical exercises, which are directed to activate the tactile analyser: finger movements of one or both hands at the same time, exercises using the principle of finger-to-thumb opposition, fingers of one hand to fingers of the other, exercises with the use of palm contact of hands, definition of forms and sizes of various sports objects, and also their distinction of the surface character (rubber, wood, plastic, iron, leather, etc.) without visual control.

Special exercises were included in the preparatory, main and final parts of lessons; sports minutes were practiced during lessons of general education subjects, and, in the system of organized changes, exercises were also given in the form of homework. Besides, the main and final parts of lessons were complemented with the modified outdoor games, which joined the above listed exercises. Research methods: analysis of scientific and methodical literature, pedagogical testing, aesthesiometry method, stating and forming a pedagogical experiment, methods of statistical analysis. The analysis of scientific and methodical literature was carried out with the purpose of stating the studied question. Experts' opinions on the significance of the tactile analyser in physical education and sport were considered.

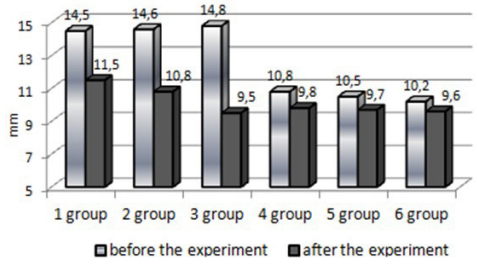
Pedagogical testing assumed the use of motive tests for determining the development level of the main physical qualities. So, the extent of speed development was determined by performance indicators of a 30 m run for 7-9 year old pupils and 60 m for 10-15 year old pupils (s); the coordination of movement (dexterity) for performance indicators was determined by a 4x9 m (s) shuttle run; flexibility was determined with the trunk bending forward from a sitting position (cm); the force by a bending extension of arms in a lying position (number of times) and torso lifting from a back-lying position (number of times); the endurance by a 500 m run for 7-9 year old pupils and 1000 m for 10-15 year old pupils (min., s). The aesthesiometry method, which assumed the definitions of tactile sensitivity by means of the Weber's compass on various skin sites, was used for researching the level of functioning related to the tactile sensory system: middle of the palm, the 3rd phalanx, the back surface of a hand and forearm.

Statistical analysis: research materials were processed with the use of the Excel programme. We calculated: the arithmetic average ( ) – for the characteristics of the set in separate parameters; standard error of the average (m) – for the definition of the arithmetic average deviation from the corresponding parameters of general totality; reliability of distinctions (p) – was calculated with the purpose to establish the extent of changes in average sizes of the studied signs after the experiment conducted by means of the student's parametrical criterion (t) at the significance level not lower than 0.05; correlation analysis (r) - was used to define the extent of communication between the studied signs.

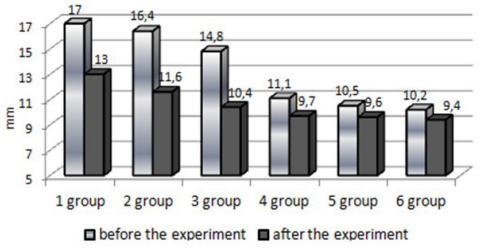
Research results

Data from the initial research on separate parameters of the functional state of the tactile analyser allowed to establish the lack of reliable differences in indicators of experimental and control groups' pupils ($p>0.05$). By analysing the received results in the age aspect, it is established that tactile sensitivity in pupils tends to improve with age for all indicators. However, these distinctions do not generally have a reliable character ($p>0.05$). The insignificant prevalence of results for boys over the data for girls is revealed when it comes to the sexual aspect, except for the 3rd phalanx sensitivity results where the data on girls generally prevails over those for boys. However, these distinctions are unreliable in most cases ($p>0.05$).

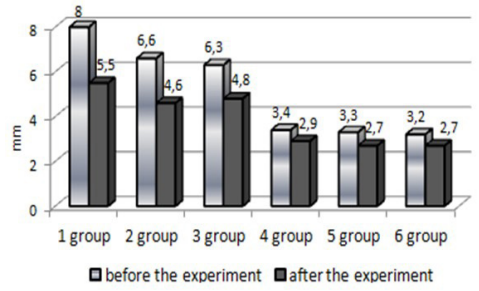
A comparison of the received results with the norms, which are presented by Smirnov & Budylina, 2003, showed that tactile sensitivity according to the measurements of the middle of the palm and the 3rd phalanx is lower than the norm, while in accordance with the results related to the measurement of the back surface of the hand and the forearm, it is a little higher than the norm. In our opinion, it is illustrated that the presented norms aren't graduated on the age sign. By analysing the received results after the experiment, presented in Fig. 1, it should be noted that the improvement has a reliable character in all age groups according to the measurements of the 3rd phalanx and the middle of the palm ($p<0.05–0.001$).



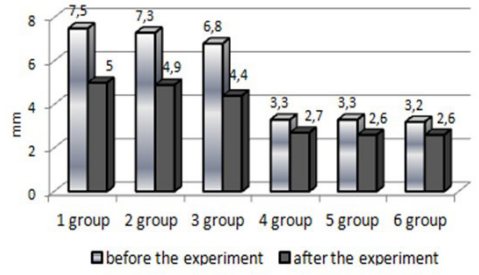
a)



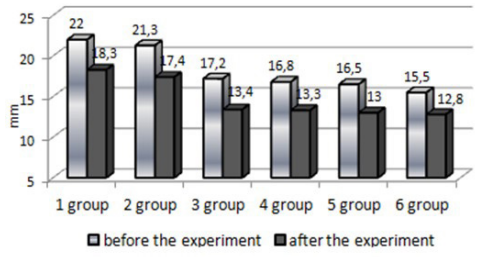
b)



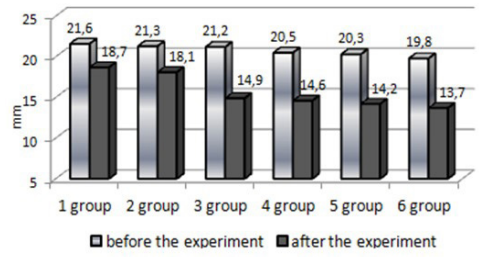
c)



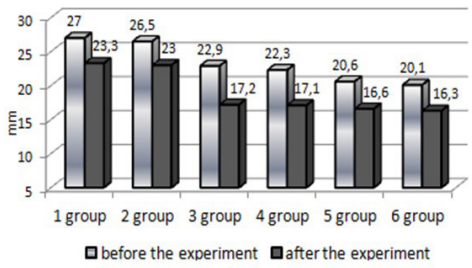
d)



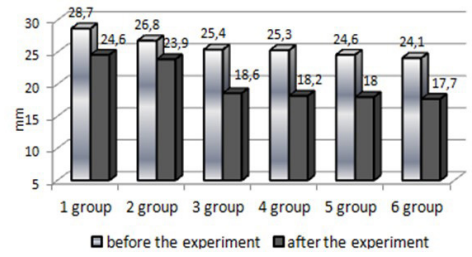
e)



f)



g)



h)

Figure 1: Tactile sensitivity indicators for pupils belonging to the I - VI experimental groups before and after the experiment: a) the boys' middle of the palm; b) the girls' middle of the palm; c) boys' 3rd phalanx; d) girls' 3rd phalanx; e) the boys' back surface of the hand; f) the girls' back surface of the hand; g) boys' forearms; h) girls' forearms.

Changes are reliable in pupils of the III group ($p<0.05$, 0.001) and in boys of the II age group according to the results of measurements for the back surface of the hand ($p<0.05$), while the indicators of the forearm authentically improved only in pupils of the III age group ($p<0.05$).
The gain of results on data related to measuring the sensitivity of the 3rd phalanx in boys belonging to the I age group was 31.2%, in boys of the II group, it was 30.3%, the III group had a gain of results amounting to 23.8%, the IV had a 17.2% gain, the V had a 15.1%, and the VI had a 13.3% gain, while for girls it was 33.3%; 32.8%, 35.2%, 18%, 13.7% and 16.3%, respectively.

The gain related to the results of measuring the sensitivity of the middle of the palm in boys belonging the I group was 20.6%, the II group had a 26%, the III group 35.8%, the IV had 9.3%, the V 6.8%, and the VI had a gain of 3.9%, while the girls had 23.5%, 29.2%, 31.1%, 11.8%, 7.1% and 7.9%, respectively. When it comes to indicators of measuring the sensitivity of the back surface of the hand in boys, the gain was 16.8%, 18.3%, 22%, 15.3%, 13.7% and 14.2%, respectively, while the girls had 13.4%, 15%, 29.7%, 16.2%, 14.6% and 12.9%. According to the measurement of forearm sensitivity in boys, the gain of results was 13.7%, 13.2%, 24.8%, 15.1%, 14.6% and 13.2%, while the girls had 14.2%; 10.8%, 26.7%, 14.6%, 13.8% and 12.5%. The most considerable improvement of results for all indicators of tactile sensitivity is generally noted in pupils of the III age group. During the experiment, indicators of pupils from the control groups are also a little improved, however, these changes are not essential, and they are unreliable ($p>0.05$).

The analysis of differences in age and sexual aspects did not reveal essential differences in comparison with the basic data. Comparing the studied indicators to the relevant standards, it should be noted that a positive tendency for the improvement of tactile sensitivity for pupils belonging to experimental groups was not significantly reflected in a rating scale. Thus, the use of specially directed exercises positively affected the pupils' tactile sensitivity of various parts of the body. It was especially clear for 9-year-old pupils. The most significantly improved tactile sensitivity was for the 3rd phalanx and the middle of the palm.

We carried out the correlation analysis for the purpose of defining the degree of interrelation between indicators related to the state of the tactile analyser and the development level of physical qualities for 7-15 year old pupils. The obtained data confirm the existence of interrelation between the tactile analyser functional state parameters and the pupils' motive abilities development level which is generally reflected as "weak" and "average" in the degree size of interrelation (the correlation coefficient varied ranging from 0.21 to 0.88 at $p<0.05$-0.01).

So, the correlation coefficient varied, ranging from 0.21 to 0.62 at $p<0.05$-0.01 between indicators of the tactile analyser and the level of speed development; for dexterity, it varied from 0.21 to 0.69 at $p<0.05$-0.01; for endurance, it varied from 0.20 to 0.51 at $p<0.05$-0.01; for force, it varied from 0.20 to 0.52 at $p<0.05$-0.01; for flexibility, it varied from 0.20 to 0.88 at $p<0.05$-0.01.

The most significant interrelation is noted between parameters of tactile sensitivity and the development level of flexibility and dexterity. The tendency of interrelation also remained at the repeated experiment level, and in certain cases, an even increase in the degree of dependence is noted. An essential increase in interrelation is noted between parameters of the tactile sensory system and the development levels of speed, dexterity and flexibility. It was revealed that interference of the studied parameters depends on age and in some cases on gender. Thus, the revealed interrelation, as a result of the correlation analysis between the studied parameters, confirms the existence of a sufficient extent of tactile analyser interference on the development level of separate physical qualities.

Our previous research showed a positive influence of special exercises on the functional state of separate analysers (visual, acoustic, vestibular) in pupils (Azhippo, A.Yu., Shesterova, L.Ye., Maslyak I. P., Kuzmenko, I.A., Bala, T.M., Krivoruchko, N.V., Mameshina, M.A., Sannikova, M.V., 2016, 2017). The use of special exercises which influence the sensory systems, and, in particular, the tactile one, led to an improvement of their functional state and, indirectly, to an improvement of the level of physical fitness in the studied contingent.

So, indicators related to the development level of speed ($p<0.001$), coordination abilities ($p<0.05$ - 0.001) and force ($p<0.05$-0.001) authentically improved in pupils belonging to experimental groups, except for the results obtained for 7-year-old pupils, where the changes are statistically unreliable ($p>0.05$), endurance in pupils belonging to the IV-VI group ($p<0.001$). Endurance development has a natural character in pupils of the I – III age groups. Indicators of pupils from the control groups also underwent changes, however, these changes are less essential, and they are unreliable ($p>0.05$). By analysing the improvement of indicators concerning age, it is established that the most essential changes are recorded in speed indicators for 7-year-old boys and in abdominal tension muscle force indicators for girls of similar age. At the age of 8 years, the most considerable changes happened in the boys' flexibility indicators and in the results of speed manifestations and abdominal tension muscle force for girls. At the age of 9 years, the most essential changes are recorded in indicators of speed, dexterity, muscle force of hands and abdominal tension for boys, and in flexibility indicators for girls. The most significant changes in indicators of high-speed abilities, endurance, dexterity, and muscle force of hands were present in 11-year-old boys. Indicators of endurance, dexterity, flexibility, muscle force of hands and abdominal tension most significantly improved in girls of this age. The substantial increase of indicators related to abdominal tension muscle force and flexibility was observed in 12-13 year old boys, while high-speed abilities were observed in girls. The less significant rates of gain for motive preparedness indicators were noted both in boys and girls at the age of 14-15.

DISCUSSION

Certain authors emphasize the significance of the tactile sensory system in physical education and sport. It plays an important role in spatial orientation of the person, helps to precisely determine the run speed, and to carry out difficult movements of coordination, etc. (Parham & Mailloux, 2010). The use of special exercises promotes an increase in its functionality (Kuzmenko, 2011). The analysis of tactile sensitivity indicators, received after the experiment, demonstrates that they improved, and the differences generally have a reliable character in most pupils belonging to experimental groups ($p<0.5$-0.001). These data will agree with the opinion of Solodkov & Sologub, 2005, who consider that tactile sensitivity increases with the growth of the child's physical activity.

The most noticeable changes of tactile sensitivity indicators were observed in pupils of the III age group. The system of specially developed physical exercises and outdoor games, which are directed to improve the functional state of the tactile analyser, was approved for the first time in the course of physical education for pupils attending a comprehensive school. The optimum age periods for increasing the sensitivity are revealed.

It should be noted that the girls' tactile sensitivity of the 3rd phalanx is slightly higher than boys'. According to certain experts in the field of physiology, physical education and sport (Solodkov & Sologub, 2005), women have a larger number of receptors on their fingers than men, which is why finger sensitivity is higher for them.

Reliable differences in tactile sensitivity indicators, received after the experiment, weren't observed in pupils belonging to control groups ($p>0.05$). Thus, the research we conducted confirm and supplement the results of research conducted by Mihaylik, 2001, Kuzmenko, 2011, Maslyak, 2015, about the use efficiency of the exercises in the educational process, which are directed to increase the functional state of the tactile analyser.

The result analysis of the repeated research, received after using the special exercises, which are in a complex, positively influencing the functional state of sensory systems, and, in particular, the tactile one, allowed revealing that some changes also took place indirectly in the development level indicators of motive qualities. So, in pupils participating in the experiment, indicators of speed manifestation, high-speed and power qualities improved in 97% of cases, while, in 93% of cases, they improved in the dexterity manifestation, and, in 95% of cases, they improved in the flexibility manifestation.

The smallest gain was observed in the results reflecting the development level for the muscle force of hands and abdominal tension, 79% and 87% respectively. It is necessary to focus our attention to various changes in indicators of the endurance development level in elementary and middle-school pupils. So, the indicators improved in 95% of cases for the middle-school

aged examinees, and the results of endurance manifestation did not practically change for younger pupils. It is confirmed by the opinion of a number of authors (Shiyan, Papusha, 2000; Volkov, 2002) who note that endurance develops poorly at a younger school age because cardiovascular and respiratory systems are insufficiently developed in this age period that interferes with the development of this physical quality. Changes in indicators related to the level of physical fitness were observed in 45-50% of cases for pupils engaged in the standard programme, which is connected, in our opinion, with age features of their development.

In our opinion, the gain of indicators related to the development levels of flexibility, dexterity and speed is explained by the existence of a rather close interrelation between the manifestation of these physical qualities and the functional state of sensory systems, in particular, the tactile one. Improvement in indicators related to the development level of force and endurance is explained by our correlation dependence between separate indicators of the studied parameters.

It is also explained by the existence of a rather close interrelation between the manifestation of physical qualities (Volkov, 2002; Shesterova, 2003), i.e. the gain of indicators related to the development of dexterity and speed causes an increase in the development levels of force and endurance, and vice versa.

As a result of the conducted research, data (Pomeshchikova, Iermakov et al., 2016; Podrigalo, Iermakov, Rovnaya et al., 2016; Maslyak, Shesterova, Kuzmenko et al., 2016) about the interrelation of sensory systems with a manifestation of physical qualities were expanded.

The data of Shesterova, Kuzmenko, Maslyak, 2011, 2015, 2017, about the influence of specially directed exercises on the activity of various analysers in pupils are expanded.

CONCLUSIONS

1. The analysis of initial research allowed to establish that the pupils' tactile sensitivity indicators of the middle of the palm and the 3rd phalanx are lower than the norm, and the results related to the back surface of the hand and the forearm are a little higher than the norm.
2. The use of specially directed exercises, that we developed, in the course of physical education positively influenced the functioning of the tactile sensory system in pupils belonging to experimental groups ($p<0.05$-0.001). The most susceptible period for training the tactile analyser is the age of 9. The results of pupils belonging to control groups did not significantly change.
3. The research on the level of physical fitness after using the system of specially directed exercises demonstrate a reliable improvement in the development of all main physical qualities ($p<0.05$-0.01) in pupils belonging to experimental groups. 7-9 year old pupils' endurance indicators, which practically did not change, are an exception. Data on pupils belonging to control groups did not undergo considerable changes.
4. The correlation analysis of the tactile analyser functional state indicators and the development level of motive qualities confirms the existence of a rather close interrelation between them ($r = 0.20$-0.88), which gives the grounds to speak about the considerable extent of interference of these parameters.

Further research in this direction can be conducted by defining the extent of influence related to the tactile sensory system activity level on motive preparedness of sportsmen.

Acknowledgements

The research was carried out according to the Kharkov State Academy of Physical Culture research Thematic plan for 2016-2020 on the subject "Improvement of process of physical education in educational institutions of various profiles" (No. of the state registration is 0115U006754).

REFERENCES

1. Aghyppo, Alexandr, Tkachov, Sergij & Orlenko, Olena (2016). Role of physical education on the formation of a healthy lifestyle outside of school hours. Journal of Physical Education and Sport, 16(2), 335–339.
2. Aghyppo, O.Yu., Kuzmenko, I.O. (2015). Faktorna struktura funkcionalnogo stanu sensornih sistem uchniv 6 klasiv [Factorial structure of functional condition of sensory systems of pupils of the 6th classes]. Sportivna nauka Ukraini, 1(55), 7–11 [In Ukrainian].
3. Andreassi, J.L. (2000). Psychophysiology. Human Behavior and physiological response. 4th edition. London: Lawrence Erlbaum Associates Publishers.
4. Azhippo, A.Yu., Shesterova, L.Ye., Maslyak I. P., Kuzmenko, I.A., Bala, T.M., Krivoruchko, N.V., Mameshina ,M.A., Sannikova, M.V. (2017) Influence of functional condition of visual sensory system on motive preparedness of school-age children. Journal of Physical Education and Sport (JPES). 17(4), 2519–2525. DOI:10.7752/jpes.2017.04284.

5. Bala, T. (2015). Change in the level of strength and endurance development of 5-6 grades pupils under cheerleading exercises influence. Slobozhanskyi herald of science and sport, 3(47), 14–18. dx.doi.org/10.15391/snsv.2015–3.003.

6. Bala, T.M. (2012). The infuence of cheerleading exercises on the schoolchildren's physical health of 5-9th forms. Pedagogics, psychology, medical-biological problems of physical training and sports, 4, 12–16.

7. Filenko, L.V., Filenko, I.U., Martirosyan, A.A. (2013). Research of indexes of physical development, physical preparedness and functional state of students aged 10-11 years under the influence of engagement in rugby-5. Pedagogics, psychology, medical-biological problems of physical training and sports, 6, 53–58. doi:10.6084/m9.figshare.714940.

8. Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D. & Bauman, A. (2007). Physical activity and public health: Updated recommendation for adults from the American college of sports medicine and the American heart association. Medicine & Science in Sports & Exercise, 39(8), 423–434.

9. Krivoruchko, N. & Maslyak, I. (2013). Dynamics of indicators of development of coordination abilities of students of HEI under the influence of cheerleading exercises [Dinamika pokaznikiv rozvitku koordinatsiynih zdibnostey studentiv VNZ pid vplivom vprav chirlidingu]. Moloda sportivna nauka Ukrayini, 17 (2), 87–91. [In Ukrainian].

10. Kryvoruchko, N.V., Masljak, I.P. & Zhuravlyova, I.N. (2013). Impact on the display of power cheerleading ability of university students I-II levels of accreditation. Pedagogics, psychology, medical-biological problems of physical training and sports, 9, 38–42. http://dx.doi.org/10.6084/m9.figshare.749696

11. Kuzmenko, I. (2017). Investigation of the cardiovascular system of schoolchildren aged 13–14 years. Slobozhanskyi herald of science and sport. № 6(62), 51–53.

12. Kuzmenko, I.O. (2011). Influence of specially directed exercises on functional state of tactile analyzer of 10-15 year old pupils [Vplyv spetsialno spriamovanykh vprav na funktsionalnyi stan taktylnoho analizatora shkoliariv 10–15 rokiv]. Sportyvnyi visnyk Prydniprovia: naukovo-praktychnyi zhurnal, № 2, 134–137. [In Ukrainian].

13. Magomedova, L.O., Shesterova, L.E. (2013). Role of sensory systems in development of coordination abilities of children of school age with defects of sight [Rol sensornih sistem u rozvitku koordinaciinih zdibnostei ditei shkilnogo viku z vadami zoru]. Slobozhanskyi herald of science and sport, 2, 5–8. [In Ukrainian].

14. Mameshina, M. (2016). Condition of physical health of pupils of the 7th-8th classes of the comprehensive school. Slobozhanskyi herald of science and sport, 5(55), 47–52. https://doi.org/10.15391/snsv.2016-5

15. Maslyak, I.P., Kryvoruchko, N.V. (2016). Physical development of students of teacher training college as a result of exercises of cheerleading. Physical education of students, 1, 55–63. http://dx.doi.org/10.15561/20755279.2016.0108.

16. Maslyak, I.P., Mameshina, M.A., Zhuk, V.O. (2014). The state of application of innovation approaches in physical education of regional education establishments. Slobozhanskyi herald of science and sport, 6 (44), 72–76. dx.doi.org/10.15391/snsv.2014-6.013

17. Maslyak, I.P., Shesterova, L.Ye., Kuzmenko, I.A., Bala, T.M., Mameshina, M.A., Krivoruchko, N.V. & Zhuk, V.O. (2016). The Influence of the vestibular analyzer functional condition on the physical fitness of school-age children. Sport science. International scientific journal of kinesiology, 9, 20–27.

18. Masliak, Irina, Bala, Tetiana, Krivoruchko, Natalia, Shesterova, Ludmula, Kuzmenko. Irina, Kulyk, Nina, Stasyuk. Roman and Zhuk, Vyacheslav (2018). Functional state of cardiovascular system of 10–16-year old teenagers under the influence of cheerleading classes. Journal of Physical Education and Sport (JPES), 18 (1), 452-458. DOI:10.7752/jpes.2018.s163

19. Maslyak, I.P. (2006). Optimization of process of physical education of pupils of elementary grades [Optymizatsiya protsesu fizychnoho vykhovannya shkolyariv molodshykh klasiv]. Theory and methods of physical education, 3, 5–8. [In Ukrainian].

20. Maslyak, I.P. (2008). Dynamics of level of physical fitness of junior pupils under the influence of the special exercises, which are directed at improvement of functional state of analyzers [Dynamika rivnya fizychnoyi pidhotovlenosti molodshykh shkolyariv pid vplyvom spetsial'nykh vprav, spryamovanykh na polipshennya funktsional'noho stanu analizatoriv]. Theory and methods of physical education and sport, 4, 47–51. [In Ukrainian].

21. Maslyak, I. (2015). Influence of specially directed exercises on separate functions of sensor-based systems of pupils of junior classes. Slobozhanskyi naukovo-sportyvnyi visnyk, 5(49), 48–51. DOI: https://doi.org/10.15391/snsv.2015-5.010

22. Mihaylik, S. (2001). Vzaimosvyaz dvigatelnogo, taktilnogo i vestibulyarnogo analizatorov v sisteme fizicheskoy podgotovki slepyih detey [Interrelation of motive, tactile and vestibular analyzers in the system of physical training of blind children]. Materialy III Vseukrainskoi naukovoi konferentsii dlia studentiv i aspirantiv fizkulturnykh navchalnykh zakladiv „Fizychna kultura, sport ta zdorovia", Kharkiv: KhaDIFK, 94. [In Ukrainian].

23. Parham, L. D., & Mailloux, Z. (2010). Sensory integration. In J. Case-Smith (Ed.). Occupational therapy for children. St. Louis: Mosby.

24. Podrigalo, L., Iermakov, S., Potop, V., Romanenko, V., Boychenko, N., Rovnaya, O., & Tropin, Y. (2017). Special aspects of psycho-physiological reactions of different skillfulness athletes, practicing martial arts. Journal of Physical Education and Sport, 17(2), 519-526. doi:10.7752/jpes.2017.s2078

25. Podrigalo, L., Iermakov, S., Rovnaya, O., Zukow, W., & Nosko, M. (2016). Peculiar features between the studied indicators of the dynamic and interconnections of mental workability of students. Journal of Physical Education and Sport, 16(4), 1211-1216. doi:10.7752/jpes.2016.04193

26. Pomeschikova, I.P. (2010). Dynamics of indicators of vestibular-somatic reactions of pupils with violations of musculoskeletal apparatus under the influence of specially selected exercises and ball games [Dinamika pokazatelei vestibulosomaticheskih reakcii uchaschihsya s narusheniyami oporno-dvigatelnogo apparata pod vliyaniem specialno podobrannih uprajnenii i igr s myachom]. Slobozhanskyi herald of science and sport, 4, 13-16. [In Ukrainian].

27. Pomeshchikova, I., Iermakov, S., Bartik, P., Shevchenko, O., Nosko, M., Yermakova, T. & Nosko, Yu. (2016). Influence of exercises and games with ball on vestibular stability of students with muscular-skeletal apparatus disorders. Sport science. International scientific journal of kinesiology, 9(1), 75–83.

28. Smirnov, V.M., Budylina, S.M. (2003). Physiology of sensory systems and higher nervous activity [Fiziologiya sensornykh sistem i vysshaya nervnaya deyatel'nost'], Moscow, Academy. [In Russian].

29. Shesterova, L.Ie. (2003). Ways of improvement of the context of physical culture classes at comprehensive school [Shliakhy vdoskonalennia zmistu urokiv fizychnoi kultury v zahalnoosvitnii shkoli]. Teoriia ta metodyka fizychnoho vykhovannia, 2, 18–20. [In Ukrainian].

30. Shesterova, L.Ye., Kuzmenko, I.A., Maslyak, I. P. (2017). Motive preparedness of school-age children under the influence of special exercises affecting the state of the acoustic analyser. Sport science international scientific journal of kinesiology. Vol. 10, Issue 2, 97–104.

31. Shiyan, B.M., Papusha, V.G. (2000). Teoriya fizichnogo vihovannya [Theory of physical education]. Ternopil': ZBRUCH.

32. Solodkov, A.S., Sologub, Ye.B. (2005). Human physiology. The general. Sports. Age [Fiziologiya cheloveka. Obshchaya. Sportivnaya. Vozrastnaya], Olimpiya Press, Moskva. [In Russian].

33. Vasylenko, V., Mitova, O. (2011). Technical training of basketball players at the stage of specialized basic preparation on the basis of development of sensomotor functions [Tekhnichna pidhotovka basketbolistiv na etapi spetsializovanoi bazovoi pidhotovky na osnovi rozvytku sensomotornykh funktsii]. Moloda sportyvna nauka Ukrainy, T. 1, 35-41. [In Ukrainian].

34. Volkov, L.V. (2002). Teoriya i metodika detskogo i yunosheskogo sporta [Theory and technique of child's and youth sport]. Kiev: Olympic literature.

UTICAJ POSEBNO USMJERENIH VJEŽBI NA FUNKCIONALNO STANJE OSJETNOG ANALIZATORA I FIZČKU SPREMNOST UČENIKA U DOBI OD 7 DO 15 GODINA

Svrha: odrediti nivo uticaja posebno usmjerenih vježbi na funkcionalno stanje osjetnog analizatora i nivo fizičke spremnosti učenika u dobi od 7 do 15 godina. Materijal: istraživanja su provedena na osnovu srednjih škola u Harkovu. Više od 800 učenika, koji su činili 6 eksperimentalnih i 6 kontrolnih grupa, je učestvovalo u istraživanjima. Rezultati: utvrđen je nivo motoričke spremnosti učenika; ispitano je funkcionalno stanje osjetnog analizatora; razlike proučavanih indikatora po pitanju dobi i pola su uzete u obzir; definisan je međusobni odnos parametara funkcionalnog stanja osjetilnog sistema za dodir i nivoa razvoja motoričkih sposobnosti učenika; otkriven je opseg uticaja posebno usmjerenih vježbi na funkcionalno stanje osjetnog analizatora i nivo motoričke spremnosti ispitanika. Zaključci: 1. Analiza početnog istraživanja nam je omogućila da ustanovimo da su indikatori osjetljivosti na dodir sredine dlana i treće falange kod učenika niži od norme, te da su rezultati dobiveni za nadlanicu i podlakticu nešto viši od norme. 2. Korelacijska analiza je ukazala na postojanje dosta bliskih međusobnih odnosa između osjetnog analizatora i nivoa fizičkih osobina. 3. Korištenje posebno odabranih vježbi je pozitivno uticalo na funkcionisanje osjetnog analizatora i, indirektno, na razvoj fizičkih osobina ispitanika.

Ključne riječi: Fizičko obrazovanje, djeca školskog uzrasta, osjetni analizator, motoričke osobine, posebne vježbe.

Received: December 02, 2018 / Accepted: December 15, 2018
Correspondence to: Irina Kuzmenko, Ph.D, assistant professor, 1 Department of Theory and Methods of Physical Education, Kharkiv State Academy of Physical Culture, Kharkov, Ukraine
E-mail: kyzmenko_irina@ukr.net

STIFFNESS REGULATION AND JOINT POWER IN RESPONSE TO THE DIFFERENT SHOE INSOLE HARDNESS DURING JUMP-LANDING

Alirezaei Fatemeh[1], Bressel Eadric[2]

1. Ferdowsi University of Mashhad, Department of Physical Education and Sport Science, Mashhad, Iran
2. Utah State University, Department of Health, Physical Education and Recreation, Logon, USA

ABSTRACT

The purpose of this study was to explore the effect of shoe insole hardness on lower extremity joint stiffness regulation and energy during jump landing. 15 male athletes were instructed to perform jump-landing in different shoe conditions. Kinematic and kinetic data were recorded simultaneously. Joint stiffness was defined as the ratio of the change in joint moment to the joint angular displacement. Hip, knee, and ankle negative sagittal powers were defined as the product of joint angular velocity and moment. There was a significant effect of shoe insole hardness on ankle joint stiffness ($p \leq 0.05$). Ankle joint stiffness increased as the shoe insole hardness increased. Ankle joint stiffness was highest for the hard insole condition. The results indicate that, during landing peak, negative power was significantly greater in soft insole condition compared to the hard condition ($p=0.01$). Shoe insole properties used in this study had a significant influence on the ankle joint stiffness. Ankle joint stiffness was greater in the hard insole condition. Shoe insole hardness affected the distal ankle joint more than the proximal knee joint. We found greater negative knee joint power during landing with soft insole condition than other conditions. Our results showed that landing with soft shoe insoles increased the negative joint power during landing which implied elevated eccentric work done on the knee extensors.

Keywords: Joint stiffness, joint power, insole, jump-landing.

INTRODUCTION

Athletic footwear and shoe inserts have been advocated successfully for sport and physical activities such as jump-landing for many different reasons, including the reduction of movement related injuries. Impact forces experienced during ground-contact in landing can reach a magnitude ranging from 3 to 7 times the body weight (Gross & Nelson, 1988; McNitt Gray 1993). Cushioning characteristics of footwear have been proposed to be related to impact loading and injury. Some of these factors may be modified to reduce or increase the vertical ground reaction force. Cushioning characteristics of athletic footwear have received much attention in biomechanical research. There is a surprising amount of debate over whether softer shoe insert materials change GRF variables. Lafortune and Henning (1996) concluded that softer versus harder midsoles produced less impact force and lower shank shock during running. Alirezaei et al. (2017) indicate that wearing shoes with different insole densities does not influence vertical GRF during jump-landing. Based on their results, no shoe effect was found for lower extremity joint angle at peak GRF; the vertical GRFs between shoe conditions were expected to be largely unaffected by the lower extremity kinematics at the instance of peak GRF. Previous studies have reported no correlation between insert hardness and vertical impact force during running (Clarke 1983, Hamill 2011). This lack of difference in vertical GRF was contrary to the results reported by Zhang et al. (2005), who found that forefoot peak GRF was significantly higher for normal and hard midsoles than for soft midsoles during drop landing from a similar height. It seems that findings from literature are still inconclusive. It is possible that subjects adjust

their landing mechanics when landing with different shoe insole hardness, changing their effective mass during landing by making their ankle or knee joint more stiff when the shoe becomes softer. A stiffer limb would result in a harder landing (higher impact force), counteracting any influence of the shoe cushioning on impact absorption. This has been supported by previous studies that have demonstrated increased leg or joint stiffness when landing or hopping on a softer surface or a shoe with thicker midsole. Given the primary role that stiffness plays in the control of human movement, as well as injury and performance, (Butler 2003), it is important to note how insole hardness may affect joint stiffness. One measure that has been used to estimate lower extremity stiffness is joint stiffness that can be used to indirectly measure the factors related to lower extremity injuries because it can be related mechanically to the attenuation of loads transmitted through the body. Joint stiffness has been implicated in overuse injuries and degenerative diseases (Hamill et al. 2009). For example, a more compliant joint will attenuate the load placed on the joint to a greater extent than a stiffer joint. Moreover, lower extremity energetics, such as joint power, are important measures of energy absorption during landing. DeVita and Skelly (1992) reported that a stiff double-leg landing exhibits less joint power and eccentric work done compared to a soft landing. However, it is still not clearly known how the lower extremity joints will respond to the different shoe insole hardness during jump-landing.

Since the actions of the ankle, knee, and hip joints are a major source of the lower extremity compliance during landing, it may be that jump-landing with different shoe insole hardness may cause the ankle and knee joints to contribute differently to the lower extremity performance. It was hypothesized that there would be alternations in lower extremity joint stiffness and power as a result of changing shoe insole hardness during jump-landing.

PARTICIPANTS

A total of 15 individuals (mean±SD; age 21.33±2.42 years; height: 180.5±10.00 cm; mass: 69.08±7.67 kg) volunteered for this study. All participants were required to be physically active, which was defined as participating in at least 30 minutes of physical activity 3 times per week, and generally healthy with no history of ACL injury, neurological disorders, lower extremity surgery, or lower extremity injury within the 6 months preceding data collection. All participants provided written informed consent, and the study was approved by the University Institutional Review Board.

EXPERIMENTAL SET-UP

Three dimensional lower extremity motions were recorded with an eight camera Oqus system (Qualisys, Inc., Gothenberg, Sweden). A force platform (type 4060-NC; AMTI Corporation, Columbus, OH) with an axis system aligned with the global axis system flush with the ground was located in the centre of the capture volume to collect force data. Kinematic and kinetic data were sampled at 120 and 1200 Hz, respectively and tracked using the Qualisys Track Manager Software (Qualisys, Inc., Gothenberg, Sweden).

DATA COLLECTION

The height and mass of each participant were recorded before data collection and used to generate a biomechanical model and normalize the dependent variables. Lower extremity and trunk kinematics were assessed using an eight camera Oqus system (Qualysis track Manager). Retro-reflexive markers were placed on the right lower extremity and pelvic of the participants according to previous studies (McClay & Manal 1997). A standing calibration trial was recorded to determine the local coordinate systems, the location of joint centres and the foot, leg, thigh and segment length of each participant. Participants were then instructed to jump and land onto the force plate.

To perform double-leg jump landings, the participants' standing position was set at a distance equal to 50% of their height away from the edge of a force plate. We instructed the participants to jump down and forward toward the force plate in an attempt to hit a suspended soccer ball, then, contact the ground with both feet at the same time, and immediately jump up for maximal height using both legs. The vertical height of the suspended ball from the force plate was also set as 50% of MVJ height. To measure MVJ, the highest standing hand reach was subtracted from the jump and the highest reach of the subject while standing (Sargent jump test). In addition, they were encouraged to use whatever technique they desired to jump as high as possible and were not provided feedback on their chosen landing techniques during the testing. The participants performed 3 practice trials and 5 successful testing trials with 30 seconds of rest between trials to minimize the potential effects of fatigue. Trials were deemed successful if participants jumped from the box and landed with both feet at the same time, completely contacted the force plate, and performed the landing task and subsequent maximal jump in a fluid motion. The experimental set-up for the jump-landing task was based on a previous research (Debiaso et al., 2013) that examined changes in plantar loading between different shoe types and genders during a jump-landing task. All participants performed three successful jump-landing trials with the same sport shoes (sneaker model, Nike Air Max Glide) that were supplied by the investigators in the study.

Three different shoe conditions (hard, soft, medium) were investigated, which differed only in terms of insole hardness: Asker insole C-40 (soft), Asker C-52 (medium), Asker C-65 (hard). The compliance of insoles was based on the manufacturing tests. These insoles were constructed of polyurethane foam moulded into the shape of a footbed (6-mm thickness at the centre of the heel and 3-mm thickness at the forefoot) with textured Poron foam top cover (1-mm thickness). The order in which the shoes were tested was randomly assigned for each subject.

Qualisys Track Manager Software (Qualisys, Inc., Gothenberg, Sweden) was used to track the marker positions and export data into a useful format. Raw kinematic and kinetic data were further processed using MATLAB software. Raw kinematic data were low-pass filtered using a fourth-order, zero-phase-lag Butterworth filter with a cut-off frequency of 10 Hz (Decker 2003), time was synchronized with the kinetic data and resampled at 1200 Hz. We calculated joint angular positions based on a right-hand convention and calculated instantaneous joint angular velocities as the first derivative of angular position.

We defined motion about the hip as the thigh relative to the pelvis, motion about the knee as the shank relative to the thigh, and motion about the ankle as the foot relative to the shank. Kinetic data were low-pass filtered at 60 Hz with a fourth-order, zero-phase-lag Butterworth filter (Kulas 2006) and combined with kinematic and anthropometric data to calculate the net internal joint moments of force at the hip, knee, and ankle and the net internal force on the shank at the knee joint during landing phase, using an inverse dynamics solution (Gangon 1992). The landing phase was determined based on a 10 n threshold from initial contact to take off. Subsequently, the moments and angles were interpolated from initial contact to toe off to 101 data points with each point representing 1 % of the landing phase. Stiffness for the ankle, knee, and hip joints in the sagittal plane was determined. The joint stiffness during the landing phase was defined as the ratio of the change in joint moment (ΔM) to the joint angular displacement (Δø) (Horita 2002). A linear fit of the slope of the moment-angle curve produced the magnitude of joint stiffness during the landing phase. Hip, knee, and ankle negative sagittal powers were defined as the product of joint angular velocity and moment, and normalized to the body weight (Yeow, 2009) (Watt × BW-).

All dependent variables were averaged across the 5 jump-landing trials of each participant before statistical analysis. The individual trial data in each condition for all parameters were averaged for each participant for the statistical analysis. Ankle and knee joint stiffness in each condition were statistically analysed using a repeated measures ANOVA. Alpha level was set at 0.05. In order to further evaluate the mean differences, effect size (ES) was calculated to express such differences relative to the pooled standard deviation.

RESULTS

There was a significant effect of the shoe insert condition on ankle joint stiffness (F=3.12, P=0.05 ES=0.5). Post hoc comparisons revealed that ankle joint stiffness is significantly different from each other (p). Ankle joint stiffness increased as the shoe insole hardness increased. Ankle joint stiffness was highest for the hard insole condition. Knee and hip joint stiffness were not significantly different between shoe conditions (F=0.18, p=0.83 and F=0.9, p=0.66). The results indicate significant differences among three different shoe conditions on knee joint power (F=10.6, p= 0.002, ES=0.6). Post hoc comparisons show that, during landing peak, negative power was significantly greater in soft insole condition compared to the hard condition (p=0.01). For negative ankle and hip joint power, a statistically significant difference between shoe conditions was not observed (F=1.6, sig=0.22 and F=0.48, p=0.48).

DISCUSSION

The purpose of this study was to examine the lower extremity joint stiffness and negative power during landing with different shoe insole densities. Ankle joint stiffness was greater in the hard insole condition. Similar findings have been found when comparing barefoot and shod running, where ankle stiffness was higher in the shod running condition compared to barefoot running (Chambon et al. 2014). It is speculated that lower joint stiffness, or more compliance, may be required in order to control the joint movement in a softer insole during landing. The possible interpretation for this may be the result of the “bottoming out effect”, with the individuals in the present study adjusting their joint stiffness. Joint stiffness provides an indication of how much joint displacement occurs for a given moment.

The ankle joint in soft insole condition is more compliant, less stiff, thus, absorbing a greater amount of energy during landing with soft insole condition. A joint that is compliant will absorb the energy of the foot-ground impact to a greater extent than a stiff joint. It seems that, in hard insole condition, the ankle may not have sensed a need to show compliance during landing.

The results also indicate that the ankle joint is more sensitive than the knee and hip joints to changes in shoe insole density. It has been suggested that, based on the mass-spring model, the ankle joint is the dominant joint during locomotion (Farley, 1996). Kinetic energy or ground reaction force during landing will be received initially at the joint that is most distal upon impact.

We found greater negative knee joint power during landing with soft insole condition than other conditions. Fukuda (1988) and Bobbert et al. (1986) have reported lower extremity joint power during landing which was similar to the present results and had a landing phase of knee extensor dominant power. DeVita and Skelly (1992) reported that the presence of a negative knee joint power indicated eccentric work done on knee extensors to dissipate impact energy. It suggests that knee extensors were key contributors to energy dissipation during landing. Our results showed that landing with soft shoe insoles increased the negative joint power during landing which implied elevated eccentric work done on the knee extensors. During landing, internal hip, knee, and ankle extension moments must be produced via eccentric muscle contraction to control joint motion and to absorb the kinetic energy. Kinetic energy or ground reaction force during landing will be received initially at the joint that is most distal upon impact. Any energy that is not absorbed at this joint will continue to travel up the kinetic chain to the next proximal.

CONCLUSION

Shoe insole properties used in this study had a significant influence on the ankle joint stiffness. Ankle joint stiffness was greater in the hard insole condition. Shoe insole hardness affected the distal ankle joint more than the proximal knee joint. We found greater negative knee joint power during landing with soft insole condition than other conditions. The results from this study may also have important implications for the loads imposed on certain tissues of the lower extremity while landing in different shoe insole hardness.

Table 1: Mean ± SD of joint stiffness (N.m/degree) for hard, soft and medium insole during jump-landing task

	Hard	Medium	Soft	
Ankle joint stiffness	1.27±1.00	0.75±0.45	0.74±0.50	F=3.12 p=0.05
Knee joint Stiffness	1.16±0.70	0.90±0.75	1.18±1.00	F=0.18 p=0.88
Hip joint Stiffness	1.98±	0.91±0.70	1.5±0.85	F=0.9, p=0.66

Table 2: Mean ± SD of joint power (Watt/kg) for hard, soft and medium insole during jump-landing task

	Hard	Medium	Soft	
Ankle Joint Power	31.50±13.19	33.13±11.35	36.61±8.20	F=1.6 p=0.22
Knee Joint Power	2.32±1.20	4.87±3.80	4.46±2.42	F=10.6 p=0.002
Hip joint Stiffness	24.00±6.45	22.88±7.48	22.54±6.71	F=0.48 p=0.62

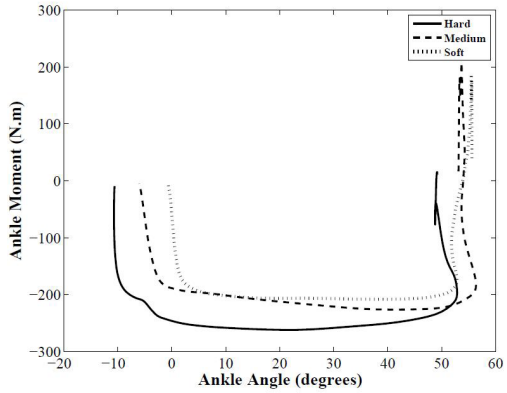


Figure 1: Representative profiles of a subject for ankle joint stiffness during the landing phase. The landing phase was defined by the duration of initial contact to toe off.

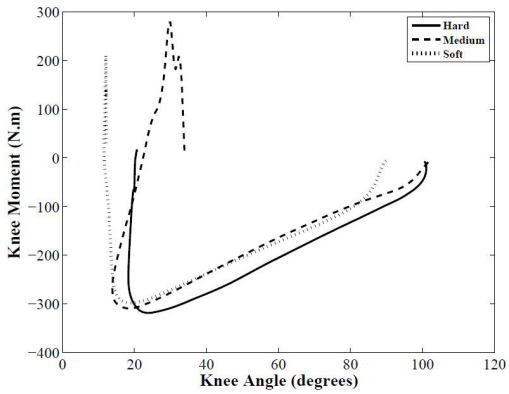


Figure 2: Representative profiles of a subject for knee joint stiffness during the landing phase. The landing phase was defined by the duration of initial contact to toe off.

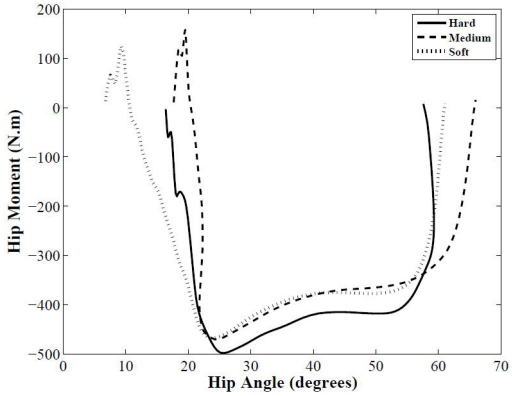


Figure 3: Representative profiles of a subject for hip joint stiffness during the landing phase. The landing phase was defined by the duration of initial contact to toe off.

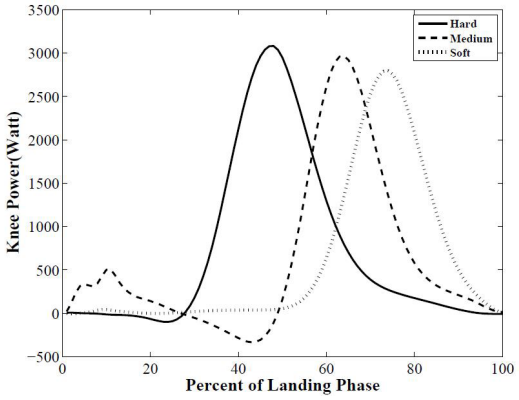


Figure 5: Representative profiles of a subject for hip joint stiffness during the landing phase. The landing phase was defined by the duration of initial contact to toe off.

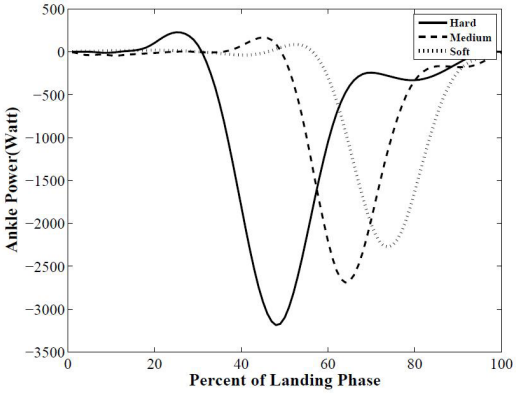


Figure 4: Representative profiles of a subject for ankle joint power during the landing phase. The landing phase was defined by the duration of initial contact to toe off.

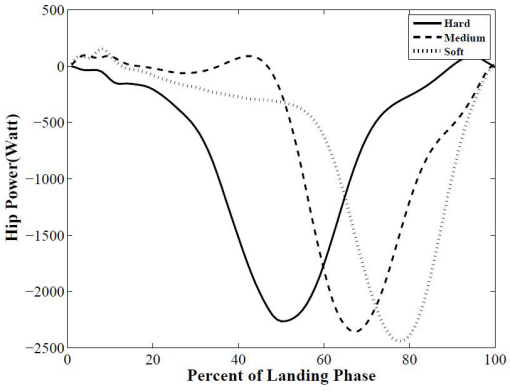


Figure 6: Representative profiles of a subject for hip joint power during the landing phase. The landing phase was defined by the duration of initial contact to toe off.

REFERENCES

1. Alirezaei, N F, Bressel, E. 2017. Effect of shoe insole density on impact characteristics and performance during a jump-landing task. Footwear Science; 9(2):95-101.

2. Bobbert MF, Huijing PA, van Ingen Schenau. An estimation of power output and work done by the human triceps surae muscle-tendon complex in jumping. J Biomech, 1986, 19:899-906.

3. Chambon N, Delattre N, Gueguen N, Berton E, Rao G. Is midsole thickness a key parameter for the running pattern? Gait Posture 2014; 40:58-63.

4. Clarke T.E., Frederick E.C., Cooper L.B., Effects of shoe cushioning upon ground reaction forces in running. Int J Sports Med, 1983, 4 (4), 247–251, doi: 10.1055/s-2008-1026043.

5. Decker MJ, Torry MR, Wyland DJ, Sterett WI, Steadman RJ. Gender differences in lower extremity kinematics, kinetics and energy absorption during landing. Clin Biomech (Bristol, Avon) 2003; 18(7):662–669.

6. Farley, CT & Gonzales O. 1996. Leg stiffness and stride frequency in human running. Journal of Biomechanics, 29; 181-186.

7. Fu, W., Liu, Y., Zhang, S. 2013. Effects of footwear on impact forces and soft tissue vibrations during drop jumps and unanticipated drop. International Journal of Sports Medicin, 34: 477-483.

8. Fukuda, H. Biomechanical analysis of landing on surfaces with different stiffness. In: Biomechanics XI-B, G. DeGroot, A. P. Hollander, PA. Hiujing and G J van Ingen Schenau (Eds.). Amsterdam: Free University Press, 1988, pp. 679-684.

9. Gagnon D, Gagnon M. The influence of dynamic factors on triaxial net muscular moments at the L5/S1 joint during asymmetrical lifting and lowering. J Biomech. 1992; 25(8):891–893.

10. Gross TS, Nelson RC. The Shock attenuation role of the ankle during landing from a vertical jump. Med Sci Sports Exerc 1988; 20:506-514.

11. Gross TS, Nelson RC. The Shock attenuation role of the ankle during landing from a vertical jump. Med Sci Sports Exerc 1988; 20:506-514.

12. Hamill J, Russell E, Gruber A, Miller R. 2011. Impact characteristics in shod and barefoot running. Footwear Science; 3:33-40.

13. Horita T, Komi PV, Nicol C, Kyrorlaeinen H. 2002. Interaction between pre-landing activities and stiffness regulation of the knee joint musculoskeletal system in the drop jump: implications to performance. European Journal of Applied Physiology, 88: 76-84.

14. Kulas AS, Schmitz RJ, Shultz SJ, Watson MA, Perrin DH. Energy absorption as a predictor of leg impedance in highly trained females. J Appl Biomech. 2006; 22(3):177–185.

15. Lafortune MA, Henning EM. 1996. Dominant role of interface over knee angle for cushioning impact loading and regulating initial leg stiffness. J Biomech 1996, 29:1523-1529.

16. McNitt-Gray JL. Kinetics of the lower extremities during drop landings from three heights. Journal Biomech 1993; 26: 1037-1046.

17. McClay, L., Manal, K. (1997). Coupling parameters in runners with normal and excessive pronation. J Appl Biomech, 13:109-24.

18. Stefanyshin D, Nigg B. Dynamic angular stiffness of the ankle joint during running and sprinting. J Appl. Biomech. 1988; 14:292-299.

19. Yeow CH, Lee PV, Goh JC. 2009. Regression relationships of landing height with ground reaction forces, knee flexion angles, angular velocities and joint power during double-leg landing. Knee, 16(5):381-386.

20. Zhang S, Clowers K, Kohstall C, Yu YJ. 2005. Effects of various midsole densities of basketball shoes on impact attenuation during landing activities. Journal of Applied Biomechanics, 21 (1), 3-17.

REGULACIJA UKOČENOSTI I SNAGE ZGLOBOVA KAO ODGOVOR NA TVRDOĆU RAZLIČITIH ULOŽAKA ZA CIPELE KORIŠTENIH TOKOM DOSKOKA

Svrha ove studije je istražiti efekat tvrdoće uložaka za cipele na regulaciju ukočenosti zglobova i energiju donjih ekstremiteta tokom doskoka. 15 sportista muškog spola je dobilo upute za izvođenje doskoka u cipelama sa različitom tvrdoćom uložaka. Kinematički i kinetički podaci su istovremeno zabilježeni. Ukočenost zgloba je definisana kao odnos promjene u momentu sile u zglobu i ugaonog pomicanja zgloba. Negativna sagitalna snaga kuka, koljena i gležnja je definisana kao proizvod ugaone brzine i momenta sile u zglobu. Zapažen je značajan efekat tvrdoće uložaka za cipele na ukočenost gležnja ($p \leq 0,05$). Ukočenost gležnja se povećavala sa povećanjem tvrdoće uložaka za cipele. Ukočenost gležnja je bila najviša prilikom upotrebe tvrdih uložaka za cipele. Rezultati ukazuju da je, prilikom dostizanja maksimalne sile reakcije podloge u doskoku, negativna snaga bila značajno veća kod upotrebe mekih uložaka za cipele u odnosu na tvrde uloške za cipele. Svojstva uložaka za cipele koji su korišteni u ovom istraživanju su imala značajan uticaj na ukočenost gležnja. Ukočenost gležnja je bila veća prilikom upotrebe tvrdih uložaka za cipele. Tvrdoća uložaka za cipele je više uticala na distalni dio gležnja nego na proksimalni dio koljena. Otkrili smo veću negativnu snagu zgloba koljena prilikom doskoka uz upotrebu mekih uložaka za cipele nego što je to slučaj sa drugim vrstama uložaka za cipele. Naši rezultati su pokazali da doskok uz upotrebu mekih uložaka za cipele povećava negativnu snagu zglobova prilikom doskoka što implicira povišeni ekscentrični rad ekstenzora koljena.

Ključne riječi: Ukočenost zglobova, snaga zglobova, ulošci za cipele, doskok.

Received: March 15, 2018 / Accepted: April 15, 2018
Correspondence to: Fatemeh Alirezaei, Ferdowsi University of Mashhad, Department of Physical Education and Sport Science, Mashhad, Iran
E-mail: alirezaei.ft@gmail.com

RESEARCH OF YOUNG ATHLETES' RELATIONSHIPS TO FAIR PLAY OR JUST PLAY

Milan Dragić[1], Edita Kastratović[2], Damir Ahmić[3], Kada Selimović[4]

1. Faculty for Business Economics and Entrepreneurship, Belgrade, Serbia
2. Faculty of education, University of Travnik, Bosnia and Herzegovina
3. Faculty for Business Economics and Entrepreneurship, Belgrade, Serbia
4. Special Olympics, Bosnia and Herzegovina

ABSTRACT

This paper describes a study of young athlete's relationships to fair play in sport. The subject of the study was fair play, a phenomenon that represented the original sport's guideline and the guideline of every sports event in history. The aim of the research was to analyse the current situation in sport in terms of violent behaviour and approval of such behaviour by children who are actively involved in sports. The research is also aimed to determine whether young athletes consider that violence and cheating are an integral part of the sport, and whether fair play is still present in amateur sports? The results of this study indicate that there is a difference between younger athletes and adolescent athletes in terms of behaviours and attitudes related to fair play. The results confirm that the majority of young athletes do not apply violence and misconduct towards other athletes. The results also suggest that young athletes consider that cheating is not an integral part of sport and understanding of sport. The results of this research contribute to the understanding and comprehension of the real situation regarding the young athletes' relationship to the phenomenon of the fair play game. Young athletes do not see cheating as an integral part of sport, and consider that fair play is still present among young athletes.

Keywords: Fair play, sport, violence, ethics, competition.

INTRODUCTION

Modern sport brings with it a variety of positive and negative connotations. The imperative of success is a significant motivating factor that often influences the change of athlete's behaviour during a competition. The pressure that every athlete feels before a match and the expectations that must be fulfilled limit the role in terms of expression in sport. We are witnessing frequent moments during competitions in which athletes are crossing the line of fair play and putting the victory in front of everything. The principle "It is important to participate" has long been put at the second place with the ability to use it in situations that promote sport as an exalted activity. This is exactly what Koković is talking about and emphasises the moment of moving from the sacred rule "It is important to participate" towards the rule "It is important to win". The period of the destruction of real sports values refers to the last Olympics that are rightly called "illusion" (Koković, 2008, p. 23). The Olympic Games have occurred from the term agonistic. Agonisticism is the result of a word AGON that marks the skill, the urge for competition, glory and victory. Contemporary sport insists on AGON at this point - that professional and more and more amateur athletes moved from the dimension of chivalry to the dimension of the gladiator. Insisting on victory in the level that the athletes intentionally hurt the opponent points to the loss of the human dimension in sports competitions. Harshness in contemporary sport and many incidental events initiated the necessary intervention of the law in sport. Non-discretionary law deals with civil violations and misdemeanours. There are more and more cases of court disputes in modern sport. One of the many examples of violating the rights of the modern sport refers to a football match between Bradford City AFC and Huddersfield Town AFC (in 1999), the second league (First Division), in which a footballer with a rough start in the form of sliding has undermined the security of the opponent. As a result of this, a lawsuit initiated a legal challenge.

The court ruled that the player Kevin Gray is guilty. The indemnity amounted to £ 25,000. The past loss of earnings amounted to 152,461 pounds; the future loss of earnings amounted to 700,500 pounds; tax relief pensions benefit of 30,000 pounds are lost; lost bonus awards amounted to 8,265 pounds; medical expenses amounted to 12,168 pounds (Beech, 2010, pp 296).

This is just one example of sanctioning roughness in sport in order to protect the rights of athletes and the fundamental values of sport and games. Protecting athletes in ancient Greece was based on the principles of ethical codes. These codes were guiding athletes in pankration, a sporting event introduced into the Greek Olympic Games in 648 BC which was an empty-hand submission sport with scarcely any rules. The athletes used boxing and wrestling techniques, but also others, such as kicking and holds, locks and chokes on the ground. The only things not acceptable were biting and gouging out the opponent's eyes. Pankrationists, according to the codes of conduct, had to preserve their opponent's life, have mercy, be honourable, true, noble, humble and dignified in the fight (Mandaric, S., 2016, pp 107).

THEORETICAL CONSIDERATIONS

Fair Play

Fair play is an integral factor in all sports activities, and it refers not only to athletes, but also to other individuals who have contact with sports activities. Coaches, athletes, judges, and other passive participants in sporting events and sports environment board members, the media and others have equal responsibility in promoting fair play games. (Mićović, 2011, pp: 754).

In the name of all competitors, I promise that we shall take part in these Olympic Games, respecting and abiding by the rules that govern them, in the true spirit of sportsmanship, for the glory of sport and the honour of our teams

The text of the Olympic oath was published in the Olympic Charter in 1964, and the author of the oath was Pierre de Coubertin (Kragujević B. , 1984). The founder of modern Olympics, Pierre de Coubertin (Pierre de Coubertin) was the initiator of the moral norms of behaviour:

- Developing fair, friendly relationships among sports rivals,
- Respect for rules and referee's decisions,
- Developing activism with the aim to refine the sportive contest in the competition,
- Synchronising personal needs and interests with the needs and interests of the club, team,
- Developing anti-colonial, anti-racist, anti-nationalist attitude in wider sports competitions (Kozarčanin, 2008).

Promotion of fair play is also mentioned in the Olympic Charter, in 1991. It emphasises that the goal of the Olympic Movement is "to contribute to building a peaceful and better world through the education of young people in sport without any discrimination in the Olympic spirit, which implies mutual understanding, the spirit of friendship, solidarity and fair play" (Ranđelović, 2013, pp: 107). Fair play is highlighted in almost all the legal documentation related to the sport.

Everyone has the right to participate in sports and recreational activities which should be humane, free and voluntary, healthy and safe, in line with the natural and social environments, fair, tolerant, ethically acceptable and responsible, regardless of the abuse and objectives which are contrary to the spirit of sport, as well as available to all citizens on equal terms, regardless of age, the level of physical abilities, the level of any disability, gender and other personal attributes.

Sociological aspects of contemporary sport and physical education

Physical education and sport are increasingly moving away from each other. The common basis in the form of games, joy and the need to move slowly disappears from the domain of sport and remains only in terms of physical education. The level in which students - athletes are going to experience sport and physical education as an affirmative activity depends on the expertise of trainers and teachers of physical education. It is important to explain every significant aspect of sports activities and how to behave at trainings and competitions to the young athletes. Each child is an individual and has developed a personal pattern of behaviour on the basis of long-standing educational influence of parents, educators, teachers, society, and the media. It is necessary to have a systematic approach to the education of young athletes in terms of appropriate ways to react in different situations. Sports psychology can contribute to the adequate preparation of athletes in terms of their response and independent initiatives for a fair and correct competition (Mladenović, 2005, pp 54).

Imperative to win

The psychological dimension of competition in modern sport indicates certain negative behaviours of the individuals or a group of athletes. This indicates a systematic departure from the fundamental value of sport and competition. The reaction of athletes and coaches to victory and defeat points to their emotional stability and frustrating tolerance. Both victory and defeat have their positive and negative effects.

The positive effects of victory are: the feeling of success, satisfaction, security, optimism, etc. Victory must be presented to athletes as an enhancement of previous personal capabilities and an upgrade of knowledge, skills and abilities, not as dominating the opponent. The negative effects of victory relate to: excessive and unrealistic self-confidence, overestimation of their own capabilities, underestimation of the opponent's opportunities, etc. Coaches are often presenting defeats as an undesirable category, and as something unacceptable. In this way, they initiate a sense of insecurity and frustration in athletes, in case of bad results and defeat. The negative presentation of the defeat and the imperative of victory affect athletes so that they are trying to achieve the victory by using every allowed and unauthorized resource. Each defeat represents a new experience and an element of maturation and psychomotor upgrades. Defeat allows athletes to perceive the real level of their technical, physical and psychological readiness for the competition (Mladenović, 2005, pp 204). Amateurism has been abandoned as the guiding principle of the Olympic Movement since the Olympic Games in Seoul in 1988, and sport has become a part of a professional show business or pro-show, where the rules are different from those of the Etona playground (Renson, 2009).

PREVIOUS RESEARCH

Interesting research was conducted at the Faculty of Pedagogical Sciences of the University of Kragujevac (Jagodina), where students expressed their views on the issue of doping, the use of unfair procedures for the victory and potential prevention strategies. From the context of this research, 87.5% of respondents answered negatively to the question of whether to use unfair methods to reach victory (Ignjaović, 2014).

Research on the program content of physical education from the perspective of preventing violence was conducted in primary schools from the Šumadija district (Sretenović, 2013). The research involved the analysis of documents related to the school's plan and program, the development plan and the annual plan. The research results indicate that the development plan is contained in 73.92% of the surveyed schools.

The framework action plan for the prevention of violence is present in only 47.82% of the schools. What is striking is the fact that none of the 46 schools covered by the research do not have a general plan for the realization of physical education. These data indicate a lack of the directors' and teachers' responsibilities, as well as failure to plan the process of controlling the implementation of the Strategy as an obligatory document for educational institutions.

Social and economic degradation of the society, especially of the pedagogical profession, influenced the appearance of forms of deviant behaviour in individual students - athletes. Investigations of the violent and unsporting behaviour of young football players from the City of Zagreb showed that there is a certain tolerance of young athletes towards unsporting behaviour in important matches in the form of approving the player's push during the jump, lying about the ball position, pulling the opposing team, etc. The research results indicate that there is a relatively significant representation of violence between athletes in the various forms of verbal aggression (Risiš, 2016, pp. 24). 58.4% of young footballers consider the forms of roughness like pushing the opposing player during a jump generally or fully acceptable when it comes to an important game. 53.5% of football players consider dragging an opponent by the shirt, while 45.2% of them believe that it is acceptable to lie about the ball crossed in out, or in a corner.

These results point to the absolutely obvious negative influence of the coaches on the athlete's behaviour in order to achieve a certain result, advantage or victory. These are worrisome data about the results of research conducted among students on their attitude towards sport.

They are concerned with the results of research conducted among students on their attitude towards sport. The results of this research show a gradual degradation of the student's positive attitude towards sport. 61.65% of the respondents expressed a positive attitude towards sport, 15.29% expressed a moderate attitude and 23.06% of them expressed a negative one. Students who have expressed a negative attitude towards sports have a very negative perception of the meaning and importance of sport. They expressed the view that sport does not develop peacefulness and that it is boring, that it does not develop personality and that athletes are not brave (Milošević, 2016 pp: 139).

Contemporary sport and physical culture are also involved in a network of political goals. The primary value of sport and physical culture is affected by the socio - political impacts, with the aim of adopting control of children and the youth (Koković, 2008, pp. 74).

As a part of the strategy of sport development in the Republic of Serbia, general and specific goals are presented. One of those specific objectives is: "The improvement of media coverage and promotion of school and university sports with the aim of nurturing a culture of sporting behaviour, fair play, cooperation, tolerance and respect for diversity in sports grounds and next to them; enhanced links between schools and organizations in the field of sport and to encourage programs in sports that attract children and the youth" (Strategy for development of sport in the Republic of Serbia for the period 2014-2018).

GOAL OF THE RESEARCH

The aim of this research is to answer the following questions:

1. Whether athletes behave violently, and the extent of the athlete's violent and unsportsmanlike behaviour towards other athletes?
2. Do young sportswomen consider violent sporting behaviour as an integral part of sports?
3. Has cheating become an integral part of sports for the young athletes?
4. Is fair play present in sports of young athletes - is honesty worthy in sports?

RESEARCH HYPOTHESES

H1 - Most young athletes do not apply violence and misconduct towards other athletes. The impact of primary and secondary education system on students who participate in sports is the last ray of hope in contemporary society. Most socially responsible pedagogical workers are transferring positive values to their students and, thus, indirectly affect a positive transfer of a desirable behavioural approach to students who are participating in the sports activities. H2 - Young athletes do not consider violence as an integral part of sport. Although there are cases of violent behaviour in young athletes, it is not yet a mass phenomenon and corrective measures can be taken in order to solve this problem.

METHODOLOGY

The survey included 405 young athletes of both sexes in the territory of Vojvodina, aged 9-17 from the following sports: football, basketball and volleyball. The research included interviews of young athletes (anonymous survey) where the athletes marked seven dependent variables related to the phenomenon of fair play in sport with the answers yes or no. The research was conducted in the territory of Vojvodina in the period from September to November 2016. For achieving the goals of the study, the following statistical methods and analysis were used: (1) methods of descriptive statistics (frequencies), (2) methods of comparative statistics: T-test / LSD test / ANOVA / Comparison of Means.

RESEARCH RESULTS

Independent variables: gender, age, level of education, period of sports engagement are presented with descriptive statistics.

Table 1: Frequency

Age		N	%
Valid	7-9	61	14.1
	10-12	189	43.8
	13-15	161	37.3
	16-18	21	4.9
	Total	432	100

Table 2: Frequency

Gender		N	%
Valid	M	303	70.1
	F	129	29.9
	Total	432	100

Table 3: Frequency

Education level		N	%
Valid	Primary	381	88.2
	Secondary	51	11.8
	Total	432	100

Table 4: Frequency

Period of sports engagement		N	%
Valid	- 1 year.	30	6.9
	1-3 years.	252	58.3
	3-5 years.	129	29.9
	More than 5 years.	21	4.9
	Total	432	100

Comparative statistics show the results of the following tests: ANOVA, LSD, T-test and Comparison of Means. Multi-category independent variables (Age and Sporting Time) were subjected to ANOVA variance analysis with LSD test support, while the two-category variables were subjected to T-test and Comparison of MEANS.

Table 5: ANOVA

	F	Sig.
Sometimes I cheat to win	3.851	.010
Deliberate violation for victory	11.085	.000
Cheating is an integral part of sport	4.331	.005

Analysis of variance ANOVA indicates a significant difference in athletes of different ages in terms of the following variables: sometimes I cheat to win, deliberate violation for victory, cheating is an integral part of sport. In order to find out among which ages of athletes there is a statistically significant difference in terms of these variables, it is necessary to apply an LSD test.

Table 6: LSD (ages)

Dependent Variable	(I) ages	(J) ages	Mean Difference (I-J)	Sig.
Sometimes I cheat to win	7-9	10-12	.13444	.030
		13-15	.16251	.010
		16-18	.33021*	.002
Deliberate violation for victory	16-18	7-9	-.61124*	.000
		10-12	-.44444*	.000
		13-15	-.31056*	.006
Cheating is an integral part of sport	16-18	7-9	-.35831*	.002
		10-12	-.29101*	.006
		13-15	-.19876	.064

Table 7: MEAN

		Sometimes I cheat to win	Deliberate violation for victory	Cheating is an integral part of sport
7-9	Mean	1.9016*	1.7541*	1.7869*
10-12	Mean	1.7672	1.5873	1.7196*
13-15	Mean	1.7391	1.4534	1.6273
16-18	Mean	1.5714*	1.1429*	1.4286*
Total	Mean	1.7662	1.5394	1.6806

Based on a comparison between arithmetic means, it can be concluded that athletes aged 7-9 (M = 1.9) were statistically significantly different from athletes aged 16 to 18 (M = 1.57) because they declare that they do not cheat for victory. Athletes of older ages, 16-18 years old (M = 1.43), are significantly different compared to athletes aged 10-12 (M = 1.72), and especially in relation to the athletes aged 7-9 (M = 1, 79) regarding the attitude of cheating as an integral part of sport.

By analysing the ANOVA variance, it can be concluded that there are statistically significant differences in athletes with different periods of sports engagement in terms of the following variables: "If a lie would help me win, I would lie", "Cheating is an integral part of sport", "Sometimes I use roughness to gain advantage".
In order to find a statistically significant difference in the above mentioned variables, it is necessary to apply an LSD test. LSD test indicates a significant difference between athletes who train up to 1 year (M = 2.0) and athletes who train for 5-10 years (1.43), wherein the arithmetic values indicate that athletes who train up to 1 year, unlike the athletes who train for 5-10 years, would not lie for victory.

Table 8: ANOVA

Period of sports engagement	F	Sig.
I would lie for victory	12.718	.000
Cheating is an integral part of sport	14.603	.000
Sometimes I use roughness to gain adventage	14.579	.000

Table 9: LSD

Dependent Variable	(I) Period of sports engagement	(J) Period of sports engagement	Mean Difference (I-J)	Sig.
Sometimes I cheat to win	-1 year	1-3	.18651	.000
		3-5	.25659*	.000
		5-10	.57143*	.462
Sometimes I use roughness to gain adventage	16-18	1-3	.25714*	.005
		3-5	.44651*	.000
		5-10	.73333*	.000
Cheating is an integral part of sport	16-18	1-3	.06349	.005
		3-5	-.29845*	.000
		5-10	.54762	.000

The results of the LSD test also indicate the existence of statistically significant differences in the attitude of the athletes that cheating is an integral part of sports.

Comparing the arithmetic means, athletes who are engaged in sports for approximately 1 year (M = 1.83) do not agree with the statement that cheating is an integral part of sports, as opposed to athletes who have been engaged in sports for more than 5-10 years (M = 1.28).

Athletes who are engaged in sports for up to 1 year are statistically significantly different from athletes with longer sporting time in terms of the use of roughness for achieving the resultant advantage (up to 1 year M = 1.733, 3-5 years M = 1.29, 5-10 yrs. M = 1.00).

Independent Samples T-test was used in the case of two-category variables: gender and education of athletes.

Based on the T-test, it can be stated that there is a statistically significant difference between athletes of both sides in terms of the three examined variables: "Sometimes I cheat to win", "Intentional offence for injury" and "Cheating is an integral part of sport".

By comparing the arithmetic means, male athletes (M = 1.70) rarely, but still more likely, cheat for the victory (M = 1.91) in comparison with female athletes. It can also be concluded that female athletes would rarely choose a deliberate offence for victory (M = 1.85). In contrast, male athletes are more willing to make a deliberate offence to win (M = 1.41).

Based on the T-test, it can be concluded that there is a statistically significant difference between athletes of elementary and secondary school in relation to the three examined variables: "Sometimes I cheat to win", "If a lie would help me to win, I would lie", and "Cheating is an integral part of sport".

By comparing the value of the arithmetic means, secondary school athletes (M = 1.59) are more willing to cheat for victory than primary school athletes (M = 1.79). It can also be concluded that secondary school athletes l (M = 1.54) are more likely to lie than the athletes of primary school age (M = 1.78), if the lie would help them win.

Table 10: MEAN

Period of sports engagement	If a lie would help me win, I would lie	Cheating is an integral part of sport	Sometimes I use roughness to gain adventage
-1 year	2.0000*	1.8333*	1.7333*
1 - 3 years	1.8135	1.7698	1.4762
3 - 5 years	1.6434	1.5349	1.2868*

Period of sports engagement	If a lie would help me win, I would lie	Cheating is an integral part of sport	Sometimes I use roughness to gain adventage
5-10 years.	1.4286*	1.2857*	1.0000*
Total	1.7569	1.6806	1.4144

Table 11: T-test

Independent Samples Test					
T-test (gender)	Levene's Test for Equality of Variances		T-Test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Sometimes I cheat to win	153.481	.000	1.2868*	-4.878	.000
				-5.871	.000
Intentional offence for injury	195.170	.000	1.4144	-9.327	.000

Table 12: MEAN

Independent Samples Test					
				-10.590	.000
Cheating is an integral part of sport	66.293	.000	-3.469	430	.001
					.001

DISCUSSION

Research results show that younger athletes aged 7-9 are not inclined to cheat in order to achieve victory, unlike the athletes of older ages, especially athletes aged 16-18, who are much more likely to cheat in order to achieve victory. Older athletes are prone to making intentional offence for the victory, while the younger athletes significantly distance themselves from such conduct. Older athletes (16-18 years old) are significantly different in relation to the younger athletes in terms of attitude about cheating as an integral part of sport. They believe that cheating is an integral part of sports, while younger athletes do not agree with this attitude. These results are not surprising, given the recent research of athletes' behaviour and their relationship to fair play and respect for opponents. Adolescent athletes have a substantial imperative of victory built in their minds.

This imperative is in connection with the characteristic rebellious features of that age. Athletes belonging to the adolescent age have a substantial imperative of victory built-up. This imperative is in connection with the characteristic rebellious features of that age. The systematic and aggressive approach of coaches and parents to the imposition of categorical conditions in terms of outcome effect imposes frustration elements on many athletes, leaving some psychological emotional consequences in cases of non-fulfilments of unrealistic expectations.

There are a certain number of athletes (about 20%) who fall into the category of the so-called "problem" athletes (Mladenovic, 2005, pp 54). The trainer's job is to recognize these athletes and influence them independently or with the help of a psychologist to correct their behaviour. This has a positive effect on those athletes who do not behave according to ethical principles. An additional positive effect is achieved indirectly on other athletes as well, as they affirm positive attitudes about fair play and ethical codes in and out of sports.

The results of the research also point to the existence of statistically significant differences with athletes who have different duration of participation in sports regarding the following dependent variables: "If the lie helped me win, I would lie", "Cheating is an integral part of sport", "Sometimes I use roughness to gain advantage". Athletes who are briefly engaged in sports, and who train for up to one year would not lie with the aim to win. In contrast, athletes who train for a longer period of time are prepared to lie in order to achieve victory.

Athletes who are more involved in sports become more tolerant of the requirements of coaches, parents and team-mates with the aim of achieving results. The long-term influence of coaches imposing their attitude that victory has no price impacts young athletes to accept such an attitude as completely natural when it comes to sport. Plato emphasises nonsense in terms of upbringing, saying that "good upbringing also brings victory, and victory sometimes brings embarrassment and cruelty, because many become obedient because of their victories, and that obedience has become the source of all the other vices" (Cyril, 2016, according to Plato , Laws, pp.140.).

Table 13: MEAN

Period of sports engagement	gender	N	Mean	Std. Deviation	Std. Error Mean
Sometimes I cheat to win	M	303	1.7030	.45771	.02629
	F	129	1.9147	.28037	.02469
Intentional offence for injury	M	303	1.4059	.49189	.02826
	F	129	1.8527	.35577	.03132
Cheating is an integral part of sport	M	303	1.6304	.48350	.02778
	F	129	1.7984	.40272	.03546

Considering gender as an independent variable, it can be concluded that there is a statistically significant difference between athletes of both sexes with regard to the three examined variables: "Sometimes I lie for victory", "Deliberate offence to win" and "Cheating is an integral part of sport". Male athletes rarely, but more often, prefer to cheat for victory. It can also be concluded that it is rare that female athletes would chose deliberate offence.

By contrast, male-born athletes are more willing to make a deliberate offence if they would win the game.

By comparing the educational level, secondary school athletes are more willing to cheat for victory than primary school athletes. It can also be concluded that secondary school athletes are more likely to lie than the athletes of primary school, if the lie would help them win.

The results of this research contribute to the observation and realization of the real situation regarding the relation of young athletes to the phenomenon of fair play and behaviours.

CONCLUSION

The subject of this research was fair play, a fundamental phenomenon of sport, competition and its participants. The aim of this research was to research the attitudes of young athletes in terms of fair play behaviour in sports. The results of this research confirm the hypothesis H1 that most young athletes do not apply violence and unsportsmanlike behaviour to other athletes.

The positive influence of parents, pedagogues and institutions of pre-school and elementary school education on general culture of behaviour has a positive effect on sport and behaviour in the sport environment. Athletes who are longer engaged in sports are faced with unrealistic expectations, pressure, distorted value categories and other negative effects.

This affects a significant number of athletes in adolescent ages and can leave permanent negative consequences in the form of deformation in the socio-psychological context.

The results of the research confirm the hypothesis H2, which states that young athletes do not see cheating as an integral part of sport. Manifestations of violent behaviour and a tendency towards deliberate violations do not represent a mass phenomenon.

It is necessary to include, in the curriculum of educational workshops, an introduction of the historical sense of fair play games and codes of conduct which originate back in the distant past to the young athletes.

The period of adolescence, when the negative influence of the media and society is the strongest, is particularly important. The results of this research confirm the results of previous fair play phenomena and represent an excellent basis for similar or comparative research.

It also opens up space for more detailed research based on interdisciplinary approaches, so that this important theme can be seen from several angles.

Table 14: T-test

Independent Samples Test					
T-test (education level)	Levene's Test for Equality of Variances		T-Test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Sometimes I cheat to win	20.820	.000	3.229	430	.000
			2.777	59.354	.000
I would lie for victory	22.818	.000	3.737	430	.000
			3.209	59.316	.000
Deliberate offence for victory	38.172	.000	4.109	430	.001
			4.415	67.221	.001

Table 15: MEAN

Period of sports engagement	Gender	N	Mean	Std. Deviation	Std. Error Mean
Cheating is an integral part of sport	Primary school	381	1.5748	.49502	.02536
	Secondary school		1.2745	.45071	.023087

Table 16: MEAN

Period of sports engagement	Gender	N	Mean	Std. Deviation	Std. Error Mean
Sometimes I would cheat to win	Primary school	381	1.7900	.40783	.02089
	Secondary school	51	1.5882	.49705	.06960
Deliberate offence to win	Primary school	381	1.7848	.41152	.02108
	Secondary school	51	1.5490	.50254	.07037

REFERENCES

1. Beech J., Chadwick S. (2010). Sportski menadžment, Mate D.o.o., Zagreb.
2. Ignjatović, A. et al. (2014) Stavovi studenata pedagoškog fakulteta o korišćenju nedozvoljenih sredstava I metoda zarad pobede, Zbornik radova Međunarodne naučne konferencije, Beograd, 11-12. decembar, Univerzitet u Beogradu: Fakultet sporta i fizičkog vaspitanja.
3. Кастратовић, Е., (2014). Правна регулатива на нивоу ЕУ у функцији организовања и управљања у спорту, Часопис за правну теорију и праксу „Правни живот", Удружење правника Србије, 27. Копаоничка школа природног права, ИССН 0350-0500 2014, књига 571, br. 9, стр. 487-499.
4. Koković, D. (2008). Naličje takmičenja, Prometej, Novi Sad.
5. Kozarčanin, A. (2008). Etika u sportu, Sport Science Vol.1 (1): 54-56.
6. Kragujević, B. (1984). Sa olimpijskih borilišta: brže – više – jače, Zavod za udžbenike i nastavna sredstva, Beograd.
7. Mandarić, S., Delibašić, V. (2016) Krivičnopravni aspekt povreda u sportu, Beograd: Fizička kultura 70 (2): 105-114.
8. Mićović, M. (2011) Lex sportiva I fair-play, Zbornik radova Pravnog fakulteta u Splitu, 48 (4): 749-757.
9. Milošević, Z., et al. (2016). Opšti stav prema sportu učenika osnovne škole, Zbornik radova Menadžment i sport, Beograd: Fakultet za menadžment u sportu, (136-144.).
10. Mladenović, V. U. (2005). Psihologija u sportu, Sportska Akademija, Beograd.
11. Ranđelović, N. et al. (2013). Humanistički aspekti savremenog sporta, Univerzitet u Nišu, Zbornik radova Druge Međunarodne naučne konferencije "Antropološki I teoantropološki pogled na fizičke aktivnosti od Konstantina Velikog do danas": 105-115.

ISTRAŽIVANJE ODNOSA MLADIH SPORTISTA PREMA FAIR PLAY ILI POŠTENOJ IGRI

Ovaj rad opisuje istraživanje odnosa mladih sportista prema fair play postupcima u sportu. Predmet istraživanja su bili fair play postupci, fenomen koji predstavlja izvornu smjernicu u sportu i smjernicu za svaki sportski događaj u historiji. Cilj ovog istraživanja je analizirati trenutnu situaciju u sportu po pitanju nasilnog ponašanja i odobravanja takvog ponašanja od strane djece koja se aktivno bave sportom.

Istraživanje također za cilj ima odrediti da li sportisti smatraju da su nasilje i kršenje pravila integralni dio sporta, te da li su fair play postupci još uvijek prisutni u amaterskim sportovima? Rezultati ovog istraživanja ukazuju da postoji razlika između mlađih sportista i sportista-adolescenata kada su u pitanju ponašanje i stavovi vezani za fair play postupke. Rezultati potvrđuju da se većina mladih sportista ne ponašaju nasilno i nedolično prema drugim sportistima. Rezultati također ukazuju da mladi sportisti smatraju da kršenje pravila nije integralni dio sporta i razumijevanja sporta.

Rezultati ovog istraživanja doprinose razumijevanju i shvatanju stvarne situacije po pitanju odnosa mladih sportista prema fenomenu fair play igre. Mladi sportisti ne vide kršenje pravila kao integralni dio sporta, te smatraju da su fair play postupci još uvijek prisutni među mladim sportistima.

Ključne riječi: Fair play, sport, nasilje, etika, takmičenje .

Received: December 10, 2017 / Accepted: December 15, 2017
Correspondence to: Edita Kastratović, PhD, Faculty for Business Economics and Entrepreneurship Belgrade, Serbia
E-mail: kastratovice@yahoo.com

DO OBSERVATIONAL LEARNING AND RANDOM PRACTICE INCREASE THE LEARNING OF MOTOR SKILLS?

Amir Shams[1], Davoud Fazeli[2]

1. Sport Science Research Institute, Miremad Street, Fifth alley, Tehran, Iran.

ABSTRACT

The aim of this study was to examine the effect of contextual interference (practice schedule: blocked and random) and practice type (physical, observational, and mixed) on learning badminton services. Therefore, 96 male volunteer, novice and right handed students were randomly divided into 6 groups (which included blocked physical practice, random physical practice, blocked observational practice, random observational practice, blocked mixed practice, and random mixed practice). The participants performed a pre-test, exercised for eight sessions (two blocks of nine trials per session) and then participated in the acquisition, retention and transfer tests. The results showed that in the acquisition stage, the groups of blocked mixed and physical practice had a better performance than other groups. However, the results in the retention and transfer stages showed a significant difference between the experimental groups' performance. The results showed that the random mixed and physical practice groups had a better performance than other groups in all stages. According to the results of present research, it can be recommended to the coaches to use the random mixed practice while teaching the sport skills.

Keywords: contextual interference, observational practice, physical practice, mixed practice, badminton service

INTRODUCTION

Awareness of the processes involved in motor skill learning largely depends on the progress in human knowledge related to control and learning of movements. Therefore, attention to the principles and rules of motor skills performance has the great effect in how to teach these skills. In recent years, the influence of cognitive processing during motor skill learning has been an interesting topic for researchers (Wright, Li, & Coady, 1997).

Accordingly, one of the factors that can affect motor skill learning is the observational practice (Black, Wright, Magnuson, & Brueckner, 2005). Because of the important role of vision in skill learning, skill demonstration is one of the most powerful means that coaches use for short-term transfer of important information to learners (Schmidt & Lee, 2011).

According to Shea, Wright, Wulf, and Whitacre (2000) , modelling may facilitate skill acquisition and this factor, especially in the early stage of learning by skill observation, can help to produce motor patterns.

Carroll and Bandura (1990) proposed the cognitive mediation theory and suggested that modelling is one of the important methods for providing information about the performance of motor skills.

Besides, modelling led to the production and development of cognitive or perceptual representation by the observer, and, as a reference, it can help the observer to acquire a behaviour before it becomes fully active.

Accordingly, a learner acquires the cognitive demonstration from the skills and uses it to regulate the movement and as a correct criterion for error detection to perform the movement (Granados & Wulf, 2007).

On the other hand, proponents of the direct perception view of vision believe that in this perspective, action is understood directly and does not need cognitive mediators for converting observation to action, and the visual system is able to automatically process the visual information (Scully & Newell, 1985). Additionally, Bandura (1986) stated that observer learns model

performance through the development of a perceptual task blueprint. Therefore, the development of a perceptual blueprint increases through repeated skill demonstration.

Carroll and Bandura (1990) also proposed that when observers are exposed to a model, they emulate the generalizations or rules related to performance. These rules are effective in bringing the cognitive strategies that will affect their performance.
As for the effectiveness of observational practice on motor skills, several studies have shown that observational practice affected motor skill learning (Blandin, Lhuisset, & Proteau, 1999; Blandin & Proteau, 2000).

In addition, other studies showed that the physical practice group was better learned compared to the observational practice group (Buchanan & Dean, 2010; Buchanan, Ryu, Zihlman, & Wright, 2008; Cross, Kraemer, Hamilton, Kelley, & Grafton, 2009; Maslovat, Hodges, Krigolson, & Handy, 2010). In other studies, authors did not observe significant differences between physical practice and observational practice groups (Badets, Blandin, & Shea, 2006; C. H. Shea et al., 2000; Black et al., 2005).

Moreover, (Shea et al., 2000) found that, in the retention test, there were no significant differences between the physical practice group compared to the mixed (observational and physical practice) practice group.

In the transfer test, the mixed practice group performed significantly better than the physical practice group. They suggested that the combination of observational and physical practice provides unique opportunities for learning, beyond those available via either practice regimen alone.

Another factor that affects cognitive processing during the acquisition of motor skills is contextual interference (CI) during practice and skill learning (Fairbrother, Shea, & Marzilli, 2007; Wright et al., 1997).

CI is defined as an interference resulting from performing various tasks or skills within the context of practice. In other words, CI refers to the finding that practice of multiple tasks or variants of the same task under a random practice or high CI leads to better retention and transfer performance when compared to a blocked practice or low CI (Boutin & Blandin, 2010a).

There are two theoretical explanations for the CI effect in the motor learning field. Shea and Morgan (1979) and Shea and Zimny (1983) in their elaboration hypothesis proposed that random practice forces the learner to engage into more elaborate and distinctive processing, such as inter-task comparisons of the to-be-learned tasks, which are thought to highlight the similarities and differences between the tasks being acquired.

This inter-task elaboration is supposed to occur during the inter-trial interval and is considered to be critical in allowing the learner to formulate a detailed task representation that is also assumed to facilitate retention performance.
Such inter-task comparisons are impossible under blocked practice because of the trial-to-trial repetition of a particular task (Boutin & Blandin, 2010b).

On the other hand, the action plan reconstruction hypothesis (Lee & Magill, 1983) postulates that learning skills in a random practice requires the learner to actively reconstruct many action plans, which in turn leads to more effortful processing and a more permanent memory (Brady, 2008).

This importance issue that the functional relationship between practice schedules (contextual interference or CI) with the use of physical and observational practice has received little attention in literature.

Therefore, it was argued that, if learning through physical and observational practice are mediated by similar underlying processes, the use of an interspersed schedule of physical and observational practice trials during acquisition will not allow one to dissociate the effect of both variables on skill learning (Blandin, Proteau, & Alain, 1993; Blandin, Proteau, & Alain, 1994; Deakin & Proteau, 2000).

Accordingly, Lee and White (1990) found that the random mixed group was better than the random physical and observational practice groups. In addition, it was found that the random physical practice group performs better than the blocked and random observational groups (Blandin et al., 1993; Blandin et al., 1994; Wright et al., 1997).

On the other hand, no significant difference was reported between physical and observational groups that practiced with the random and blocked methods (Colson, 1997).

Moreover, in some studies, mixed practice groups were not used by using a CI condition (Blandin et al., 1993; Blandin et al., 1994; Wright et al., 1997).

Considering that today's random practice has been recognized as one of the most effective practice methods on motor learning, and observation plays an important role in motor skills learning, a question arises regarding which of the physical, observational and mixed practice methods, using low and high CI is more effective on learning the short, long and sharp badminton services?

METHODS

Participants

The participants were comprised of 96 right-handed volunteer male students (mean age=22 years, SD= 1.5) who had no previous experience in the field of badminton and were unaware of the purpose of this research. The participants from the general physical education classes were selected and, prior to entering the research protocol, randomly assigned to one of the six experimental groups (N=16 in each group): blocked physical practice, random physical practice, blocked observational practice, random observational practice, blocked mixed practice and random mixed practice.

Apparatus and task

To collect data, the French and Statler standard test for the short service, Fox and Scott standard test for long service and Ballou standard test for badminton sharp service were used.

Procedures

Before beginning the experiment, all participants took part in a session on familiarisation with the ball, racket and court badminton, as well as on how to correctly perform the short, long and sharp services. After this session, they participated in pre-test. This stage included one-block of nine trials (3×3) and each group performed three trials for each short, long and sharp service, with serial practice at the right side of the badminton court. The blocked physical practice group, in all the training trials, in each block respectively, performed the three short services, then three long services, and three sharp services. The random physical practice group performed all their trials in each block with random arrangement and did not repeat each service for two consecutive times.

However, in each block of training, the number of services (short, long and sharp) was equal. In addition, each participant in the blocked and random observational practice groups was yoked with one participant of the blocked and random physical practice groups, respectively, and their performance was observed.

The blocked mixed practice group performed the first half of their training trials (one block of 9 trials) in each session as the blocked physical practice group, and the other half of training trials (one block of 9 trials) were observed by another member of their group. Finally, the random mixed practice group, in each session, performed the first half of their training trials (one block of 9 trials) as the random physical practice group, and the other half of practice trials (one block of 9 trials) were observed by another member of their group. In addition, to control the order effect in blocked and random mixed practice groups, they first performed physical practice and then observational practice in one session, and, in the next session, this procedure was reversed. All groups practiced the tasks for eight sessions and performed an acquisition test in the last day of practice.

72 hr after the completion of the acquisition test, all groups took part in a retention test and performed one block of 9 trials. Then, the participants performed one block of 9 trials in a transfer test at the left side of the badminton court. Moreover, the average score of nine performed services was calculated as a score of the participant in acquisition, retention, and transfer tests.

Statistical Analysis

The data have been analysed with the following statistical methods: One-Way Analysis of Variance (ANOVA) in the pre-test, and Two-Factor Analysis of Variance 3 (type of practice: physical, observational and mixed) × 2 (practice schedule: random and blocked). Moreover, in order to identify the differences among groups, the Bonferroni post-hoc test was used at the significance level of $P<0.05$.

RESULTS

In the pre-test, One-Way Analysis of Variance (ANOVA), the test results showed that the difference of mean scores with $F(5, 90) = 1.250$ and $P=0.292$ was not significant. To assess the effect of practice type (physical, observational and mixed) and practice schedule (random and blocked practice) in acquisition, retention and transfer tests, the data were analysed with Two-Factor Analysis of Variance 3 (type of practice) × 2 (practice schedule).

The results in the acquisition test showed that the main effect of practice type (physical, observational and mixed) with $F=396.839$ was significant at the level of $P=0.001$.

The Bonferroni post-hoc test results showed that there was a significant difference between blocked physical and mixed practice groups, compared to other groups. Also, there was no significant difference between block physical and mixed practice groups. The main effect of practice schedule (random and blocked practice) with $F=118.358$ at the level of $P=0.001$ was significant.

Generally, blocked practice groups (=4.39) have better performance than random practice groups (= 3.58). The interaction effect of practice type and practice schedule with F=0.794 was not significant (P>0.05).

In the retention test, the results showed that the main effect of practice type with F=614.828 was significant at the level of P=0.001. The Bonferroni post-hoc test results showed that there was a significant difference between random physical and mixed practice groups, compared to other groups.

Also, there was a significant difference between random mixed practice group (= 4.28) and random physical practice group (= 3.96). The main effect of practice schedule with F=94.422 at the level of P =0.001 was significant.

Generally, random practice groups (= 3.49) have better performance than blocked practice groups (= 2.93). The interaction effect of practice type and practice schedule with F=0.120 was not significant (P>0.05).

In the transfer test, the results showed that the main effect of practice type with F=219.015 was significant at the level of P=0.001. The Bonferroni post-hoc test results showed that there was a significant difference between random physical and mixed practice groups, compared to other groups.

In addition, there was a significant difference between the random mixed practice group (= 3.78) and random physical practice group (= 3.06). The main effect of practice schedule with F=94.422 at the level of P =0.001 was significant. Generally, random practice groups (= 2.89) have better performance than blocked practice groups (= 2.30). Also, the interaction effect of practice type and practice schedule with F=3.581 was significant at the level of P=0.032. Figure 3 shows the mean scores in all stages of the experiment.

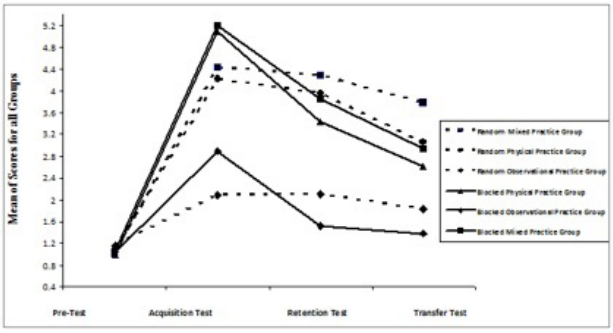


Figure 3: The mean of scores for 6 groups in all stages of the experiment

DISCUSSION

Most laboratory-based studies have been relatively consistent in producing the CI effect, where random practice (high CI) condition enhances learning in retention and transfer tests, rather than compared with the performance in acquisition test. However, non-laboratory or applied research, in real environments and with athletic skills, has provided findings both supporting and not supporting the results of laboratory findings (Porter, Landin, Hebert, & Baum, 2007). Also, studies have shown that visual demonstration is an important tool for motor skill learning (Blandin & Proteau, 2000). Therefore, the purpose of this study was the evaluation of CI effect (random and blocked practice) and practice type (physical, observational and mixed practice) on learning the short, long and sharp badminton services.

The acquisition test results showed that the performance of blocked mixed and physical practice groups was significant as opposed to the other groups, and random observational practice group, at this stage, has the weakest performance. Retention and transfer test results showed that random mixed and physical practice groups have a significantly higher mean than other groups, respectively, and blocked observational practice group has, significantly, the weakest performance.

Our results, based on the CI effect and type of practice, are consistent with the findings of previous studies (Blandin et al., 1993; Blandin et al., 1994; Lee & White, 1990; Wright et al., 1997). However, our results are inconsistent with the findings of Colson (1997). Perhaps, the inconsistency of our results could be attributed to the task type, non-laboratory skills and total number of trials with other studies.

Based on neuroimaging studies, it was demonstrated that the cortical motor regions (such as the pre-motor cortex, sensory motor cortex, dorsal and ventral pre-motor cortex, supplementary motor area (SMA) and posterior parietal cortex) are activated when participants attempt to perform tasks in high CI (random practice) condition, when compared to low CI (blocked practice) condition (Aoki et al., 2005; Lin, Fisher, Winstein, Wu, & Gordon, 2008; Lin, Winstein, Fisher, & Wu, 2010; Meister et al., 2005).

On the other hand, several neuroimaging studies reported that the common neural structures (including the pre-motor cortex, SMA, inferior parietal lobule, cingulate gyrus and cerebellum) are activated during physical and observational practice (Gallese & Goldman, 1998; Grezes & Decety, 2001; Jeannerod, 1999, 2001).

Therefore, applying the random mixed (physical and observational) practice activates the different motor regions and, probably, the combination of both random practice and mixed practice benefits led to more learning.

Our results, based on observational practice studies, are consistent with some of previous studies (Buchanan et al., 2008; Cross et al., 2009; Hodges, Chua, & Franks, 2003). These studies showed that the mixed practice group has better performance than the observational and physical practice groups. However, our results are inconsistent with many studies reported in the literature, which showed that the observational practice group had better performance than other groups, or they reported no significant difference between the groups (Badets & Blandin, 2005; Badets et al., 2006; Black & Wright, 2000; R. Magill & Schoenfelder-Zohdi, 1996).

In this regard, Deakin and Proteau (2000) stated that, during practice, both the observer and the learner engaged in processing identification and error correction. At least, some of the cognitive activities associated with observational practice are similar to those a person is experiencing while doing physical practice. However, these findings, stating that observational practice alone is not effective enough in relation to the physical and mixed practices, suggest that the performer is unable to experience all the necessary processes that are provided through physical or mixed practice. Also, Shea et al. (2000) stated that a fundamental difference between observational and physical practice is that the needs of these two practice types are different in response to the processing stage. Carroll and Bandura (1990) also found that the groups which observed the video eight times prior to their trials had better performance than those observers with only two trials before practice.

On the other hand, our results showed that the participants' performance in the random practice group (high CI), in the retention and transfer test, is better than the blocked practice groups (low CI). Magill and Anderson (2007) suggested that this effect could be explained by contextual dependency. Contextual dependency refers to a situation where learners develop a dependency on the context in which blocked practice occurs. This then hinders the performance during the transfer to task variations or conditions different from those experienced in practice rather than random practice (high CI).

However, due to the skills used in this study which had a different motor program, the obtained result was probably justified by the action plan reconstruction hypothesis (Magill & Hall, 1990). According to this theory, when tasks or skills are controlled by different generalized motor programs, CI effect occurs in generalized motor program learning. The basic idea is that random practice causes the learner to forget some task-specific information of the action plan previously encoded, and consequently, forces the learner to engage in a temporary but heightened reconstructive processing to generate an action plan before executing the forthcoming movement of that task (i.e. inter-task reconstruction). In contrast, Boutin and Blandin (2010a) argued that in the forgetting process, reconstruction processing was assumed to be responsible for the learning benefits which may be bypassed or minimized in the case of blocked practice.

On the other hand, other researchers, (Shea & Morgan, 1979; Shea & Zimny, 1983)by presentation of the elaboration hypothesis, proposed that random practice forces the learner to engage in more elaborate and distinctive processing such as inter-task comparisons. Indeed, because the multiple task variations to be learned reside together in working memory, they can be compared and contrasted at any given time during acquisition. Such comparisons during practice are impossible under blocked practice because only one task is present in the working memory. Therefore, higher levels of cognitive effort occur for learners during random practice because they engage in better relational and or distinctive processing of their actions (Boutin & Blandin, 2010b).

Our results are inconsistent with the direct perception view of vision (Scully & Newell, 1985). According to this theory, the observation could be to facilitate the production of movement and the coordination aspects (such as the relative motion of the body and organs and specific skills that are the most important elements acquired from observation). Vice versa, according to Schmidt's schema theory, an observer's primary attempts to perform movements have no difference with the control group and are weaker than the physical practice group. Based on this, observation alone could be beneficial to improve memory (recall schema) that is involved in the action production. Lee and White (1990) proposed that, in the absence of any physical practice, the formation of action plans and strategies for movement implication may not occur during observational practice. Also, it was argued that observational practice might not be more effective than physical practice, because some aspects of learning are unique to physical practice and cannot be experienced during observational practice (Granados & Wulf, 2007; Shea et al., 2000).

In summary, our results demonstrated that the random mixed practice group led to more learning than the other groups. In accordance with this result, it could be proposed that, during motor skill teaching, teachers and coaches apply the random mixed practice for more efficient learning.

REFERENCES

1. Aoki, T., Tsuda, H., Takasawa, M., Osaki, Y., Oku, N., Hatazawa, J., & Kinoshita, H. (2005). The effect of tapping finger and mode differences on cortical and subcortical activities: a PET study. Experimental brain research, 160(3), 375-383.
2. Badets, A., & Blandin, Y. (2005). Observational learning: Effects of bandwidth knowledge of results. Journal of Motor Behavior, 37(3), 211-216.
3. Badets, A., Blandin, Y., & Shea, C. H. (2006). Intention in motor learning through observation. The Quarterly Journal of Experimental Psychology, 59(2), 377-386.
4. Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. NY.: Prentice-Hall.
5. Black, C. B., & Wright, D. L. (2000). Can observational practice facilitate error recognition and movement production? Research quarterly for exercise and sport, 71(4), 331-339.
6. Black, C. B., Wright, D. L., Magnuson, C. E., & Brueckner, S. (2005). Learning to detect error in movement timing using physical and observational practice. Research quarterly for exercise and sport, 76(1), 28-41.
7. Blandin, Y., Lhuisset, L., & Proteau, L. (1999). Cognitive processes underlying observational learning of motor skills. The Quarterly Journal of Experimental Psychology: Section A, 52(4), 957-979.
8. Blandin, Y., & Proteau, L. (2000). On the cognitive basis of observational learning: development of mechanisms for the detection and correction of errors. The Quarterly Journal of Experimental Psychology: Section A, 53(3), 846-867.
9. Blandin, Y., Proteau, L., & Alain, C. (1993). Apprentissage par observation d'une tâche d'anticipation-coïncidence. Science et motricité, 20, 35-42.
10. Blandin, Y., Proteau, L., & Alain, C. (1994). On the cognitive processes underlying contextual interference and observational learning. Journal of Motor Behavior, 26(1), 18-26.
11. Boutin, A., & Blandin, Y. (2010a). Cognitive underpinnings of contextual interference during motor learning. Acta psychologica, 135(2), 233-239.
12. Boutin, A., & Blandin, Y. (2010b). On the cognitive processes underlying contextual interference: Contributions of practice schedule, task similarity and amount of practice. Human movement science, 29(6), 910-920.
13. Brady, F. (2008). The contextual interference effect and sport skills. Perceptual and motor skills, 106(2), 461-472.
14. Buchanan, J. J., & Dean, N. J. (2010). Specificity in practice benefits learning in novice models and variability in demonstration benefits observational practice. Psychological Research PRPF, 74(3), 313-326.
15. Buchanan, J. J., Ryu, Y. U., Zihlman, K., & Wright, D. L. (2008). Observational practice of relative but not absolute motion features in a single-limb multi-joint coordination task. Experimental brain research, 191(2), 157-169.
16. Carroll, W. R., & Bandura, A. (1990). Representational guidance of action production in observational learning: A causal analysis. Journal of Motor Behavior, 22(1), 85-97.
17. Colson, R. (1997). The effects of contextual interference during observational learning on the cognitive representation and acquisition of a motor task. Florida State University.
18. Cross, E. S., Kraemer, D. J., Hamilton, A. F. d. C., Kelley, W. M., & Grafton, S. T. (2009). Sensitivity of the action observation network to physical and observational learning. Cerebral cortex, 19(2), 315-326.
19. Deakin, J. M., & Proteau, L. (2000). The role of scheduling in learning through observation. Journal of Motor Behavior, 32(3), 268-276.
20. Fairbrother, J. T., Shea, J. B., & Marzilli, S. T. (2007). Repeated retention testing effects do not generalize to a contextual interference protocol. Research quarterly for exercise and sport, 78(5), 465-475.
21. Gallese, V., & Goldman, A. (1998). Mirror neurons and the simulation theory of mind-reading. Trends in cognitive sciences, 2(12), 493-501.
22. Granados, C., & Wulf, G. (2007). Enhancing motor learning through dyad practice: contributions of observation and dialogue. Research quarterly for exercise and sport, 78(3), 197-203.
23. Grezes, J., & Decety, J. (2001). Functional anatomy of execution, mental simulation, observation, and verb generation of actions: a meta-analysis. Human brain mapping, 12(1), 1-19.
24. Hodges, N. J., Chua, R., & Franks, I. M. (2003). The role of video in facilitating perception and action of a novel coordination movement. Journal of Motor Behavior, 35(3), 247-260.
25. Jeannerod, M. (1999). The 25th Bartlett Lecture: To act or not to act: Perspectives on the representation of actions. The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology.
26. Jeannerod, M. (2001). Neural simulation of action: a unifying mechanism for motor cognition. Neuroimage, 14(1), S103-S109.
27. Lee, T. D., & Magill, R. A. (1983). The locus of contextual interference in motor-skill acquisition. Journal of Experimental Psychology:

Learning, Memory, and Cognition, 9(4), 730.

28. Lee, T. D., & White, M. A. (1990). Influence of an unskilled model's practice schedule on observational motor learning. Human movement science, 9(3), 349-367.
29. Lin, C.-H., Fisher, B. E., Winstein, C. J., Wu, A. D., & Gordon, J. (2008). Contextual interference effect: Elaborative processing or forgetting—Reconstruction? A post hoc analysis of transcranial magnetic stimulation—Induced effects on motor learning. Journal of Motor Behavior, 40(6), 578-586.
30. Lin, C.-H., Winstein, C. J., Fisher, B. E., & Wu, A. D. (2010). Neural correlates of the contextual interference effect in motor learning: a transcranial magnetic stimulation investigation. Journal of Motor Behavior, 42(4), 223-232.
31. Magill, R., & Schoenfelder-Zohdi, B. (1996). A visual model and knowledge of performance as sources of information for learning a rhythmic gymnastics skill. International Journal of Sport Psychology, 27(1), 7-22.
32. Magill, R. A., & Anderson, D. (2007). Motor learning and control: Concepts and applications (Vol. 11): McGraw-Hill New York.
33. Magill, R. A., & Hall, K. G. (1990). A review of the contextual interference effect in motor skill acquisition. Human movement science, 9(3), 241-289.
34. Maslovat, D., Hodges, N. J., Krigolson, O. E., & Handy, T. C. (2010). Observational practice benefits are limited to perceptual improvements in the acquisition of a novel coordination skill. Experimental brain research, 204(1), 119-130.
35. Meister, I., Krings, T., Foltys, H., Boroojerdi, B., Müller, M., Töpper, R., & Thron, A. (2005). Effects of long-term practice and task complexity in musicians and nonmusicians performing simple and complex motor tasks: Implications for cortical motor organization. Human brain mapping, 25(3), 345-352.
36. Porter, J. M., Landin, D., Hebert, E. P., & Baum, B. (2007). The effects of three levels of contextual interference on performance outcomes and movement patterns in golf skills. International journal of sports science & Coaching, 2(3), 243-255.
37. Schmidt, R. A., & Lee, T. (2011). Motor control and learning: Human kinetics.
38. Scully, D., & Newell, K. (1985). Observational-Learning and the Acquisition of Motor-Skills-toward a Visual-Perception Perspective. Journal of Human Movement Studies, 11(4), 169-186.
39. Shea, C. H., Wright, D. L., Wulf, G., & Whitacre, C. (2000). Physical and observational practice afford unique learning opportunities. Journal of Motor Behavior, 32(1), 27-36.
40. Shea, J. B., & Morgan, R. L. (1979). Contextual interference effects on the acquisition, retention, and transfer of a motor skill. Journal of Experimental Psychology: Human Learning and Memory, 5(2), 179.
41. Shea, J. B., & Zimny, S. T. (1983). Context effects in memory and learning movement information. Advances in Psychology, 12, 345-366.
42. Wright, D. L., Li, Y., & Coady, W. (1997). Cognitive processes related to contextual interference and observational learning: A replication of Blandin, Proteau, and Alain (1994). Research quarterly for exercise and sport, 68(1), 106-109.

DA LI OPSERVACIJSKO UČENJE I NASUMIČNI TRENINZI POBOLJŠAVAJU UČENJE MOTORIČKIH VJEŠTINA?

Cilj ove studije je bio ispitati efekat kontekstualnih prepreka (raspored treninga: ograničen i nasumičan) i vrste treninga (fizički, opservacijski i mješoviti) na učenje servisa u badmintonu. Prema tome, 96 učenika, volontera muškog spola koji su početnici i dešnjaci, je nasumično podijeljeno u 6 grupa (koje su uključivale ograničeni fizički trening, nasumični fizički trening, ograničeni opservacijski trening, nasumični opservacijski trening, ograničeni mješoviti trening i nasumični mješoviti trening). Učesnici su bili podvrgnuti predtestiranju, izvršili osam treninga (dva bloka od devet pokušaja po treningu), te učestvovali u testovima usvajanja, pamćenja i prenošenja znanja. Rezultati su pokazali da su, u fazi usvajanja, grupe učesnika podvrgnute ograničenom mješovitom i fizičkom treningu imale bolju izvedbu od drugih grupa. Međutim, rezultati u fazama pamćenja i prenošenja su pokazali značajnu razliku u izvedbi između učesnika eksperimentalnih grupa. Rezultati su pokazali da su grupe učesnika podvrgnute nasumičnom mješovitom i fizičkom treningu imale bolju izvedbu od drugih grupa u svim fazama. U skladu sa rezultatima ovog istraživanja trenerima se može preporučiti korištenje nasumičnog mješovitog treninga tokom učenja sportskih vještina.

Ključne riječi: kontekstualne prepreke, opservacijski trening, fizički trening, mješoviti trening, servis u badmintonu

Received: May 27, 2018 / Accepted: June 25, 2017
Correspondence to: Davoud Fazeli, Ferdowsi University of Mashhad, Iran
E-mail: david.fazeli@stu.um.ac.ir

DIFFERENCES IN THE LEVEL OF PHYISICAL ACTIVITY BETWEEN STUDENTS WITH DIFFERENT NUTRITIONAL STATUS

Jelena Alić[1], Gordana Ivković[2], Nevia Mavra[3]

1. University of Zadar, Department of Teacher and Pre-school Teacher Education, Croatia
2. University of Zadar, Department of Teacher and Pre-school Teacher Education, Croatia
3. University of Zagreb, Faculty of Kinesiology, Croatia, a student of Doctoral studies

ABSTRACT

An insufficient level of physical activity among student population may generate numerous negative health, psychological, socio-economic and ecological effects. For this reason, targeted action is required in order to obtain the level of recommended physical activity (PA) among students. The aim of this study is to determine the level of PA on the sample of 312 female students of the University of Zadar and the differences in the level of PA between the subgroups of different nutritional status. The body mass index was calculated for the purpose of determining the nutritional status and the International Physical Activity Questionnaire (IPAQ) was used to assess both the overall level of PA and domain-specific PA. The obtained results indicate that the PA level of female students at the University of Zadar (64.75 MET-hours/week) is higher than the one measured among students from other universities. The highest level of PA measured is household PA (16.17 MET-hour/week), followed by leisure-time PA (14.69 MET-hours/week) and transportation PA (14.39 MET-hours/week). The results of Kruskal-Wallis test indicate that there are no statistically significant differences in the overall PA level of female students with different nutritional status. The differences were observed only in the frequency of leisure-time PA (p=0.05). Both the normal weight female students and obese female students show a statistically significant higher level of PA in leisure time than their underweight and overweight female colleagues.
Considering the obtained results, the interventions with regard to increasing the level of PA should be directed towards the leisure-time domain and overweight female students.

Keywords: Differences, nutritional status, physical activity, students

INTRODUCTION

Besides the need for oxygen and water, the need for movement is one of the basic biotic life-sustaining human needs (Abernethy, 2005). Physical activity is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen, Powel and Christensen, 1985) and it involves all bodily movements, i.e. occupational, leisure-time and sports activities. It can be categorized according to the level of intensity into low level and high level intensity of PA (Pan American Health Organisation, 2002). There are different types of muscle activity which can take place in four different domains of PA: 1) leisure-time physical activity; 2) occupational physical activity; 3) transportation physical activity and 4) household and gardening physical activity. In order to achieve health, psychological, socio-economic and ecological benefits, and primarily to preserve and improve the health status of female students, it is necessary to achieve energy expenditure in leisure-time physical activity of 10 MET-hours/week, which equals to 600 MET-minutes/week, i.e. to 30 minutes of moderate intensity of PA, 5 days a week, or 25 minutes of high level intensity of PA 3 times a week (Haskell, Lee, Pate, Powell, Blair, Franklin., Macera, Heath,, Thompson and Bauman, 2007). It has been demonstrated that, during the college period, the physical activity of students begins to decrease (McArthur and Raedeke, 2009). Studies show that only 30 to 50% of student population reaches the

recommended level of health-oriented physical activity (Racette, Deusinger, Strube, Highstein and Deusinger, 2005). The percentage of insufficiently active students in the population of Croatian students is in the range between 39.1% and 44.9% (41.8-49.1% among female students and 31.7-40.9% among male students) (Pedišić, 2011).

Maintaining the recommended level of physical activity throughout the college period generates beneficent results on subsequent time periods after graduation from college.

For example, students who have maintained their level of physical activity during the transition from adolescence to young adulthood have a significantly smaller risk for the onset of cardiovascular diseases and they enjoy improved mental health in comparison with students whose physical activity decreased during this transition (Rangul, Bauman, Holmen and Midthjell, 2012).

High-level physical activity among student population correlates to health benefits, including a lower level of heart frequency at rest, a higher HDL level and a slower glucose increase (Schilter and Dalleck, 2010).

Researchers have stated that 84.7% of students who regularly engage in physical activity during college also manage to keep that habit during a 5 to 10 year period after graduation, while 81.3% of those who did not engage in physical activity on a regular basis continue living a sedentary lifestyle (Sparling and Snow, 2002).

Establishing the level of physical activity among student population, as well as the differences between various subgroups will enable the design of a targeted strategy which should be oriented towards reaching and implementing the recommendations for health-oriented physical activity.

METHODS

The study was conducted in 2013 as part of the kinesiology culture class on a convenient sample of female students from the University of Zadar (N= 312), with an average age of AS=21.68 years (SD=1.54). The sample was stratified according to the nutritional status of four subsamples: underweight (BMI<18.5), normal weight (BMI 18.5-24.9), overweight (BMI 25-29.9) and obese (BMI >30) students (WHO, 2000). Body mass index (BMI) was used in order to assess the nutritional status and PAQ-C questionnaire was used to establish the level of physical activity (Craig, Marshall, Sjöström, Bauman, Booth, Ainsworth, Pratt, Ekelund, Yngve, Sallis, and Oja, 2003). The overall level and four domains of PA were calculated using particles of the questionnaire. For all of the variables, the median (ME), quartile range (QR), lower and upper quartile (LU-quartile), kurtosis (KURT) and skewness of a distribution (SKEW) were calculated. Variable distribution normality was tested with the use of a Kolmogorov-Smirnov test. In order to assess the differences in the overall level of physical activity, and according to the various domains of PA related to the female students with different nutritional status, the Kruskal-Wallis test was applied. All the data were processed using the application package Statistica for Windows, version 7.1. (StatSoft, Inc., 2005).

RESULTS AND DISCUSSION

The overall sample consisted of 3.21% of underweight, 82.69% of normal weight, 10.58% of overweight and 3.53% of obese female students (Table 1).

Table 1: Frequencies and percentage of female students according to their nutritional status

NUTRITIONAL STATUS	N	PERCENTAGE (%)
underweight (BMI<18.5)	10	3.21
normal weight (BMI 18.5-24.9)	258	82.69
Overweight (BMI 25-29.9)	33	10.58
underweight (BMI>30)	11	3.53

Legend: N-number of participants, BMI- body mass index

The results of the Kolmogornov-Smirnov test have demonstrated that distributions of the results throughout the domains of PA (apart from the occupational domain2 which only included the working students) and the results showing the overall level of PA depart significantly from normal distribution, and that they are positively asymmetric and leptokurtic to various degrees (Table 2).

The median overall level of PA for female students from the University of Zadar is 64.75 MET- hours/ week. The lower quartile of the overall level of PA is 36 MET-hours/week, while the upper quartile is 115.18 MET- hours/week.

The highest level of PA was obtained in the household domain: 16.17 MET- hours/week. The median of occupational PA of the overall sample is 0, while among students who reportedly had paid or unpaid jobs in the course of this study (15.71% of the overall

sample), the median is 63.60 MET- hours/week. Median values of leisure-time PA and transportation PA are similar in size: 14.9 MET- hours/week for leisure-time and 14.39 MET- hours/week for transportation. No statistically significant differences between underweight, normal weight, overweight and obese female students were observed in their overall level of physical activity. The differences between students with different nutritional status were significant only in leisure-time PA domain (Table 3).

Table 2: Descriptive parameters for PA variables and the overall PA of female students

PA level	Me	IQ	UL-quartile	Skew	Kurt	Max D	K-S p
occupational 1	0.00	0.00	0.00 –0.00	3.51	12.03	0.47	p < .01*
occupational 2	63.60	125.5	24.00-149.5	0.60	-0.88	0.14	p >.20
transportation	14.39	17.15	6.60–23.75	1.68	4.00	0.19	p < .01*
household	16.17	24.25	8.00-32.25	2.39	6.76	0.19	p < .01*
leisure-time	14.69	30.25	4.95–35.20	2.70	9.75	0.21	p < .01*
overall PA	64.75	79.17	36.00-115.18	1.73	3.51	0.17	p < .01*

Legend: PA- physical activity, Me - median, IQ- interquartile, UL – upper and lower quartile, Skew – skewness (of a distribution), Kurt- kurtosis (of a distribution), Max D -maximum deviation between cumulative empirical relative frequency and cumulative theoretical relative frequency, K-S p- the significance level of the Kolmogorov-Smirnov test; 1-descriptive parameters for the level of PA in the overall sample, 2- descriptive parameters for the level of PA calculated on the basis of data provided by the participants who, during the course of this study, held some paid or unpaid job (N=49), while the results of other participants have not been included in the analysis, * denotes statistically significant deviation at the level of 0.01

DISCUSSION AND CONCLUSION

The results of this study that show the overall level of physical activity are very similar to the results of the study obtained for the general population of adult females in the Republic of Croatia: 67.35 MET- hours/week (Jurakić, 2009). The above mentioned results of female students from the University of Zadar are consistent with the current knowledge that the students' level of physical activity is not significantly higher than the level of physical activity in general population. (US DHHS, 2000). In comparison with the general female population, female students were more active in the occupational (as measured on working students), transportation and leisure-time domain, while they were less active in the household domain.

A higher level of physical activity in the transportation domain among female students in comparison to the general female population can be explained by the fact that female students, considering their financial circumstances, do not own a car or some other motor vehicle and consequently, use physically "active" means of transport. Furthermore, female students have more free time and, therefore, their level of physical activity is also higher in the leisure-time domain. In addition to the above, the type of work that female students perform in comparison to more sedentary occupations predominant among adult female population is of higher intensity (very often it involves professional sports or similar), which results in a higher level of occupational physical activity among female students. On the other hand, a lower level of physical activity in the household domain among female students, in comparison to adult female population, can be explained by the fact that female students do not have families yet and therefore have less housework.

Female students from the University of Zadar are physically more active than their female peers from the University of Zagreb and female students in Turkey, however, they are less active than Turkish Kinesiology students (Pedišić, Rakovac, Titze, Jurakić, and Oja., 2014; Tasmektepligil, Agaoglu, Atan, and Cicek, 2013). One possible explanation for this higher result in the overall level of PA for female students from the University of Zadar in relation to the female students from the University of Zagreb can be found in different geographic locations which accordingly result in different climate conditions. Zagreb belongs to a geographic area of moderate continental climate which is characteristic for somewhat lower temperature values and more changeable weather when compared to Zadar which belongs to the Mediterranean area, with higher average monthly temperatures (DHMZ, 2014).

The data on regional differences in the percentage of insufficiently active females, which were obtained from the Croatian health survey in 2003, show that Zagreb city area comes first in this category (insufficiently active), men and women alike, and it is therefore possible to assume, based on these findings, that the students from Zagreb city area will achieve lower results in comparison with the general student population.

The highest median of physical activity obtained in the household domain is similar to the results of Jurakić's study from 2009, which were obtained on the sample of middle aged Croatian female workers. Similar as in the research on Zadar University female students, a lesser percentage of physical activity in transportation and leisure-time domains in the overall level of PA was also obtained in the research conducted on the general Croatian population (Jurakić, Pedišić and Andrijašević, 2009). Reasonable grounds for concern are provided by the fact that the level of physical activity for female students from the University of Zadar in leisure-time is relatively low, which is inconsistent with the current findings on this topic which prove that leisure-time physical activity is more prevalent among participants with a higher level of education (Demarest, Van Oyen, Roskam, Cox, Regidor, Mackenbach, and Kunst., 2014).

Female students from the University of Zadar achieve a lower level of physical activity from transportation, but are more active in household and leisure-time domain and have a higher overall level of PA in comparison to their female peers from the Faculty of Philosophy of the University of Zagreb (Mudronja, Petračić and Pedišić, 2011).

Similar results among Zadar University female students were obtained partly from the research conducted by Cilliers, Senekal and Kunneke (2006) which studied the differences in the level of PA in correlation to nutritional status.

The research showed that the normal weight female students were more physically active than underweight or overweight female students. In the study conducted by Dinger, Brittain and Hutchinson (2014), the authors stated that a higher percentage of participants with a "healthy" body mass index (18.5-24.9 kg/m2) achieved the recommended level of physical activity (51.7% of participants) in comparison to those who did not achieve the recommended level (48.3% of participants).

The same study has shown that, among students with an "unhealthy" body mass index (<18.5 and >24.9 kg/m2), there is a smaller percentage (46.6%) of sufficiently physically active students in comparison to insufficiently physically active students whose percentage is 53.4%. In the study conducted by Kim, Kwan and Park (2014), a higher body mass index has been found among highly active participants in comparison with moderately physically active participants, which points to the similar findings among female students from the University of Zadar. A three times higher level of physical activity among overweight and obese girls in comparison with underweight girls and the highest percentage of physically active boys was found in the obese group of boys, or among those who perceived themselves as fat (Zach, Zeev, Dunsky, Goldbourt, Shimony., Goldsmith, and Netz, 2013). A possible reason why obese female students are more active in leisure-time is the awareness of the beneficent effects of physical activity on the regulation of body mass.

From the results that were obtained in the study and based on comparison with the results from previous research, it can be concluded that the level of physical activity for female students from the University of Zadar is higher than the one recorded among students from other universities. The highest level of physical activity is recorded in the household domain, followed by leisure-time domain and transportation domain. Interventional measures with the aim of increasing the level of physical activity in female students from the University of Zadar should be directed towards forming habits related to spending physically active leisure time and using physically "active" means of transport.

Female students from the University of Zadar with different nutritional status do not show significant differences in the overall level of physical activity. The difference between underweight, normal weight, overweight and obese students is significant only in the leisure-time domain. Both the normal weight female students and obese female students achieve a significantly higher level of physical activity in comparison with their underweight and overweight female peers. Considering the results obtained from the study, interventional measures with regard to increasing the level of physical activity should be directed towards overweight female students.

One of the ways to achieve the recommended level of health-oriented physical activity among student population is to implement the following rules: "Everyday walking (or cycling) to and from the university. Use every little occasion for activity: the stairs, physical chores, and 2-3 sports activities in the week, visits to gyms or swimming pools. Longer walks on weekends, cycling, swimming and sports activities." (Cavill, Kahlmeier and Ricioppi, according to Heimer, 2010).

Table 11: Results of the ANOVA for the differences in the areas of difficulties that the students attending physical education colleges face in practical courses according to the rating variable

DOMAINS OF PA	BMI category	N	Sum of ranks	X^2	df	p
occupational	underweight	10	182.10	2.316	3	0.509
	normal weight	258	156.04			
	overweight	33	151.39			
	obesity	11	159.36			
transportation	underweight	10	124.55	1.605	3	0.658
	normal weight	258	158.17			
	overweight	33	157.61			
	obesity	11	142.95			
household	underweight	10	188.40	2.626	3	0.453
	normal weight	258	157.62			
	overweight	33	138.36			
	obesity	11	155.64			
leisure-time	underweight	10	113.65	7.831	3	0.050*
	normal weight	258	161.06			
	overweight	33	125.15			
	obesity	11	182.59			
overall	underweight	10	183.25	3.264	3	0.353
	normal weight	258	157.90			
	overweight	33	133.55			
	obesity	11	168.23			

Legend: PA – physical activity, BMI - body mass index, X^2-hi square test, df- degrees of freedom, p - level of significance, * statistical significance level $p<0.05$

REFERENCES

1. Caspersen, C.J., Powel, K.E. & Christensen, G.M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Reports, 100, 126-131.
2. Cilliers, J., Senekal, M & Kunneke, E. (2006). The association between the body mass index of first-year female university students and their weight-related perceptions and practices, psychological health, physical activity and other physical health indicators. Public Health Nutrition, 9, 234-24.
3. Craig, C. L., Marshall, A.L., Sjöström, M., Bauman, A.E., Booth, M.L., Ainsworth, B.E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J.F. & Oja, P. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. Medicine & Science in Sports & Exercise, 35 (8), 1381-1395.
4. Demarest, S., Van Oyen, H., Roskam, A., Cox, B., Regidor, E., Mackenbach, J., & Kunst, A. (2014). Educational inequalities in leisure-time physical activity in 15 European countries. European Journal of Public Health, 24(2), 199-204.
5. DHMZ (Croatian Meteorological and Hydrological Service) (2014). Croatian climate. Retrieved on November 4, 2018 from: http://klima.hr/klima.php?id=k1#pog1
6. Dinger, K.M., Brittain, D.R. & Hutchinson, S.R. (2014). Associations between Physical Activity and Health-Related Factors in a National Sample of College Students. Journal of American college health, 62(1), 67-74.
7. Haskell, W.L., Lee, I-M, Pate R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C-A., Heath, G.W., Thompson, P.D. &i Bauman, A. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Medicine and Science in Sports and Exercise, 39, 1423–1434.
8. Heimer, S. (2010). Physical activity and health in Europe: evidence for action. (Translation) World Health Organization – Regional Office for Europe, original title "Physical activity and health in Europe: evidence for action", Cavilli, N., Kahlmeier, S. & Ricioppi, F. (Ed). The Faculty of Kinesiology, University of Zagreb.
9. Jurakić, D. (2009). Taxonomic characteristics of middle aged employees as a basis for sport and recreational programs, Doctoral thesis, The Faculty of Kinesiology, University of Zagreb, (Original title: Taksonomske karakteristike zaposlenika srednje dobi kao osnova izrade sportsko-rekreacijskih programa)

10. Jurakić, D., Pedišić, Ž. & Andrijašević, M. (2009). Physical Activity of Croatian Population: Cross-sectional Study Using International Physical Activity Questionnaire. Croatian Medical Journal, 50 (2), 165-173.

11. Kim, S., Kwon1, Y-M. & Park, Y. (2014). Association between Physical activity and Health-Related Quality of life in Korean: The Korea National health and Nutrition Examination Survey IV. Korean Journal of Family Medicine, 35, 152-159.

12. McArthur, L.H., & Raedeke, T.D. (2009). Race and sex differences in college student physical activity correlates. American Journal of Health Behaviour, 33(1), 80-90.

13. Mudronja, L., Petračić, T. & Pedišić, Ž. (2011). Physical activity and Barriers to exercise among students from Faculty of Philosopy of Zagreb, In Milanović, D. I Sporiš, G. (Ed.), Proceedings Books of 6th International Scientific Conference on Kinesiology, Zagreb, 8-11. 2011. "Integrative power of Kinesiology" (pp. 343-346). Zagreb: Kineziološki fakultet.

14. Pan American Health Organisation (2002). Physical activity: How much is needed? Washington: USA.

15. Pedišić, Ž. (2011). Physical activity and its correlation to health and quality of life in student population, Doctoral thesis, The Faculty of Kinesiology, University of Zagreb, Zagreb, HR, (Original title: Tjelesna aktivnost i njena povezanost sa zdravljem i kvalitetom života u studentskoj populaciji)

16. Pedišić, Ž. Rakovac, M., Titze, S., Jurakić, D. & Oja, P. (2014). Domain-specific physical activity and health-related quality of life in university students. European journal of sport science, 14(5), 492-499.

17. Racette, S.B., Deusinger, S.S., Strube, M.J., Highstein, G.R., & Deusinger, R.H. (2005). Weight changes, exercise, and dietary patterns during freshman and sophomore years of college. Journal of American College Health, 53, 245-251.

18. Rangul, V., Bauman, A, Holmen, T.L., & Midthjell, K. (2012). Is physical activity maintenance from adolescence to young adulthood associated with reduced CVD risk factors, improved mental health and satisfaction with life: the HUNT Study? Norway International Journal of Behavioral Nutrition and Physical Activity, 9(1), 144- 153.

19. Sparling, P.B. & Snow, T.K. (2002). Physical activity patterns in recent college alumni. Research Quarterly for Exercise and Sport, 73(2), 200-205.

20. Schilter, J. & Dalleck, L. (2010). Fitness and fatness: Indicators of metabolic syndrome and cardiovascular disease risk factors in college students? Journal of Exercise Physiology, 13(4), 29-39.

21. Tasmektepligil, M.Y., Agaoglu, S.A., Atan, T. & Cicek, G. (2013). The contrastive study of physical activity Levels of physical education students and the other department students. International Journal of Academic research, 5 (6), 90-95.

22. U.S. Department of Health and Human Services. (2000). Healthy people 2010: Understanding and Improving Health. 2nd ed. Washington, DC: US Government Printing office.

23. WHO (2000). Obesity: preventing and managing the global epidemic - WHO Technical Report Series 894 Geneva. Retrieved on June 16, 2018 from: http://ec.europa.eu/health/ph_determinants/life_style/nutrition/documents/iotf_en.pdf

24. Zach, S., Zeev, A., Dunsky, A., Goldbourt, U., Shimony, T., Goldsmith, R., & Netz, Y. (2013). Perceived body size versus healthy body size and physical activity among adolescents – Results of a national survey. European Journal of Sport Science, 13(6), 723-731.

RAZLIKE U RAZINAMA TJELESNIH AKTIVNOSTI IZMEĐU STUDENATA SA RAZLIČITIM STATUSIMA UHRANJENOSTI

Nedovoljna razina tjelesne aktivnosti studentske populacije može generirati brojne negativne zdravstvene, psihološke, društvene, ekonomske i ekološke učinke. Iz tog razloga nužno je ciljano djelovanje na dostizanje preporučene razine ukupne tjelesne aktivnosti studenata. Cilj istraživanja je na uzorku od 312 studentica Zadarskog Sveučilišta utvrditi razinu tjelesne aktivnosti i razlike u toj razini između subgrupa različitog statusa uhranjenosti. Za određivanje statusa uhranjenosti izračunat je indeks tjelesne mase, a za procjenu ukupne razine tjelesne aktivnosti i razine tjelesne aktivnosti u pojedinim domenama korišten je Upitnik za procjenu tjelesne aktivnosti – IPAQ. Dobiveni rezultati ukazuju da je razina tjelesne aktivnosti zadarskih studentica (64,75 MET-sati/tjedan) viša nego što je zabilježena kod studenata drugih sveučilišta. Najviša razina tjelesne aktivnosti dobivena je u kućanstvu (16,17 MET-sat/tjedan), potom slijede tjelesna aktivnost u slobodno vrijeme (14,69 MET-sati/tjedan) i tjelesna aktivnost u transportu (14,39 MET-sati/tjedan). Rezultati Kruskal-Wallis testa ukazuju da ne postoje statistički značajne razlike u ukupnoj razini tjelesne aktivnosti studentica različitog statusa uhranjenosti. Razlike su uočene samo u provođenju tjelesne aktivnosti u slobodno vrijeme (p=0,05). Primjereno uhranjene studentice i pretile studentice ostvaruju statistički značajno veću razinu tjelesne aktivnosti u slobodno vrijeme od pothranjenih i prekomjerno uhranjenih kolegica. Uzimajući u obzir dobivene rezultate, intervencije u smislu povećanja razine tjelesne aktivnosti trebale bi biti usmjerene na domenu slobodnog vremena i prekomjerno uhranjene studentice.

Ključne riječi: Razlike, status uhranjenosti, studentice, tjelesna aktivnost

Received: December 03, 2018 / Accepted: December 15, 2018
Correspondence to: PhD Jelena Alić, University of Zadar, Department of Teacher and Pre-school Teacher Education
E-mail: jcetinic@unizd.hr

THE EFFECT OF A 30-DAY PLYOMETRIC TRAINING PROGRAMME ON INCREASING EXPLOSIVE STRENGTH AND AGILITY IN BASKETBALL PLAYERS

Artan Kryeziu[1,3], Bujar Begu[2,3], Fadil Nika[4]

1. Faculty of Child Care and Welfare, Fama College, Pristina Kosovo
2. Faculty of Physical Education, Universe College, Pristina Kosovo
3. Center for Research, Studies in Physical Education, Sport and Health (CRSPES) Pristina, R. Kosovo
4. Faculty of Physical Education, University of Tetovo, Tetovo Macedonia

ABSTRACT

The purpose of this research is to investigate the effect of a 30-day plyometric training programme on increasing explosive strength and agility in basketball players. 20 basketball players divided into the control group (CG n=10) and the experimental-plyometric group (PG n=10) of the age 15 + / - 6 months have participated in this research. There are thirteen (13) variables in the research; 3 from anthropometry and 10 motor tests of explosive strength, repetitive (iterative) strength, flexibility and agility (Bal, B. et al., 2011, Asadi, A., et al., 2012; Andrejić, O. et al., 2012). The plyometric training programme is realized according to the model of Poomsalood, S. and Pakulanon, S. (2015). Data processing methods are applied by way of SPSS version 21.0, which applies the basic statistical parameters, and the method for finding statistically significant differences was the T-test. We may conclude that the effect of a 30-day plyometric training programme can be achieved in increasing explosive strength and agility of the basketball players.

Keywords: Basketball, plyometric programme, explosive strength, agility, significant differences

INTRODUCTION

Basketball requires agility and vertical jumps Plyometrics can help players strengthen skills such as strength, speed, and agility (Potach, D. et al., 2000; Bal, B. S. et al., 2011). Plyometrics consists of a rapid muscle extension (ecstatic action) having immediately a concentric action or the same cut of muscle and connective tissue (Bompa, T. 1993; Baechlet, et al., 2000). Researchers have shown that plyometric training, when it is used with a programme designed for strength training can contribute in improving vertical jump performance, feet strength and muscular strength (Miller, M. et al., 2002; Khlifa, R., et al., 2010). Plyometric training usually includes stopping, jumping-off and changing the direction of movement explosively. These moves are the components that can help in the development of agility (Craig, B., 2004; Michael G., et al., 2006). Otherwise, plyometrics is closely related to speed and strength, which is ultimately the result of force. Regarding plyometric exercises, we can consider the possibility of muscles which express the maximum strength for a short time used in basketball (D Matavulj, et al., 2003; Michael G. et al., 2006; Santos EJ et al., 2011). Nowadays, plyometrics is one of the most effective methods of preparation

which is highly controversial for its effects on the musculoskeletal system and the development of reactive muscle ability, accepted by many contemporary studies, while in relation to debates, it can be said that they are merely the product of not knowing enough for this delicate method (Ferunaj, P., 2010; Adigüzel, N.S. et al., 2016).

The goal of this research is to investigate the effect of a 30-day plyometric training programme in increasing the explosive strength and agility of basketball players.

At the same time, another aim is to treat the experimental group which have been following the 30-day plyometric programme in basketball and the differences between the control and experimental group in two measurements.

RESEARCH METHODOLOGY

Sample (model) of entities:

The sample has 20 basketball players which are divided into two groups. The first group with 10 basketball players is the control group, while the second group with 10 basketball players is the experimental group - plyometric group.

Variable sample:

It consists of 13 variables, 3 of which are morphological parameters and 10 motor tests. 1. BH - Body height; 2. PM- Body mass; 3. BMI - Body Mass Index; 4. JPL - Standing Long Jump; 5. SAR1 - Standing High Jump; 6.SAR2 - High Jump with Take-off from One Foot; 7. V20m - 20 Metres Running (sprint); 8. MB - Abdominal Muscles; 9. PU - push-ups (Pump); 10. T-Test; 11. Illinois Agility; 12. TMBD - Throwing a Medicine Ball in the Distance; 13. SR - Sit and Reach (flexibility). Measuring instruments are applied based on those used by the authors (Bal, B. S., Kaur, P. J., & Singh, D. 2011; Asadi, A., & Arazi, H. 2012).

Plyometric programme training procedure:

Exercises took place twice a week for the period of 4 weeks. The plyometric programme lasts about 60 minutes or 480 minutes divided into four weeks, including 10 minutes of warming up and preparing the muscles for the 45-minute plyometric training, as well as 5 seconds off from the interval of exercise, and 2 minutes after exercising. The exercises have begun on 2nd May, 2016 and lasted until 31st May, 2016, during the interval time from 17:00 to 18:00. The plyometric model was applied based on the publication of the authors Poomsalood, S. and Pakulanon S., which was applied to basketball players for a 4-week training programme.

Table 1: Plyometric training programme

Training week	Training volume (Foot contacts)	Plyometric drill	Sets × Repetitions	Training intensity
1.		- Front cone hops	3x12	Low
2.		- Lateral cone hops	3x12	Low
3.	100	- Standing jump and reach	4x7	Low
1.		- Lateral cone hops	3x10	Low
2.	120	- Standing jump and reach	5x6	Low
3.		- Lateral barrier jump	3x10	Moderate
4.		- Alternate bounding	3x10	Moderate
1.		- Diagonal cone hops	3x8	Low
2.		- Lateral barrier jump	3x8	Moderate
3.	140	- Cone hops with 180 degree turn	4x8	Moderate
4.		- Cone hops with change of direction sprint	4x8	Moderate
5.		- Single leg vertical jump	4x7	High
1.		- Diagonal cone hops	3x10	Low
2.	120	- Cone hops with 180 degree turn	3x10	Moderate
3.		- Cone hops with change of direction sprint	3x12	Moderate
4.		- Single leg vertical jump	4x6	High

Table 2: The basic statistical parameters of the control group.

	Control group				
		Initial		Final	
	N	Mean	Std. Dev.	Mean	Std. Dev.
BH	10	173.090	10.9443	173.090	11.1617
BM	10	64.300	12.1477	65.100	12.4762
BMI	10	19.0680	2.73136	18.4930	3.17803
JPL	10	37.400	4.9261	36.860	5.3883
SAR1	10	39.000	4.3970	38.260	6.8364
SAR2	10	175.200	19.6175	175.560	25.2704
R20m	10	4.4640	.42432	4.1950	.43691
AM	10	19.400	3.4705	22.800	3.7653
PU	10	14.000	8.8944	21.100	13.3121
T-test	10	12.3300	1.38076	12.5580	1.10230
Illinois Agility	10	20.8600	2.10653	20.9680	1.96806
TMBD	10	4.0870	.64135	4.5010	1.15839
SR	10	6.4000	8.59199	7.200	9.05293

Result elaboration methods:

The results will be elaborated with SPSS version 21.0 for WINDOWS. The basic statistical method for determining the basic statistical indicators of descriptive variables are: Arithmetic mean (Mean.); Standard deviation (SD). The T-test will be used to present significant differences between the two groups.

RESULTS

Based on table no. 2., the basic statistical parameters on the arithmetic mean (Mean) and standard deviation (Std. Dev.) of the morphological variables and the motor tests conducted by the control group in the final and final measurement

Table 3: The basic statistical parameters of the experimental-plyometric group.

	Experimental group				
		Initial		Final	
	N	Mean	Std. Dev.	Mean	Std. Dev.
BH	10	171.93	8.46	171.93	8.42618
BM	10	70.84	14.69	70.48	14.69972
BMI	10	20.56	3.90	20.44	3.94483
JPL	10	28.10	11.21	34.40	8.30261
SAR1	10	32.80	6.61	37.40	10.73106
SAR2	10	174.21	34.88	185.00	27.58954
R20m	10	4.56	.76	4.1350	.39036
AM	10	21.50	6.53	24.600	3.94968
PU	10	14.10	11.50	21.000	10.91380
T-test	10	11.59	.92	11.4380	.67942
Illinois Agility	10	20.30	1.78	18.9980	1.06338
TMBD	10	5.00	.70	5.9000	.37253
SR	10	10.88	8.49	12.1200	7.40342

did not register significant differences, but, as we can see, the 20 metres running (sprint) test (R20m), abdominal muscles (AM), and the push-ups (Pump) test have shown little differences compared to the first (initial) measurement.

Table no. 3. shows that in the experimental-plyometric group, in the initial and final measurement of arithmetic average (Mean) and standard deviation (Std. Dev.), there are differences between the two measurements. As we can see, the best results in the final measurement are recorded in the standing long jump (JPL), standing high jump (SAR1), high jump with take-off from one foot (SAR2), 20 m running (sprint) (R20m), push-ups (pump) and Illinois agility. According to this, we see that the 4-week plyometric training programme has had an impact on the increase of motor performance, but in the near future, it will be necessary to have more tests, and a longer plyometric training programme.

In table no. 5., the T-test has been submitted to the initial and final measurement in the experimental group. As we can see, there are statistically significant differences in seven motor tests. In standing long jump (JPL), there is a statistically significant difference of .003; in the high jump with take-off from one foot (SAR2), there is a statistically significant difference of .035; the 20 m running (sprint) test (R20m) has a statistically significant difference of .023; abdominal muscle test (AM) has a statistical difference of .074; in push-ups (pump) (PU), there is a statistically significant difference of .004; the Illinois agility test has the most significant statistically significant difference of .012; in throwing a medicine ball in the distance (THMB), there is a statistically significant difference of .078.

Table 4: T-test of the control group in the initial and final measurement.

	Paired Differences					T	df	Sig.
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
BH	-.27000	.70087	.22164	-.77137	.23137	-1.218	9	.254
BM	-.80000	1.68655	.53333	-2.00648	.40648	-1.500	9	.168
BMI	.57500	2.35191	.74374	-1.10746	2.25746	.773	9	.459
JPL	.54000	3.56813	1.12834	-2.01249	3.09249	.479	9	.644
SAR1	.74000	4.48236	1.41745	-2.46649	3.94649	.522	9	.614
SAR2	-.36000	12.44537	3.93557	-9.26288	8.54288	-.091	9	.929
R20m	.26900	.27534	.08707	.07204	.46596	3.090	9	.013
AM	-3.40000	4.37671	1.38404	-6.53091	-.26909	-2.457	9	.036
PU	-7.10000	12.57378	3.97618	-16.09474	1.89474	-1.786	9	.108
T-test	-.22800	1.34487	.42528	-1.19006	.73406	-.536	9	.605
Illinois Agility	-.10800	.83082	.26273	-.70233	.48633	-.411	9	.691
TMBD	-.41400	.98058	.31009	-1.11546	.28746	-1.335	9	.215
SR	-.80000	3.48967	1.10353	-3.29636	1.69636	-.725	9	.487

Table 5: T-test of the experimental-plyometric group in the initial and final measurement

	Paired Differences					t	df	Sig.
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
BH	-.23000	.62548	.19779	-.67744	.21744	-1.163	9	.275
BM	.36000	1.22764	.38822	-.51820	1.23820	.927	9	.378
BMI	.11800	.38629	.12215	-.15833	.39433	.966	9	.359
JPL	-8.70000	6.78315	2.14502	-13.55237	-3.84763	-4.056	9	.003
SAR1	-4.80000	9.56614	3.02508	-11.64321	2.04321	-1.587	9	.147
SAR2	-11.05000	14.07324	4.45035	-21.11739	-.98261	-2.483	9	.035
R20m	.43100	.50037	.15823	.07306	.78894	2.724	9	.023
AM	-3.10000	4.84080	1.53080	-6.56290	.36290	-2.025	9	.074
PU	-6.90000	5.60654	1.77294	-10.91068	-2.88932	-3.892	9	.004
T-test	.15800	.60842	.19240	-.27724	.59324	.821	9	.433
Illinois Agility	1.30700	1.30695	.41329	.37207	2.24193	3.162	9	.012
TMBD	-.38500	.61285	.19380	-.82341	.05341	-1.987	9	.078
SR	-1.24000	6.75116	2.13491	-6.06949	3.58949	-.581	9	.576

DISCUSSION

The aim of this this work - experiment is to explore the relationship between indicators of explosive strength, repetitiveness - agility strength and flexibility through a 4-week plyometric training model. In a study by Adigüzel N.S. and Günaya M. (2016), they conducted a research on 30 basketball players with statistically significant differences present in tests of explosive strength in the experimental group which followed an 8-week plyometric training programme.

Also, Poomsalood, S. and Pakulanon S. (2015) conducted a research in a four-week study that has been able to confirm the statistically significant difference in the 20 metre run test for the experimental group.

During the realization of this study, we have seen that, during the 4 weeks of plyometric training, we have reached agility tests. In this case, it supports previous research such as Asadi, A., & Arazi, H. (2012) who researched a significant improvement of agility in tests (T-test and Illinois agility) of basketball players after 6 weeks of high-intensity plyometric training.

Also, Poomsalood, S. and Pakulanon, S. (2015) have conducted a research for 4 weeks where the control group didn't have any statistically significant differences, while the experimental group had significant differences in agility tests.

According to what is presented in the plyometric training model, we see that we have a positive impact on the accomplishment of important motor tasks, but the most important is the model accomplished with the aim of achieving the impact of the plyometric training programme.

Explosive strength and agility indicators have an improvement in raising these skills in order to increase the impact of the training programme.

CONCLUSION

It would be important to apply the most efficient methods to increase the performance of young basketball players with the model of the plyometric training programme. During the research conducted in this work - experiment, we have highlighted the value of the plyometric training programme model in increasing motor performance, in particular, the explosive strength, the repetitive strength and the agility of the young basketball players. The crucial findings show that participating in a model of the plyometric training programme for a short-term duration contributes to improving the performance of the new basketball players. This experiment also confirms that it is possible to make progress in statistically significant difference, in particular, in the experimental group of the plyometric training model.

However, this plyometric training programme model can be a tool, modality, methodology or technical useful for the work of coaches with players, because the innovative work or new product in this model of the plyometric training programme can be a significant contributor to a set of players who have the goal of developing plyometrics within 30 days of the basketball game.

REFERENCES

1. Adigüzel, N.S. & Günay M. (2016). The Effect of Eight Weeks Plyometric Training On Anaerobic Power, Counter Movement Jumping and Isokinetic Strength in 15-18 Years Basketball Players. International Journal of Environmental & Science Education. Volume 11, Issue 10, pp. 3241-3250.
2. Asadi, A., & Arazi, H. (2012). Effects of high-intensity plyometric training on dynamic balance, agility, vertical jump and sprint performance in young male basketball players. Journal of Sport and Health Research, 4(1), 35-44.
3. Baechlr, T. R.; Earle, R. W. (200). Essentials of strength training and conditioning. 2nd edition. Champaign, IL: National Strength and Conditioning Association.
4. Bal, B. S., Kaur, P. J., & Singh, D. (2011). Effects of a short term plyometric training program of agility in young basketball players. Brazilian Journal of Biomotricity, 5(4), 271-278.
5. Bompa, T. (1993). Power training for sport-plyometrics for maximum power development. Coaching Association of Canada
6. Chu, D. (1993). Jumping into plyometrics. VHS. Human Kinetics, Champaign II, USA.
7. Miller, M. G.; Berry, D. C.; Bullard, S.; Gilders, R. (2002). Comparisons of land-based and aquatic based plyometric programs during an 8-week training period. Journal of Sports Rehabilitation, v. 11, p. 269-283.
8. Michael G., Miller, Jeremy J. Herniman, Mark D. Ricard, Christopher C.
9. Cheatham and Timothy J. Michael (2006). The effects of a 6-week plyometric training program on agility. Journal of Sports Science and Medicine. Sep; 5(3): 459-465.
10. Potach, D., and Chu, D. (2000). Plyometric Training. In: Essentials of Strength training and Conditioning (Second Edition). T.R. Beachle and R.W. Earle, ed. Champaign, Human Kinetics, pp. 427-470. USA.
11. Craig, B. W. (2004). What is the scientific basis of speed and agility? Strength and Conditioning Journal, v. 3, p. 13-14.
12. D Matavulj, M Kukolj, D. Ugarkovic, J. Tihanyi (2003). Effects on plyometric training on jumping performance in junior basketball players. The Journal of Strength and Conditioning Research 17(4):704-709.
13. Michael G. Miller, Jeremy J. Herniman, Mark D. Ricard, Christopher C. Cheatham and Timothy J. Michael (2006). The effects of 6-week plyometric training program on agility. Journal of Sports Science and Medicine 5, 459-465
14. Ferunaj. P., Mjeksia sportive, Pliometria, si mjet parandalues dhe rehabilitues ndaj dëmtimeve. Fq,156.2007
15. Santos EJ, Janeira MA. (2011).The effects of plyometric training followed by detraining and reduced training periods on explosive strength in adolescent male basketball players. J Strength Cond Res. 2011 Feb; 25(2):441-452.
16. Khlifa, R., Aouadi, R., Hermassi, S., Chelly, M. S., Jlid, M.C., Hbacha, H., & Castagna, C. (2010). Effects of a plyometric training program with and without added load on jumping ability in basketball players. The Journal of Strength and Conditioning Research, 24(11), 2955-2961.

EFEKAT PLIOMETRIČKOG TRENINGA U TRAJANJU OD 30 DANA NA POVEĆANJE EKSPLOZIVNE SNAGE I AGILNOSTI KOŠARKAŠA

Svrha ovog istraživanja je ispitati efekat pliometričkog treninga u trajanju od 30 dana na povećanje eksplozivne snage i agilnosti košarkaša. 20 košarkaša podijeljeno u kontrolnu grupu (CG n=10) i eksperimentalnu-pliometričku grupu (PG n=10) starosti 15 + / - 6 mjeseci je učestvovalo u ovom istraživanju. U istraživanju je prisutno trinaest (13) varijabli; 3 iz domena antropometrije i 10 motoričkih testova eksplozivne snage, repetitivne (iterativne) snage, fleksibilnosti i agilnosti (Bal, B. et al., 2011, Asadi, A., et al., 2012; Andrejić, O. et al., 2012). Pliometrički trening je realiziran u skladu sa modelom datim od strane Poomsalood, S. i Pakulanon, S. (2015). Metode obrade podataka su primjenjene korištenjem SPSS programa, verzije 21.0, koji primjenjuje osnovne statističke parametre, a metoda za pronalazak statistički značajnih razlika je bio T-test. Možemo zaključiti da se efekat pliometričkog treninga u trajanju od 30 dana na povećanje eksplozivne snage i agilnosti košarkaša može postići.

Ključne riječi: košarka, pliometrički program, eksplozivna snaga, agilnost, značajne razlike

Received: May 02, 2018 / Accepted: May 25, 2018
Correspondence to: Artan R. Kryeziu, FAMA College, Pristina, Kosovo
E-mail: artankryeziu88@hotmail.com

ANALYSIS OF STUDENT ATTITUDES TOWARDS PHYSICAL EDUCATION LESSONS

Nermin Nurković[1], Faris Rašidagić[1], Dženana Imamović[1], Hana Hadžibulić-Nurković [3]

1. Faculty of Sports and Physical Education, University of Sarajevo
2. Faculty of Natural Sciences and Mathematics, University of Sarajevo

ABSTRACT

The behaviour of physical education teachers during the educational process influences the formation of student attitudes. If the pedagogical work of the teacher is on a low interactive level, it can form negative student attitudes towards lessons or the subject. Student attitudes towards physical education lessons do not necessarily have to begin during the educational process. They can be previously formed in a negative or positive way. In both cases, they influence the entire attitude towards the subject. These opinions can be a reflection of the teacher's work. This research has been made with the aim to determine the attitude of primary-school students towards physical education lessons. In the examinee sample, students of the seventh and eighth grades from ten different primary schools in Sarajevo Canton have been examined. This research has gathered 514 examinees in total, 53% of male participants and 47% of female participants. Data which has defined the examinees' attitude were gathered by filling in anonymous questionnaires containing twenty different questions. After data gathering, a factor analysis conducted. The results obtained from the analysis have shown that there are three significant latent components. The first latent component can be identified as the students' negative attitude towards physical education lessons. It contains about 20% of the explained variance with a 4.127 root. The second latent component can be identified as an extremely positive attitude towards physical education lessons. It contains about 16% of the explained variance with a 3.233 root. The third latent component with a 1.31 root and the explained variance of 5.65% is considered to be a mathematical artefact inclined towards the students' negative attitude. Categorizing correlation coefficients is not the same as in the first latent component and it is a part of a completely different subgroup of physical education lessons. After the completion of the factor analysis, it can be stated that the aim of this research has been accomplished. Two clear student attitudes towards physical education lessons have been determined. One is positive and the other is negative. The third attitude, contained in the third latent dimension is negative and has elements of a different subgroup in lessons. To fully understand the students' attitude towards physical education lessons, there are several research methods that can be organized within various age categories that differ from the one inspected in this case. The obtained data can also be differentiated according to the students' sex. This would more clearly define the guidelines for teachers in order to improve the students' attitude towards physical education lessons.

Keywords: factor analysis, students, primary school

INTRODUCTION

The behaviour of physical education teachers, their attitude towards students, affinity to work with children and teenagers as well as one's authority, greatly impacts the beginning, flow and end of the lesson (Stefanick, 1988). The behaviour and interaction between the teacher and student influences the acceptance of lesson value by students (Tannehill and Others, 1994). The overall organization of a teacher's work influences the appropriate pedagogical climate during the lesson (Arsentijević, 1972; Bratanić, 1997; Havelka, 1998). Pedagogical climate directly influences the formation of student attitudes towards lessons (Luke and Sinclair, 1991). If the students' attitude towards a certain lesson is negative, it can make passive behaviour or avoidance of the lesson (Đorđević and Đorđević, 1988; Kiryacu, 1994;

Milijević, 1995). Sometimes, a teacher's behaviour is not a consequence of the student's negative attitude towards the lesson. Several different factors (social, economic, cultural, educational) can influence this attitude. In the research conducted by Bimler (2001) and Livazović (2011), it has been determined that there is a connection between negative family relations of the student and increased absences from school.

Sallis and McKenzie (1991) did a research to determine which measures would influence the formation of a positive attitude towards physical education lessons.

In the results of that research, one of the crucial factors was for students to "realize the utility of lessons" so that they can have a positive attitude towards it.

Research about the students' attitude towards physical education lessons is significant not only because the attitude is an important factor to implement the educational process, but also because of the feedback that teachers receive about their work.

This research did not draw a parallel between the students' negative attitude towards lessons and the teachers' level of competence (Redžić, 1992).

Physical education lessons have a purpose to positively transform the students' anthropological status and form habits for a healthy way of life.

If students have a negative attitude towards these lessons, it is possible that they will be more absent from them and the need to keep the students active will not be satisfied (Biletić and Others, 2008).

The attitude as a psychological category is often a subject for research (Silverman and Subramaniam, 1999).

It is present in almost every aspect of social life and its importance comes from the fact that it can be very easily determined and serve as a source of feedback which is helpful in explaining and predicting the students' behaviour.

This research has been made to determine the structure of student attitudes towards physical education lessons in primary schools of Sarajevo Canton - Bosnia and Herzegovina.

The main goal of this research is to identify the students' attitude after gathering data and applying a factor analysis on the seventh and eighth grade students in primary schools.

Determiners can be significant since teachers can influence the students' attitude towards physical education lessons if they apply certain positive changes in their work (Brodie and Britwistle, 1990; Mowatt and Others, 1988).

An increased number of students with a positive attitude would mean: less absences from physical education lessons, creating a positive transformation in the students' anthropological status and satisfying students' needs for active movement.

METHODS

The sample examinees

This research included ten primary schools from Sarajevo Canton. 514 students were examined. In the sample, according to the students' sex, 53% or 237 boys, and 47% of girls were examined. The research was implemented on students of the seventh grade (283) and the eighth grade (231).

The sample variables

Students who participated in the research had all the facts about the examiners' intentions. They regularly attended physical education classes.

The questionnaire was filled in with a previously obtained approval of the school and parents.

The questionnaire was completely anonymous. Research participation was on a voluntary basis. The questionnaire consisted of 20 questions according to a survey conducted by Te Ava & Rubie-Davies (2016). The questionnaire was filled in during a homeroom class.

The scale used to determine the statements is the Likert scale ranging from 1 to 5, from an extremely negative to an extremely positive attitude. 5 categories of intensity were offered in this way: 1-strongly disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, 5-strongly agree.

In comparison with Te Ava & Rubie-Davies survey from 2016, the scale was set reversely due to the school system in Bosnia and Herzegovina where 5 is the best mark. Before analysing the results, a survey retest was conducted on a random sample of 30 examinees.

The significance of difference was checked by means of a t-test for dependent samples. The difference was not statistically significant which justified a further analysis of results. Variables from the questionnaire are stated in the following table:

Table 1: Questions from the survey to determine the students' attitude

1	I do not enjoy competition during the physical education lessons because it ruins emotional control.
2	My family thinks that physical education helps us to study better at school, but I do not think it contributes to my intellect.
3	The running exercise during PE lessons does not contribute to building a positive character.
4	Participating on PE lessons can evoke negative emotions in my case.
5	When I participate in PE activities, I do not develop my spirit, so it does not make me feel excited or happy.
6	Participation and enjoyment during PE lessons makes boys become bullies.
7	My family gives me money to buy clothes for PE lessons, they think it's important, but I don't like spending money for that.
8	My family thinks PE lessons are important, but I think kids who are good at those lessons are not popular amongst their fellow students.
9	I enjoy doing different activities on PE lessons (different sports and games) because they contribute to developing thinking and memory.
10	Participating on PE lessons is important to me because it can help me become popular at school.
11	I enjoy doing different activities on PE lessons because it develops a sense of art and beauty.
12	I enjoy PE lessons because it gives me an opportunity to show and prove myself.
13	PE lessons are an important part of education and, if it was up to me, we would have it every day.
14	Participation in PE activities helps us understand the personal level of physical competence.
15	I like doing activities during PE because you can learn how to accept defeat and not stay angry about it.
16	My school pays too much attention to PE lessons.
17	My wishes should be considered during PE lessons because I do not get a chance to learn about moral and spiritual values.
18	I would enjoy these lessons more if I knew that even healthy students need more than one class per week.
19	I would enjoy these lessons more if I knew that body deformities can be successfully managed with exercise and no doctor.
20	I enjoy PE lessons even when girls are present during class, no matter if it can make them less feminine at some point.

STATISTICAL ANALYSIS

Different methods were available for data analysis in this research. According to the survey conducted by Oliver (1982), factor analysis gives appropriate data, so it was used for this research.

Fulgosi (1979) explained the way to apply and analyse given data through factorization, and gave an idea about simple structure and defined criteria that the factor matrix has to fulfil. According to the given criteria, factors need to be as independent as possible, internally and towards different variable groups. In this research, no matter the extracted number of variables, only the components that have isolated value over 1.00 were shown. The given data was analysed in the statistical program SPSS 22.

RESULTS

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.864
Bartlett's Test of Sphericity	Approx. Chi-Square	2131.229
	df	66
	Sig.	.000

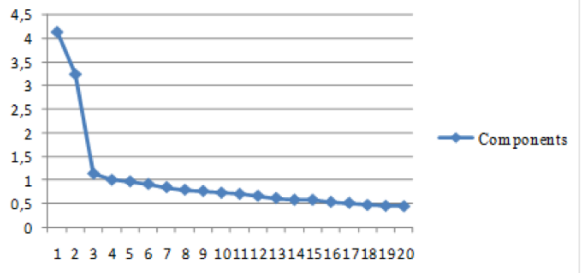


Table 3: Correlation of Components

Component	1	2	3
1	1.00		
2	-.215	1.00	
3	.205	.175	1.00
underweight (BMI>30)	11		3.53

Table 4: Extracted Components with Total Value over 1

Comp	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Var	Cum. %	Total	% of Var	Cum. %	Total	% of Var	Cum. %
1	4.127	20.63	20.63	4.127	20.63	20.63	3.594	17.969	17.969
2	3.233	16.16	36.80	3.233	16.16	36.80	3.191	15.955	33.923
3	1.131	5.65	42.45	1.131	5.65	42.45	1.707	8.535	42.459

KMO and Bartlett's test were used to check if the matrix is adaptable towards factorization. Given the fact that it was positive on the level p=.000 (Table 1), factor analysis could be done. The reduction of manifested variables was conducted by the Guttman-Kaiser criteria to determine the number of significant main components (Table 4). 20 latent components were isolated from the overall explained variant.

Extraction was shown in Scree plot 1. Only 3 latent components had a total value higher than 1 (Component1: 4.127, Component 2: 3.233 and Component 3: 1.131) and could be taken for further analysis. The percentage of variants was: Component 1 – 20.63%; Component 2 – 16.16%; Component 3 – 5.65%. The overall explanation for all three components is 42.45%. Table 3 shows the internal correlation of isolated components. It can be stated they are on a low level since the value of coefficient correlation is 175, 205 and -215.

The low level is adequate for this research because one can assume that each of the components belongs to a separate group. The first component with a total value of (4.127) is connected through a rotated matrix with the most manifested variables (Table 5). Coefficients that show the significance of internal connection are within the range: the lowest (.320) to the highest (.693). Neither of the components has a coefficient lower than (.300).

The second characteristic isolated component with a total value of (3.233) is also shown in Table 5, and it has nine coefficients connected to the manifested groups. The values of components range from (.437) to (702). Groups of correlation coefficients that explain the component are coherent and stationed in a different zone than the first component.

The third isolated latent characteristic component has the value of 1.131. The explained variable is on the level of 5%. Due to this low value and overall low percent value, it can be defined as a mathematical artefact. When doing factor analysis, all components that have a value over 1.00 are considered, so this research also included component three.

This component is connected to the manifested space through six coefficients whose value is from the lowest (-.305) to the highest (.599).
Correlation coefficients are sorted in groups in the lower third of the Table.

Additionally, several coefficients related to the first two components are also in relation to the third one. Five coefficients of the third component are intertwined with other components (Table 5).

Table 5: Matrix of Components - Rotated

1	.693	/	/
2	.667	/	/
3	.657	/	/
4	.646	/	/
5	.629	/	/
6	.591	/	/
7	.578	/	/
8	.544	/	/
9	/	.702	/
10	/	.656	/
11	/	.635	-.305
12	/	.605	/
13	/	.599	/
14	/	.595	/
15	/	.504	/
16	/	/	.407
17	.320	/	.599
18	.323	/	.583
19	/	.437	.472
20	.365	/	.459

DISCUSSION

If we connect the latent and manifested space of the first latent component, then it is certain that all coefficients with a significant correlation express a negative attitude towards physical education lessons ("I do not enjoy competition during the physical education lessons because it ruins emotional control."; "My family thinks that physical education helps us to study better at school, but I do not think it contributes to my intellect.", "Participation and enjoyment during PE lessons makes boys become bullies.").

The given comments clearly state the students' negative orientation towards physical and health education. It is evident that there is a great number of students who think of physical education in their adolescent period as a burden.

The negative attitude can be explained according to a certain number of authors who have researched the reasons why students think negatively of physical education lessons. Those reasons can be assumed as follows: the specific age when the students were examined (Smoll and Schutz, 1980; Mowatt et al., 1988; Martinek, 1991), low motor abilities of students (Ennis, 1996), a rigid approach by the teachers and monotonous content presented in classes (Portman, 1995; Wersch et al., 1992; Sharples, 1969).

As for the other latent component which is completely opposite of the first one, there are positive indicators: "Participating on PE lessons is important to me because it can help me become popular at school.", "I enjoy doing different activities on PE lessons because it develops a sense of art and beauty.", "I enjoy PE lessons because it gives me an opportunity to show and prove myself". Given the above stated, the second factor is considered to be the students' positive attitude towards physical education lessons.

This positive attitude can be explained according to authors who conducted structured research and stated: good results impact the positive attitude of students (McConnel, 1986), better understanding of certain sport techniques influences a positive attitude of students (Tjeersdma et al., 1996), better understanding of physical education importance influences a positive attitude of students (Siedenttop and O,Sullivan, 1992; Sparkes et al., 1992), younger students have a more positive attitude (Luke and Sinclair, 1991; Strand and Scantling, 1994), if the lesson content has more challenges and risks, then boys are positive about it; girls are more positive if the lessons have an aesthetic tone (Folsom-Meek, 1992).

The point of physical education lessons should be in creating sports habits and using them continuously in everyday life (Colquitt et al., 2012). The third latent dimension in these results contains 5% of the information from the overall explained variants. Information according to which we can structure the students' attitude is sorted in the last section of the Table, where negative connotations are presented.

The given comments were: "My school pays too much attention to PE lessons.", "My wishes should be considered during PE lessons because I do not get a chance to learn about moral and spiritual values.", "I would enjoy these lessons more if I knew that even healthy students need more than one class per week.", "I would enjoy these lessons more if I knew that body deformities can be successfully managed with exercise and no doctor.".

Although this component is of marginal importance, one can notice it contains the students' negative attitude towards physical education lessons. As opposed to the first component, the reasons for such negativity are slightly different. Certain changes in physical education classes would help teachers convert the negative into positive attitude.

After the completed research, the aim was fulfilled and the attitudes of the seventh and eighth grade students towards physical education lessons were determined. The attitude is clearly divided into the extremely positive and extremely negative one.

There is also a component which can be identified as the neutral one. In some future research with the same or a similar theme, it would be interesting to determine the structure of the attitude according to the students' sex.

The difference could be analysed comparing school age categories to widen the knowledge of teachers on this matter and find out some alternative goals to improve the positive attitude towards physical education lessons.

REFERENCES

1. Arsentijević, N. (1972). The Place and Role of Student in Modern Education, Lessons and Education, Vol. 3, Belgrade.

2. Biletić, I., Benassi, L., Baić, M., Cvetković, Č. and Lukšić, E. (2008) Attitude of Primary School Students in Pula and Poreč Towards Physical Education Lessons, Summary of Work on 17th Summer School of Kineziologists in Republic of Croatia, Pg. 82-87. "Školska knjiga" Zagreb.

3. Bimler, D. (2001.), School Truants and Truancy Motivation Sorted Out with Multidimensional Scaling. Journal of Adolescent Research, Vol. 16(1), 75- 102.
4. Brodie, D.A., and Britwistle, G.E. (1990). Children's Attitude to Physical Activity, Exercise, Health and Fitness Before and After a Health-related Fitness Measurement Program. International Journal of Physical Education, 27(2), 10-14.
5. Bratanić, M. (1997). Analysis of Interaction Between Teachers and Students, Pedagogical Work, Vol. 3-4. Zagreb.
6. Colquitt, G., Walker., A., Langdon, J. and McCollum, S. (2012) Exploring Student Attitudes Toward Physical Education and Implications for Policy, SPA, Vol. 9, Issue 2: 5-12
7. Đorđević, J., Đorđević, B. (1988). Students about Teachers' Characteristics, „Prosveta", Belgrade.
8. Ennis, C.D. (1996). Students, Experiences in Sport –based Physical Education: More than Apologies Are Necessary. Quest, 48, 453-456.
9. Fulgosi, A. (1979). Factor Analysis, „Školska knjiga", Zagreb
10. Folsom-Meek, S.L. (1992). A Comparison of Upper Elementary School Children's Attitudes Toward Physical Activity (ERIC Document Reproduction Service No. ED 350 297)
11. Havelka, N., Kuzmanović, B. and Popadić, D. (1998.). Methods and Techniques of Social and Psychological Researches, Society of Psichologists in Serbia, CPP, Beograd, str. 238.
12. Kiryacu, Ch. (l994). Principal Educational Achievements, Eduka, Zagreb.
13. Livazović, G. (2011). Relationship Between Media and Adolescent Hazard Behaviour. Criminology and Social Interaction. Vol. 20 no. 1, Pg. 122.
14. Luke, M.D. and Sinclair, G.D. (1991) Gender Differences in Adolescents' Attitudes Toward Physical Education. Journal of Teaching in Physical Education, 11, 31-46.
15. Martinek, T.J. (1991). Psycho-Social Dynamics If Teaching Physical Education. Dubuque, IA: Brown and Benchmark.
16. McConnel, A.M. (1986). Effects of Gains in Performance on Attitudes Formed Toward a Motor Learning Task. (ERIC Document Reproduction Service No. ED 274 631).
17. Milijević, S. (1995). Teachers' Resistance Toward Changes, „Naša škola", Vol. 1. Banja Luka.
18. Mowatt, M., DePauw, K.P., and Hulac, G.M. (1988). Attitudes Toward Physical Activity Among College Students. The Physical Educator, 45, 103-108.
19. Oliver, B. (1982). Female Teachers, Students' Achievement and Attitude in Coed Instruction. Education, 103(2), 139-144.
20. Portman, P.A. (1995). Who is Having Fun in Physical Education Classes? Experiences of Six-grade Students in Elementary and Middle Schools. Journal of Teaching in Physical Education, 14. 445-453.
21. Sallis, J.F., & McKenzie, T.L. (1991). Physical Education's Role in Public Health. Research Quarterly for Exercise and Sport, 62, 124-137
22. Sharples, D. (1969). Children's Attitudes Towards Junior School Activities. British Journal of Educational Psychology, 39, 72-77.
23. Siedenttop, D., and O'Sullivan, M. (1992) Preface. Quest, 44,285-285
24. Silverman, S. and Subramaniam, R. (1999). Student Attitude Toward Physical Education and Physical Activity: A Review of Measurement Issues and Outcomes. Journal of Teaching in Physical Education 19(1):97-125
25. Smoll, F.L., and Schutz, R.W. (1980) Children's Attitudes Toward Physical Activity: A Longitudinal Analysis, Journal of Sport Psychology, 2, 137-147
26. Sparkes, A., Templin, T.J., and Schempp, P.G. (1992). The Problematic Nature of a Carrer in a Marginal Subject: Some Implications for Teacher Education Programs. Journal of Education for Teaching, 16, 3-28.
27. Stefanović, V. (1988). Pedagogy of Physical Culture. IRO „Naučna knjiga Beograd" and IPRO „Partizan", Belgrade.
28. Strand, B., and Scantling, E. (1994) An Analysis of Secondary Student Preferences Towards Physical Education. The Physical Educator, 61, 119-129.
29. Tannehill, D., Romar, J., O Sullivan, M., England, K., and Rosenberg, D. (1994). Attitudes Toward Physical Educations: Their Impact on How Physical Educators Make Sense of Their Work. Journal of Teaching in Physical Education, 13 406-420.
30. Te Ava, A., & Rubie-Davies, C. (2016). Cook Islands Students' Attitudes Towards Physical Education. Australian Journal of Teacher Education, 41(4).
31. Theodorakis, Y. (1992). Change of Attitudes Toward Skiing After Participation in a Skiing Course. Perceptual and Motor Skills, 75, 272-274.
32. Tjeerdsma, B.L., Rink, J.E., and Graham, K.C. (1996). Student Perceptions, Values, and Beliefs Prior to, During, and After Badminton Instruction. Journal of Teaching in Physical education, 15, 464-476.
33. Wersch, A.V., Trew, K., and Turner, I (1992). Post-primary School Pupils' Interest in Physical Education: Age and Gender Differences. British Journal of Educational Psychology, 62, 56-72.

ANALIZA STAVOVA UČENIKA PREMA NASTAVI TJELESNOG I ZDRAVSTVENOG ODGOJA

Ponašanje pedagoga tjelesnog i zdravstvenog odgoja tokom nastavnog procesa utiče na formiranje stavova učenika. Ako je pedagoški rad nastavnika na nižem interaktivnom nivou, može uzrokovati formiranje negativnih stavova učenika prema nastavi i/ili nastavnom predmetu. Stavovi učenika prema nastavi tjelesnog i zdravstvenog odgoja ne moraju uvijek nastati tokom nastavnog procesa. Mogu biti i prethodno formirani u pozitivnom ili negativnom obliku. I u jednom i u drugom slučaju utiču na cjelokupni odnos prema nastavnom predmetu. Stavovi mogu biti korektiv nastavnikovog rada. Ovo istraživanje je provedeno sa ciljem utvrđivanja stavova učenika osnovne škole prema nastavi tjelesnog i zdravstvenog odgoja. U uzorku ispitanika anketirani su učenici i učenice sedmog i osmog razreda iz deset osnovnih škola sa područja Kantona Sarajevo. Ukupno je obuhvaćeno 514 ispitanika, od toga muškog spola 53% i ženskog spola 47%. Podaci koji su definisali stav ispitanika prikupljeni su popunjavanjem anonimnih upitnika koji su sadržavali dvadeset različitih pitanja. Nakon prikupljanja podataka primjenjena je faktorska analiza. Rezultati analize su pokazali da su izdvojene tri značajne latentne komponente. Prva latentna komponenta može da se identificira kao negativni stav učenika prema nastavi tjelesnog i zdravstvenog odgoja. Sadrži oko 20% objašnjene varijanse sa korjenom 4,127. Druga latentna komponenta može da se identificira kao izrazito pozitivan stav učenika prema nastavi tjelesnog i zdravstvenog odgoja. Sadrži oko 16 % objašnjene varijanse sa korjenom 3,233. Treća latentna komponenta sa korjenom 1,31 i objašnjenosti varijanse od 5,65% lako se može smatrati matematičkim artefaktom koji inklinira negativnom stavu učenika. Grupisanje koeficijenata korelacije nije kao kod prve latentne komponente i pripada sasvim drugom podprostoru nastave tjelesnog i zdravstvenog odgoja. Nakon realizovane faktorske analize može se konstatovati da je ostvaren cilj istraživanja. Identificirana su dva jasna stava učenika prema nastavi tjelesnog i zdravstvenog odgoja. Jedan je pozitivan, drugi je negativan. Za treći stav, sadržan u trećoj latentnoj dimenziji, može se konstatovati da je negativan i da sadrži elemente drugog podprostora nastave. U cilju proširenja spoznaja o stavovima učenika prema nastavi tjelesnog i zdravstvenog odgoja mogu se organizovati istraživanja koja za uzorak ispitanika imaju različitu uzrasnu kategoriju od one koja je obuhvaćena ovim istraživanjem. Podaci koji se dobiju od ispitanika mogli bi se diferencirati i prema spolu učenika. Navedeno bi jasnije definisalo smjernice rada nastavnika, a sve u cilju poboljšanja stavova učenika prema nastavi tjelesnog i zdravstvenog odgoja.

Ključne riječi: Faktorska analiza, učenici, učenice, osnovna škola.

Received: December 03, 2018 / Accepted: December 15, 2018
Correspondence to: Faris Rašidagić Faculty of Sports and Physical Education, University of Sarajevo
E-mail: faris.rasidagic@gmail.com

THE EFFECT OF EXERCISE TRAINING USING STABLE AND UNSTABLE SURFACES ON BALANCE, GAIT, FATIGUE AND THE QUALITY OF LIFE IN PATIENTS WITH MULTIPLE SCLEROSIS

Pegah Rahmani[1], Vahid Zolaktaf[2], Amir Hossein Barati[3]

1. Department of Sport Injuries, Faculty of Sport Science, University of Isfahan, Isfahan, Iran
2. Department of Sport Injuries, Faculty of Sport Science, University of Isfahan, Isfahan, Iran
3. Department of Sport Injuries, Faculty of Sport Science, Shahid Rajaee Teacher Training University, Tehran, Iran

ABSTRACT

The aim of the present study was to investigate the effect of 10-week exercise training using stable and unstable surfaces on balance, gait, fatigue and the quality of life in patients with multiple sclerosis. Thirty patients were divided into two exercise groups. All patients received supervised exercise training sessions, 3 times per week for a 10-week period. Berg Balance Scale, 10-metre walk test, 2-minute walk test, Fatigue Severity Scale and Multiple Sclerosis Quality of Life-54 were used to assess balance, walking speed and endurance, fatigue and the quality of life, respectively. Data were analysed using a mixed ANOVA repeated measure at the significance level of $P<0.05$. The results showed that there were significant improvements for all outcome measures in both exercise groups. The exercise group which used an unstable surface showed a significantly larger improvement in balance, walking speed and walking endurance than the exercise group using a stable surface. According to research findings, the exercise in both groups resulted in considerable improvements in balance, walking speed and endurance, fatigue and the quality of life in patients with multiple sclerosis.

Keywords: multiple sclerosis, gait, balance, fatigue, quality of life

INTRODUCTION

Multiple sclerosis is one of the most common debilitating diseases, affecting millions worldwide (O'Connor et al., 2008). Patients with multiple sclerosis frequently experience symptoms and problems such as pain, fatigue, spasticity, muscle weakness, balance/coordination problems, walking impairment and poor quality of life (Negahban et al., 2013). The benefits of exercise in patients with multiple sclerosis have been investigated in relation to aerobic training (Newman et al., 2007), resistance exercise (Taylor et al., 2006), and core stability training (Freeman et al., 2010). Since multiple sclerosis has caused many clinical problems, studies examining adaptations of exercise training in patients with multiple sclerosis have focused on different outcome measures.

A Cochrane systematic review of exercise therapy for patients with multiple sclerosis confirms there is good evidence that exercise can be beneficial for mobility, isometric muscle strength, physical fitness, fatigue and the quality of life (Stroud et al., 2009).

Although balance, coordination, functional and core stability exercises have an important

contribution to function in individuals with multiple sclerosis, a limited number of studies have contained specific exercises for balance and coordination, as well as strengthening and stretching exercises (Learmonth et al., 2012). Therefore, we aimed to investigate the efficacy of our exercise programme, including all dimensions in accordance with our outcome measures.

Exercise training with the use of unstable surfaces is an important aspect of neuromuscular rehabilitation and conditioning, and, consequently, it furnishes improvement in coordination and the neuromuscular recruitment pattern. During physical training, the instability of movement places joints in risk situations. Thus, the activation of proprioceptive impulses that are integrated in various sensory-motor centres regulates adjustments in the contraction of postural muscles, thereby maintaining general postural balance (Ferreira et al., 2011). Thus, exercises on unstable surfaces generate rapid changes in the length of the ankle ligament due to the stimulation of the joint on multiple planes of movement, thereby generating afferent stimuli and reflexive motor responses in order to produce rapid joint stability (Myers et al., 2003). Ferreira et al. (2011) suggested that exercises on unstable surfaces generated a significant increase in EMG activity, especially with the eyes closed, and are therefore a valuable resource in the sensory-motor rehabilitation of the muscles.

According to Oliveira et al. (2006), the aim of this type of training is to induce unforeseen perturbation, thereby stimulating the stabilization reflex and the production of agonist-antagonist co-contraction. There is evidence indicating that exercise training using unstable surfaces has the potential to induce a positive effect on muscle force and activation, muscle strength, balance, stability and fatigue (Anderson et al., 2005).

Nevertheless, no study has yet investigated the effects of exercise training using unstable surfaces on various components of impairment and functional limitations in patients with multiple sclerosis.

Overall, the studies of postural responses indicate that patients with multiple sclerosis have delayed automatic postural responses to postural perturbations, and that there is a relationship between these postural response delays and delays in spinal somatosensory conduction (Cameron et al., 2010).

In addition, patients with multiple sclerosis have also been found to have poorer trunk control than healthy people when sitting on an unstable surface (Lanzetta et al., 2004). For these reasons, in the present study, foam surfaces with similar advantages to other unstable surfaces were put to use. Therefore, the aim of this randomized controlled pilot study was to investigate the comparative effects of a 10-week exercise training using stable and unstable surfaces on balance, gait, fatigue and the quality of life in patients with multiple sclerosis.

METHODS

Sample subjects

This study was a prospective, randomized controlled pilot trial with a repeated measures design and blinded assessments. The randomisation method was a balanced randomization process in which 30 patients were matched based on age and EDSS and randomly assigned to two subgroups in equal sample proportions using a table of random numbers. The groups consisted of the exercise training using a stable surface (group 1) and exercise training using an unstable surface (group 2).

Patients were included in the study if they had clinically or laboratory confirmed relapsing–remitting, an Expanded Disability Status Scale between 2 and 4, ability to stand without any support and the ability to walk 500m independently. Exclusion criteria encompassed a severe relapse one month before the study, involvement in any physical therapy programme before beginning the study, cardiovascular and respiratory diseases, diabetes, psychiatric disorders or severe cognitive impairment, severe blurred vision and vestibular disease (Negahban et al., 2013; Tarakci et al., 2013).

Tests and measurements

Patients with multiple sclerosis first underwent outcome assessments pretest1 (week -10) followed by a run-in 10-week period without any intervention or specific training to control the effect of the drug and time. Two other outcome assessments were performed before pretest2 (week 0) and at the end posttest (week +10) of the exercise training (figure 1). Then, the Berg Balance Scale (Negahban et al., 2013), 10-metre walk test (Tarakci et al., 2013), 2-minute walk test (Negahban et al., 2013), Fatigue Severity Scale and Multiple Sclerosis Quality of Life-54 (Tarakci et al., 2013) were used to assess balance, walking speed and endurance, fatigue and the quality of life, respectively.

Training programme

The training protocol was conducted 3 times per week for 10 weeks in both groups. All sessions began with 5-minute warm-ups using a treadmill, followed by a 30-to-50-minutes training protocol, and ended with a 5-minute cool-down including muscle stretching.

The exercise training programme was based on the exercise provided in Tarakci et al. (2013) and Negahban et al. (2013). In brief, the exercise protocol was a combined set of strength, stretching,

core stabilization, balance and walking exercises including straight leg raising, forward lunge, muscle stretching, double/single leg standing and tandem standing. Also, walking activities including forward/backward/side walking, walking through obstacles and walking up and down the stairs were exercised by each patient. The patients in the exercise training group which used a stable surface performed exercises on a rigid surface. However, patients in the exercise training group which used an unstable surface performed the same training programme on a foam surface. The height of the foam was gradually increased from 6cm in week 1 up to 10 cm in week 10. The exercise was intended to be light to moderately intense, and a Borg Rating of Perceived Exertion (RPE) scale was targeted for levels 9 to 13 by all participants over the 10-week period. This exercise was done in 4 sets (Maximum) with 30 to 60 seconds of rest. The training took place under the direct supervision of the exercise specialist with support of research assistants in an accessible gymnasium.

Statistical analysis

Data were analysed using SPSS software version 22.0 for Windows. The level of statistical significance was set at P< 0.05. Demographic data of both groups were compared, using an independent samples t-test. Based on the within-subject factor of time (i.e. 3 pre–post times) and the between-subject factor of group (i.e. two study groups), the researchers conducted a 2 × 3 (2 groups by 3 pre–post times) mixed model of the analysis of variance (ANOVA) to determine the main effects and interactions of group and time factors for each outcome measurement. Within-group differences for 3 pre–post times (week -10, week 0 and week +10) were analysed using a repeated measures analysis of variance. Post hoc analyses were conducted using the Bonferroni correction for multiple comparisons. Between-group differences were analysed using an independent samples t-test.

RESULTS

The two groups of this study did not differ in terms of demographics (Table 1). The results of between-group differences in all outcome measurements showed that there was no significant difference between both groups in pretest1 (week -10) and pretest2 (week 0). As shown in Table 2, there was no significant interaction of groups by time for some outcome measurements, including fatigue and the physical and mental health composite scores of the Multiple Sclerosis Quality of Life-54.

The main effect of time was significant for both the physical (PHCS) and mental health (MHCS) composite scores of the Multiple Sclerosis Quality of Life-54 and fatigue, meaning that, irrespective of the group main effect, patients had a higher quality of life and a reduction fatigue posttest (week +10) relative to the pretest2 (week 0).

Alternatively, there was a significant interaction of groups by time for other outcome measurements including the Balance Scale, 10-metre walk and 2-minute walk. Therefore, the simple main effects of time within each experimental group were analysed (Table 3). Results from the repeated measures ANOVA test provide evidence of a significant time effect for all outcome measurements. Bonferroni corrected pair-wise comparisons indicate a significant improvement between the pre-test (week 0) and post-test (week +10) for the Berg Balance Scale, 10-metre walk, 2-minute walk, fatigue and Multiple Sclerosis Quality of Life-54 in both groups. The results of between-group differences in change scores showed that, with the exception of fatigue and Multiple Sclerosis Quality of Life-54, there was a significant difference between both groups in all outcome measurements. Patients in the exercise training group which used an unstable surface showed significantly larger change scores in the Berg Balance Scale (0/006), 10-metre walk (0/010) and 2-minute walk (0/005) than the exercise training group which used a stable surface.

Table 1: Demographic characteristics

	Exercise group using a stable surface (n=15)	Exercise group using an unstable surface (n=15)	p
Age	29.20±3.12	29.33±3.97	0.91
Weight	166.14±5.91	165.53±8.24	0.81
Height	52.89±6.35	55.36±6.95	0.31
History	9.40±1.50	9.73±1.38	0.53
EDSS	3.33±0.48	3.53±0.63	0.34

Table 2: Tests of Within-Subjects Effects

Interaction		Main Effect				
Group*Time		Group		Time		
p	F	p	F	p	F	
0.021	4.11	0.17	1.98	>0.0001	48.45	Berg Balance Scale
0.016	4.46	0.40	0.72	>0.0001	70.40	10-metre walk
0.032	3.66	0.28	1.20	>0.0001	88.61	2-minute walk
0.857	0.15	0.94	0.04	>0.0001	335.03	Fatigue Scale
0.372	1.007	0.18	1.88	>0.0001	1533.09	MSQOL-54 (PHCS)
0.21	1.60	0.95	0.04	>0.0001	446.13	MSQOL-54 (MHCS)

Table 3: Tests of Within-Subjects Effects

Exercise group using an unstable surface			Exercise group using a stable surface			
p	Mean difference		p	Mean difference		
1.00	0.55	Pre1-pre2	1.00	0.49	Pre1-pre2	
>0.0001	7.51	Pre1-post	0.004	4.60	Pre1-post	Berg Balance Scale
>0.0001	8.06	Pre2-post	0.010	4.11	Pre2-post	
1.00	0.02	Pre1-pre2	1.00	0.10	Pre1-pre2	
>0.0001	4.64	Pre1-post	>0.0001	2.73	Pre1-post	10-metre walk
>0.0001	4.67	Pre2-post	>0.0001	2.83	Pre2-post	
1.00	0.02	Pre1-pre2	1.00	0.02	Pre1-pre2	
>0.0001	0.82	Pre1-post	>0.0001	0.56	Pre1-post	2-minute walk
>0.0001	0.84	Pre2-post	>0.0001	0.54	Pre2-post	
1.00	0.07	Pre1-pre2	1.00	0.14	Pre1-pre2	
>0.0001	2.33	Pre1-post	>0.0001	2.45	Pre1-post	Fatigue Severity Scale
>0.0001	2.26	Pre2-post	>0.0001	2.30	Pre2-post	
0.091	1.10	Pre1-pre2	1.00	0.26	Pre1-pre2	
>0.0001	14.67	Pre1-post	>0.0001	14.83	Pre1-post	MSQOL-54 (PHCS)
>0.0001	15.77	Pre2-post	>0.0001	15.09	Pre2-post	
0.015	1.59	Pre1-pre2	1.00	0.42	Pre1-pre2	
>0.0001	12.16	Pre1-post	>0.0001	14.03	Pre1-post	MSQOL-54 (MHCS)
>0.0001	13.75	Pre2-post	>0.0001	14.45	Pre2-post	

DISCUSSION

The results of this study showed that balance, walking speed and endurance, fatigue and the quality of life all enhanced in favour of the exercise training using stable and unstable surfaces in patients with multiple sclerosis. The results of between-group comparisons showed that exercise training using an unstable surface resulted in a larger improvement in balance and walking speed and endurance than the exercise training using a stable surface. However, no significant differences were observed between improvements related to the quality of life and fatigue reduction in both groups.

Following a 10-week study, patients in both groups showed significant improvements in Berg Balance Scale scores. Similar to our findings, Freeman et al. (2010) found a significant improvement with fewer group exercise sessions (10 weeks, twice a week) in Berg Balance Scale scores. Also, Tarakci et al. (2013) showed significant improvements in the Berg Balance Scale after the 12-week group exercise training. On the other hand, Learmonth et al. (2012) reported improved physical activity levels and perceived balance confidence, but they did not observe improvements in the Berg Balance Scale after 12-weeks group exercise in patients with multiple sclerosis.

Also, the results of the present study showed that exercise training using an unstable surface resulted in a larger improvement in balance than the exercise training using a stable surface. There are several possible reasons that might explain these results. Research on the focus of attention has consistently demonstrated that an external focus (i.e. foam) enhances motor performance and learning relative to an internal focus (i.e. on body movements). Wulf et al. (2013) showed that the performance and learning advantages through instructions or feedback inducing an external focus extend across different types of tasks, skill levels, and age groups. Benefits are seen in movement effectiveness (e.g. accuracy, consistency, balance) as well as efficiency (e.g. muscular activity, force production, cardiovascular responses).

Therefore, the external focus (foam) could result in a larger improvement of balance in the exercise training group which used an unstable surface as compared to the exercise training group using a stable surface (Kramer et al., 2014; Wulf, G., 2013). Furthermore, Behm et al. (2003) showed that the activation of trunk stabilizers was significantly greater with the unstable surfaces. Unstable exercises on trunk muscle activation seem to concur that the introduction of instability into the activity increases the extent of muscle activation. Trunk or core stabilization is essential for maintaining static or dynamic balance, especially when attempting to exert forces upon external objects (foam) (Anderson and Behm, 2005). Therefore, unstable exercises with positive effects in activation of the trunk stabilizers could result in a larger improvement of balance in the exercise training group which used an unstable surface as compared to the exercise training group using a stable surface (Anderson and Behm,2005; Beham et al., 2003).

One of the key findings of the present study was an increase in walking speed and endurance in both groups. Consistent with the finding of our study, Tarakci et al. (2013) showed significant improvements in the functional capacity of walking after the 12-week group exercise training.

Also, Negahban et al. (2013) showed a significant improvement in walking speed and endurance after a 5-week exercise therapy. On the other hand, Taylor et al. (2006) showed in their study that there was no significant improvement after a twice-a-week 10-week progressive resistance exercise programme in walking capacity. Differences in therapy contents of the two trials may lead to this different result. Taylor et al. (2006) only applied progressive resistive training in their study, while, in our study, there were strengthening, stretching, balance, core stability and walking exercises, which may cause an improvement in walking speed and endurance. Walking speed and endurance may also be affected by muscle tonus and balance in people with multiple sclerosis. Therefore, the larger improvement of balance on an unstable surface in our study may cause a larger improvement of walking speed and endurance in the exercise training group which used an unstable surface as compared to the exercise training group using a stable surface.

Our results showed that exercise training using stable and unstable surfaces is effective on fatigue reduction in patients with multiple sclerosis. Parallel to our findings, the effects of various exercise programmes on improving fatigue have been published before, using different fatigue scales (McCullagh et al., 2008; Stroud et al., 2009). Hebert et al. (2013) stated that symptomatic fatigue is significantly related to balance, and is a significant predictor of balance as a function of central sensory integration in patients with multiple sclerosis. They support the theory that for those patients with multiple sclerosis who struggle to maintain steady balance during tasks that stimulate

the central sensory integration process, complaints of significant levels of fatigue are probable (Hebert et al., 2013). Stretching exercises which improve endurance, and might reduce fatigue (McCullagh et al., 2008; Stroud et al., 2009). We applied some stretching exercises that might reduce fatigue in MS patients.

The results of the present study showed that exercise training using stable and unstable surfaces was associated with a significant improvement in the quality of life in people with multiple sclerosis. While improvements were found significant after the exercise sessions in some studies, there is other research that has not supported this finding (Motl et al., 2008). Our findings are similar to the studies that found a significant improvement in the quality of life after exercise training. The improvements in the quality of life suggest that a better perception of balance can have a positive impact on patient behaviour. It has been previously reported that balance disorders with a fear of falling represent an important problem affecting the quality of life, even in early and mild stages of multiple sclerosis (Cattaneo et al., 2007).
However, no significant differences were observed between improvements related to the quality of life and fatigue reduction in both groups. Therefore, it could be argued that, in cases where the aim is to improve fatigue and the quality of life in patients with multiple sclerosis, the exercise training using an unstable surface does not have any specific advantages over the exercise training using a stable surface.

CONCLUSION

According to research findings, exercise on stable and unstable surfaces resulted in considerable improvements in balance, walking speed and endurance, fatigue and the quality of life in patients with multiple sclerosis, with no worsening of their clinical status.

REFERENCES

1. Anderson, K., Behm, D.G. (2005). The impact of instability resistance training on balance and stability. Sports Med, 35(1):43-53.
2. Behm, D.G., Leonard, A., Young, W., and et al. (2003). Trunk muscle EMG activity with unstable and unilateral exercises. Can J Appl Physiol, 28 Suppl.: S30.
3. Cameron, M.H., Lord, S. (2010). Postural control in multiple sclerosis: Implications for fall prevention. Curr Neurosci Rep, 10:407-412.
4. Cattaneo, D., Jonsdottir, J., Zocchi, M., Regola, A. (2007). Effects of balance exercises on people with multiple sclerosis: a pilot study. Clin Rehabil, 21(9):771-81.
5. Ferreira, B.L.A., Pereira, W.M., Rossi, L.P., Kerpers, I.I., Rodrigues, de Paula A. Jr. (2011). Analysis of electromyographic activity of ankle muscles on stable and unstable surfaces with eyes open and closed. J of Bodyw Mov Ther, 15(4): 496-501.
6. Freeman, J.A., Gear, M., Pauli, A., et al. (2010). The effect of core stability training on balance and mobility in ambulant individuals with multiple sclerosis: a multi-centre series of single case studies. Mult Scler, 16: 1377–1384.
7. Hebert, J.R., Corboy, J.R. (2013). The association between multiple sclerosis-related fatigue and balance as a function of central sensory integration. Gait Posture, 38, 37-42.
8. Kramer, A., Dettmers, C., and Gruber, M. (2014). Exergaming with additional postural demands improves balance and gait in patients with multiple sclerosis as much as conventional balance training and leads to high adherence to homebased balance training. Arch Phys Med Rehabil, 95: 1803–1809.
9. Lanzetta, D., Cattaneo, D., Pellegatta, D., Cardini, R. (2004). Trunk control in unstable sitting posture during functional activities in healthy subjects and patients with multiple sclerosis. Arch Phys Med Rehabil, 85(2): 279–83.
10. Learmonth, Y.C, Paul, L., Miller, L., Mattison, P., and McFadyen, A.K. (2012). The effects of a 12-week leisure centre-based, group exercise intervention for people moderately affected with multiple sclerosis: a randomized controlled pilot study. Clin Rehabil, 26: 579–593.
11. McCullagh, R., Anthony, P.F., Raymond, P.M. (2007). Long-term benefits of exercising on quality of life and fatigue in multiple sclerosis patients with mild disability: a pilot study. Clin Rehabil, 22(3): 206-214.
12. Motl, R.W., and Gosney, J.L. (2008). Effect of exercise training on quality of life in multiple sclerosis: a meta-analysis. Mult Scler, 14: 129–135.
13. Myers, J.B., Riemann, B.L., Hwang, J.H., Fu, F.H., Lephart, S.M. (2003). Effect of peripheral afferent alteration of the lateral ankle ligaments on dynamic stability. Am J Sports Med, 31(4): 498-506.
14. Newman, M.A., Dawes, H., van den, B.M., Wade, D.T., Burridge, J., Izadi, H. (2007). Can aerobic treadmill training reduce the effort of walking and fatigue in people with multiple sclerosis: a pilot study. Mult Scler, 13:113–119.
15. O'Connor, A.B., Schwid, S.R., Herrmann, D.N., Markman, J.D., Dworkin, R.H. (2008). Pain associated with multiple sclerosis: systematic review and proposed classification. Pain, 137: 96–111.
16. Oliveira, F.B., et al. (2006). Avaliac¸a ˜o de doismodelos de ta´buaproprioceptiva com doistipos de apoiospormeio da eletromiografia de superfı´cie. Fisioterapia Brasil, 7(3).

17. Stroud N.M., and Minahan, C.L. (2009). The impact of regular physical activity on fatigue, depression and quality of life in persons with multiple sclerosis. Health and Quality of Life Outcomes, 7:68.

18. Tarakci, E., Yeldan, I., Huseyinsinoglu, B.E., Zenginler, Y., Eraksoy M. (2013). Group exercise training for balance, functional status, spasticity, fatigue and quality of life in multiple sclerosis: A randomized controlled trial. Clinical Rehabilitation, 27(9): 813-822.

19. Taylor, N.F., Dodd, K.J., Prasad, D., and Denisenko, S. (2006). Progressive resistance exercise for people with multiple sclerosis. Disabil Rehabil, 28:1119–1126.

20. Wulf, G. (2013). Attentional focus and motor learning: a review of 15 years. International Review of Sport and Exercise Psychology, 6(1):77-104.

EFEKAT TRENINGA SA VJEŽBAMA U KOJIMA SE KORISTE STABILNE I NESTABILNE POVRŠINE NA RAVNOTEŽU, DRŽANJE, UMOR, I KVALITET ŽIVOTA PACIJENATA SA MULTIPLA SKLEROZOM

Cilj ove studije je bio istražiti efekat treninga sa vježbama na stabilnim i nestabilnim površinama u trajanju od 10 sedmica na ravnotežu, držanje, umor i kvalitet života pacijenata sa multipla sklerozom. Trideset pacijenata je podijeljeno u dvije grupe koje su izvodile vježbe. Svi pacijenti su bili podvrgnuti treninzima sa vježbama uz nadzor, 3 puta sedmično tokom perioda od 10 sedmica. Bergova skala za procjenu ravnoteže, hodanje 10 metara, hodanje 2 minute, Skala procjene umora i Instrument za procjenu kvaliteta života oboljelih od multipla skleroze su korišteni za procjenu ravnoteže, brzine hodanja i izdržljivosti, te umora i kvaliteta života, pojedinačno za svaku od navedenih. Podaci su analizirani korištenjem mješovite ANOVA analize za ponovljena mjerenja u nivou značajnosti od $P<0.05$. Rezultati su pokazali postojanje značajnih poboljšanja za sve ishode u obje grupe koje su izvodile vježbe. Grupa koja je izvodila vježbe na nestabilnim površinama je pokazala značajno veća poboljšanja ravnoteže, brzine hodanja i izdržljivosti tokom hodanja u odnosu na grupu koja je izvodila vježbe na stabilnim površinama. U skladu sa nalazima ovog istraživanja, vježba u obje grupe je rezultirala značajnim poboljšanjima ravnoteže, brzine hodanja, izdržljivosti i kvalitete života, te smanjenjem razine umora pacijenata sa multipla sklerozom.

Ključne riječi: multipla skleroza, držanje, ravnoteža, umor, kvalitet života

Received: June 30, 2017 / Accepted: August 08, 2017
Correspondence to: Vahid Zolaktaf, Department of Sport Injuries, Faculty of Sport Science, University of Isfahan, Isfahan, Iran
E-mail: v.zolaktaf@spr.ui.ac.ir

THE RELATIONSHIP OF MOTOR-BASED ANAEROBIC CAPACITY TESTS WITH VARIOUS SPORTS ACTIVITIES: A SYSTEMATIC REVIEW

Ivana Petrović[1], Nikola Utvić[1], Ratko Stanković[1]

1. Faculty of Sport and Physical Education, University of Niš, Serbia

ABSTRACT

Activities in which athletes must move their body across a field with a quick burst of energy require a high relative peak power and anaerobic capacity. Some of the procedures that have been used in previous studies to estimate anaerobic power and/or capacity are the maximal accumulated oxygen deficit (MAOD), Wingate test (WAnT), jump tests, maximal anaerobic running test and running-based anaerobic sprint test (RAST). The aim of this systematic review is the relationship of anaerobic capacity-based tests with various sports activities. Four electronic databases (Medline, PubMed, Kobson and Google Scholar) were searched. The included studies were coded for the following criteria: anaerobic capacity assessment tests, the impact of motor skills-based tests on anaerobic capacity and its correlation with the type of activity. A total of 20 studies met the inclusion criteria. The most used tests to determine the anaerobic capacity in the analysed research were WAnT and RAST tests, as well as their relation to the motor skills tests such as jump tests, agility and sprint tests, and isokinetic tests. The WAnT and RAST are reliable and valid tests which can be used to assess anaerobic power and predict short-distance performances. Vertical jump is good for measuring the leg muscle strength and power in activities that require a running and jumping-based ability. The countermovement jump and bench press power tests are good for measuring anaerobic capacity in activities that require repeated short sprints, and agility tests are good when assessing performance measures that require lower body strength and power necessary for quick changes in direction.

Keywords: Anaerobic capacity, agility, vertical jump, countermovement jump, squat jump, speed

INTRODUCTION

Anaerobic capacity is defined as the maximum amount of adenosine triphosphate that can be resynthesized via anaerobic metabolism during maximal exercise (Minahan, Chia, & Inbar, 2007), thus, it is an energy expenditure that uses anaerobic metabolism (without the use of oxygen) that lasts less than 90 s, utilizing an exhaustive effort (Wilmore, & Costill, 2004).

Anaerobic capacities mainly dominate in the activities of short duration (jumping, running, throwing) (Abbasian, Golzar, Onvani, & Sargazi, 2012). Its performance depends on many factors, such as age and sex (Maughan, Watson, & Weir, 1983; Kin-Isler, Ariburun, Özkan, Aytar, & Tandogan, 2008), muscle fibre composition (Kin-Isler et al., 2008), muscle cross sectional area (Reilly, Secher, Shell, & Williams, 1990; Kin-Isler et al., 2008), body composition, strength and training (Saavedra, LagassÉ, Bouchard, & Simoneau, 1991; Kin-Isler et al., 2008).

Some of the procedures that have been used in previous studies to estimate the anaerobic power and/or capacity are the maximal accumulated oxygen deficit (MAOD) (Balčiūnas, Stonkus, Abrantes, & Sampaio, 2006; Lima, 2007), Wingate test (WAnT) (Bar-Or, 1987; Nummela, Hamalainen, & Rusko, 2007), jump tests (Hoffman, & Kang, 2002), continuous jump tests (Sands et al., 2004), vertical jump tests (Nummela et al., 2007), attained running (Zemková, & Hamar, 2004), the maximal anaerobic running test (MART) (Nummela et al., 2007) and the running-based anaerobic sprint test (RAST) (Meckel, Machnai, & Eliakim, 2009). These methodologies

have been studied for a considerable amount of time, and they have been applied in the evaluation of anaerobic power of athletes (Moore, & Murphy, 2003), healthy subjects and cardiac patients (Mezzani et al., 2008). The maximum accumulated oxygen deficit (MAOD) is considered the gold standard for estimating anaerobic capacity. Using MAOD to estimate anaerobic capacity is not easy. It requires several submaximal exercise bouts and one supramaximal exercise bout and their uses represent a high financial cost (Medbo et al., 1988).

The Wingate test (WAnT) is inexpensive and commonly used (Bar-Or, 1987; Nummela et al., 2007). Several studies have demonstrated a relationship between the parameters measured from WAnT and anaerobic capacity (Minahan et al., 2007). Minahan et al. (2007) showed that the mean power (MP) and fatigue index (FI) from WAnT were correlated with MAOD. The Wingate test (Bar-Or, 1987) is widely accepted as a criterion and has been used to investigate the validity of a range of different anaerobic tests (Haj-Sassi et al., 2011). WAnT is a cycling-based anaerobic test and RAST is its adaptation to running (Meckel et al., 2009).

The RAST output (peak power, mean power, fatigue index, maximal speed and mean speed) are similar to those determined in WAnT, showing high correlations with the same variables. It is acknowledged as a good predictor of running performance (35 to 400 m), which can easily be added to a training routine (Zagatto, Beck, & Gobatto, 2009).

It was also reported that muscular strength is one of the significant factors that have a major role in anaerobic performance (Özkan et al., 2012). Muscular strength has the ability to generate in short-term high-intensity activities (Morrow Jr, Zhu, Franks, Meredith, & Spain, 2009). In the study of Çakir-Atabek (2014), it was concluded that all WAnT performance variables (App, RPP, AMP, RMP) significantly correlate with all jump performance variables. The height achieved on the vertical jump has a direct correlation with the amount of force produced by muscle fibres (Faigenbaum et al., 2009).

According to another study, all jump performance variables have a significant relationship with peak power and mean power ($p < .05$ and $p < .01$) (Ziyagil, Cengiz, & Aksoy, 2016).

Previous studies showed that RAST is a good test to be used in sports that have running as a principal form of locomotion (Balčiūnas et al., 2006), and that RMAT and VJ tests can be used to measure the leg muscle strength and power in activities that are running-based, instead of using cycling that is required in WAnT (Haj-Sassi et al., 2011). Based on the above mentioned, the aim of this paper is to analyse recent research that examined the relationship of anaerobic capacity-based tests with various sports activities.

METHODS

Research strategy

The search was conducted via the following electronic databases: Medline, PubMed, Kobson and Google Scholar to identify relevant articles that investigated the relationship of anaerobic capacity-based tests with various sports activities. A manual search was performed using a combination of the following key terms: anaerobic capacity, agility, vertical jump, countermovement jump, squat jump, speed.

The reference lists of each included article were also scanned to identify additional relevant studies. The database search was limited to the journal articles published in English during the last 10 years, namely between 2008 and 2017.
Inclusion criteria

Type of Study

The review included journal articles written in English and published during the last 10 years.

Type of Intervention

To be included in the analysis, the articles were required to include a test for anaerobic capacity assessment, the impact of some motor skills-based tests on anaerobic capacity and its correlation with the type of activity.

Type of Outcome Measure

The included articles were required to report the anaerobic capacity as the outcome measure during some motor-based tests for speed, agility or strength.

Exclusion criteria

The exclusion criteria were as follows: (1) studies without motor-based tests; (2) studies without estimation of the anaerobic capacity and (3) studies written in languages other than English.

Data analysis

Table 1 provides an overview of close analyses of 20 studies that met the set criteria. Following the conventions for systematic reviews, the table presents the following parameters: groups, participants' sample information (gender, number and age of subjects), anaerobic power (power and mean peak, fatigue index), motor skills-based tests, results and conclusion.

RESULTS

Study selection

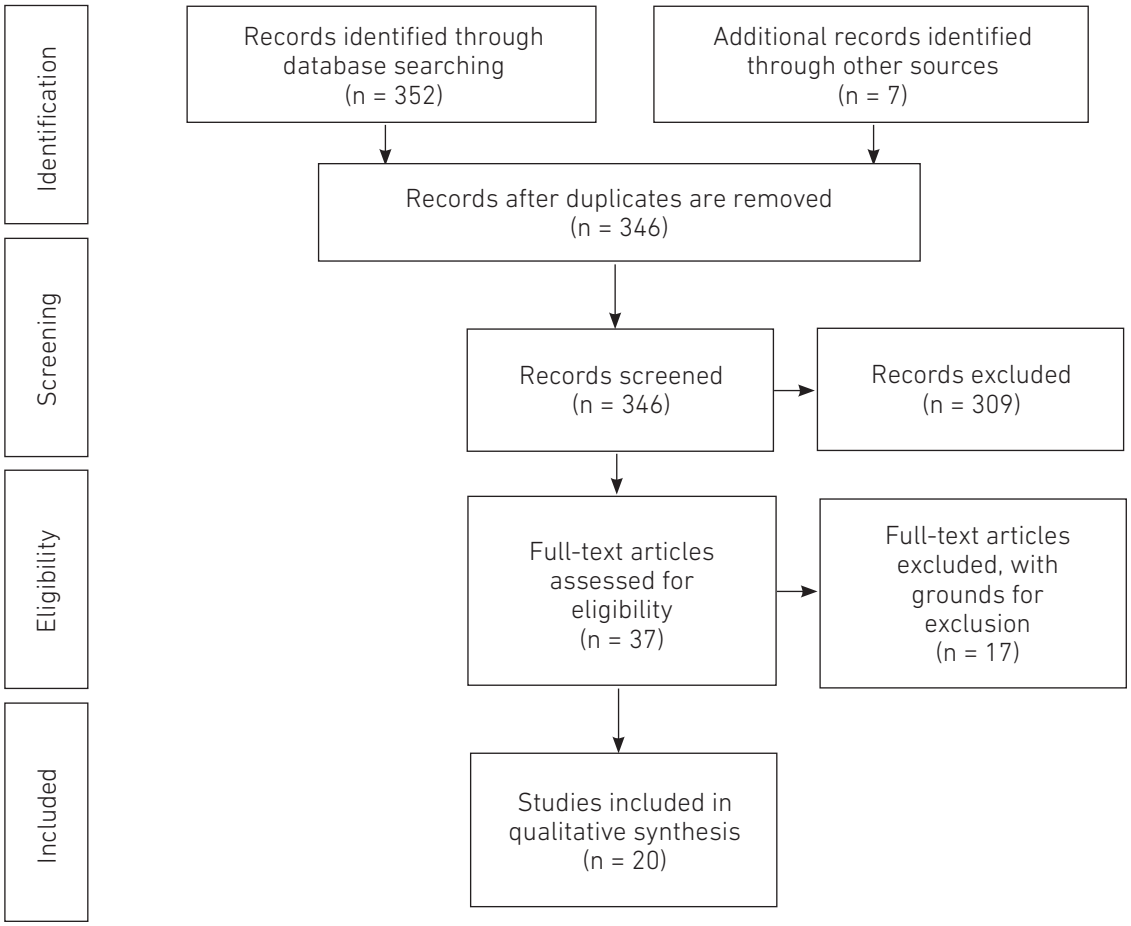
The database search returned 346 articles. After eliminating all duplicated articles, analysing titles and screening abstracts, 37 studies entered the next stage of analysis. Only the studies that had included relevant outcomes were considered.

The final number of studies, in the final analysis, was 20. Details of the study selection process are shown in Fig. 1.

Study characteristics

All studies that met the inclusion criteria were published in the English language between 2008 and 2017. The pooled sample size of the 20 studies is 1851, whereas a typical size of individual studies ranged from 11 in the research of Kaminagakura et al. (2012) and Balsalobre-Fernández, Tejero-González, del Campo-Vecino, Bachero-Mena, & Sánchez-Martínez (2014) to 725 subjects per group in the research of Ziyagil et al. (2016). The first study in this group was published in 2008 (Kin-Isler et al., 2008), and the last in 2017 (Allison et al., 2017). The participants mostly belonged to the age group from 11.7 (8) ± 0.6 (5) in the research of Jones and Lorenzo (2013) to 25.1 ± 1.7 year-old subjects in the research of Alemdaroğlu (2012). Gender-wise, males were the more represented group, with 14 studies including only male participants, five including both sexes (Zupan et al., 2009; Changela, & Bhatt, 2012; Jones, & Lorenzo, 2013; Çakir-Atabek, 2014; Ziyagil et al., 2016), whereas only in one study, participants were solely female (Allison et al., 2017). All the participants belonged to the healthy and active group of people, all of which took part in some sports activities, collective sports teams (Dal Pupo et al., 2013; Balsalobre-Fernández et al., 2014; Dardouri et al., 2014; Andrade et al., 2015; Burgess, Holt, Munro, & Swinton, 2016; Kin-Isler et al., 2008; Meckel et al., 2009; Alemdaroğlu, 2012; Chaleh et al., 2012; Changela, & Bhatt, 2012), individual sports (Zagatto et al., 2009; Kaminagakura et al., 2012; Çakir-Atabek, 2014; Ziyagil et al., 2016) and collegiate sports organizations (Zupan et al., 2009; Haj-Sassi et al., 2011; Jones, & Lorenzo, 2013; Dardouri et al., 2014; Abbasian et al., 2012; Burgess et al., 2016; Allison et al., 2017).

Figure 1: Summary of the literature search



DISCUSSION

Assessment of anaerobic fitness is an important parameter in controlling and monitoring sports training performance. The most used tests to determine anaerobic capacity in the analysed research were WAnT test (Kin-Isler et al., 2008; Meckel et al., 2009; Zagatto et al., 2009; Zupan et al., 2009; Haj-Sassi et al., 2011; Alemdaroğlu, 2012; Changela, & Bhatt, 2012; Dal Pupo et al., 2013; Çakir-Atabek, 2014; Burgess et al. 2016) and RAST test (Kaminagakura et al., 2012; Balsalobre-Fernández et al., 2014; Dardouri et al., 2014; Andrade et al., 2015; Abbasian et al., 2012).

The WAnT is easy to apply and it only requires 30 seconds on a cycle ergometer (Balčiūnas et al., 2006). It has been shown to be an excellent predictor of anaerobic power (Vandewalle, Péerès, & Monod, 1987) and a good performance predictor in short-distance sporting events (Perez-Gomez, et al. 2008). Because of its scientific acceptance as a good procedure for assessing anaerobic power and capacity, the cycling WAnT has been used as a standard procedure to verify the validity of anaerobic evaluation tests. From the 20 analysed research articles in this paper, the WAnT was used in ten of them to develop anaerobic capacity.

The running-based anaerobic sprint test (RAST) has been adapted from the Wingate anaerobic test (WAnT) protocol as a tool to assess the running sprint ability and anaerobic power (Keir, Thériault, & Serresse, 2013). The RAST test consists of six 35-m maximal sprints with a 10-second recovery. By measuring body mass and running times, it is possible to determine the power of effort in each sprint. The RAST results can give an estimate of neuromuscular and energy determinants of maximal anaerobic performance, and it is a good test for the evaluation protocol to be used in sports that have running as a principal form of locomotion (Balčiūnas et al., 2006).

Significant correlations between the WAnT and RAST have been reported for peak power (ranging from r = 0.46 to r = 0.90) and mean power (ranging from r = 0.53 to r = 0.975) (Zagatto at al., 2009; Abbasian, Golzar, Onvani, & Sargazi, 2012). From the analysed research, Hay-Sassi et al. (2008) have found a significant correlation between these two tests in peak power (r = - 0.44) and mean power (r = - 0.72), and, in the research of Burgess et al. (2016), correlations were found for peak power (r = 0.70) and mean power (r = 0.60), which is in an agreement with the previous research.

Zagatto et al. (2009) investigated the reliability and validity of the running anaerobic sprint test (RAST) in anaerobic assessment and prediction of short-distance performance. They included 40 members of armed forces in the research. The RAST had significant correlations with the Wingate test (peak power (r = 0.46), mean power (r = 0.53) and fatigue index (r = 0.63)) and 35, 50, 100, 200 and 400 m performance scores ($p < 0.05$). In another research, a survey was conducted on a sample of 17 students of Physical Education with the aim of comparing parameters of anaerobic capacity (Zemková, & Hamar, 2004).

They found a high correlation between the parameters of anaerobic capacity, obtained during the run on a carpet for a period of 30 s with the driving resistance of the driving isokinetic cycle ergometer, such as maximum power (r = 0.877), average power (r = 0.920) and fatigue index (r = 0.896). Non-significant correlations between these measures have also been reported in previous research (Keir et al., 2013). Keir et al. (2013) conducted it on only eight participants and they did not include an unloaded acceleration phase immediately prior to the initiation of the 30 s WAnT test which is contrary to the standard protocol (Bar-Or, 1987).

This finding is similar to that reported by Zagatto et al. (2009) who also found that the RAST produced significantly lower peak power scores than the WAnT, and Kaminagakura et al. (2012), in their study, indicated that the RAST cannot be used to predict anaerobic capacity, and a reason for disagreement can be that they included only nine subjects in their survey. In the analysed research of Kaminagakura et al. (2012) and Andrade et al. (2015), we can point out their reference that the parameters from RAST did not associate with MAOD, suggesting that this method should not be used to evaluate anaerobic capacity which is an interesting reference if we know that there is a high correlation between MAOD and WAnT (Minahan et al, 2007).

Other analysed research used some motor skills-based tests to confirm the relationship and reliability in the development of anaerobic capacity. For example, in the research of Popović et al. (2015), they found a high correlation between the RAST and performance in short distances.

With these findings, they have confirmed that it could predict any changes in performance and could be used as a training tool in anaerobic training.

Results from the Chaleh (2012) study showed a statistically significant relationship between anaerobic power and speed of soccer players, the relationship between anaerobic power and agility, as well as speed and agility.

They have concluded that by considering the relationship between speed, agility and anaerobic power, it can be expected that low level of one of these three factors can also affect the other.

Haj-Sassi et al. (2011) were evaluating the reliability and validity of the repeated modified agility test (RMAT) to assess anaerobic power and explosiveness.

The TT of the RMAT had significant correlations with WAnT PP (r = - 0.44) and MP (r = - 0.72), vertical jumps (squat jump: r = - 0.50; countermovement jump: r = - 0.61; drop jump (DJ) r = - 0.55; DJ with dominant leg: r = - 0.72; DJ with non-dominant leg: r = - 0.53) and five jump tests (r = - 0.56).

These show that vertical and horizontal jumps correlated with both TT and PT of the RMAT. In fact, Haj-Sassi et al. (2011) reported a significant correlation between 5JT and TT of the 6 x 5 m shuttle sprint test.

The RMAT and the VJ tests can easily be used to measure the leg muscle strength and power in activities that are running-based instead of using cycling that is required in WAnT. Dardoui et al. (2014) have reached similar results.

They examined the relationship between repeated sprint performance and anaerobic speed reserve (AnSR), aerobic fitness and anaerobic power, and observed a significant correlation between the 5JT and both TT (r = - 0.47, p < 0.01) and PT (r = - 0.49, p < 0.006). TT and PT were significantly correlated with T30 (r = 0.63, p = 0.001 and r = 0.62, p = 0.001), horizontal jump performance (r = - 0.47, p = 0.001 and r = - 0.49, p = 0.006) and AnSR (r = 0.68, p = 0.001 and r = - 0.70, p = 0.001).

Muscular strength is the ability of the body's musculature to generate significant amounts of power and is considered to be a strong predictor of athletic success (Morrow Jr, Zhu, Franks, Meredith, & Spain, 2009).

The dynamic and static contraction power of legs are closely related to anaerobic power performance where it is an important criterion for the sport performance in sports involving explosive efforts (Fox, Bowers, & Foss, 1993).

The height achieved on the vertical jump has a direct correlation with the amount of force produced by muscle fibres (Faigenbaum et al., 2009). In particular, explosive muscular strength has been accepted as a crucial component of anaerobic (Arslan, 2005) and sprint performance (Thorland, Johnson, Cisar, Housh, & Tharp, 1987).

Thorland, Johnson, Cisar, Housh, & Tharp (1987) reported that dynamic leg strength was one of the major factors explaining anaerobic power and Arslan (2005) stated that explosive leg strength was significantly correlated with anaerobic performance.

In the study of Ziyagil (2016), a correlational analysis indicated that anaerobic power in physically active males significantly correlated with vertical jump (p < 0.05, r = 0.84), 10 meters sprint running (p < 0.05, r = 0.19) and 100 meters sprint running (p < 0.05, r = 0.348).

Squat jump and countermovement jump are commonly used tests to measure the athletes' jumping ability.

Squat jump is used as a measure of lower body concentric strength/power, while countermovement jump is used as a measure of lower body reactive strength/power (Newton, Rogers, Volek, Häkkinen, & Kraemer, 2006).

The results of the presented study indicated that all jump performance variables (height, total work and anaerobic power) had a significant relationship with load (kg), PP and MP (p < 0.05 and p < 0.01).

Continuous jump tests have been extensively used by coaches and physical trainers, but insufficient information concerning their validity and reliability has been presented in the literature (Sands et al., 2004). Sands et al. (2004) only used a correlation approach to find evidence for the validity of continuous jump tests applied for 60 s.

Additionally, the available information about reliability is limited or inadequate. Çakir-Atabek (2014) found a remarkable relation between repeated-sprint ability, the countermovement jump and upper body strength, and Haj-Sassi et al. (2011) presented in their study that the RMAT total time significantly correlates with countermovement jump (r = - 0.61; p < 0.02).

Alemdaroğlu (2012) has only found a correlation between countermovement jump and sprint ability tests.

The 30 s continuous jump (CJ30) test showed excellent test-retest reliability for the maximal jump height (ICC = 0.94), mean vertical jump height (r = 0.98) and fatigue index (r = 0.87). Continuous jumps measure some of the same anaerobic properties as WAnT.

The continuous jump test seems to be more specific for sports that are acyclic and involve participants experiencing the stretch-shortening cycle in their action.

Because of its simple instrumentation, the CJ30 test is more economical than other methods of anaerobic power assessment (Dal Pupo et al., 2013).

In a previous study, they reported weak negative associations between countermovement and squat jump performance and 5, 10 and 30 m sprint times

(Cronin, & Hansen, 2005),
but Hennessy and Kilty (2001) found that countermovement jump performance was related to the sprint times and that the bounce drop jump index was related to 30-m and 100-m sprint times in a group of female athletes.

One possible reason for the lack of correlation between the tests' performance may be different energy systems that each measure needs. Ghangela (2012) confirmed the validity of the vertical jump test as a field test of anaerobic power in high school athletes.

There was a positive correlation between the average power ($r = 0.031$, $p < 0.05$) and the peak power ($r = 0.044$, $p < 0.05$) of vertical jump test and the Wingate cycle test.

A similar conclusion was drawn by Changela and Bhatt (2012) in their research with high school female basketball players, where the result suggested that vertical jump tests may be accepted as a field measure of anaerobic power. Jones and Lorenzo (2013) used pro-agility shuttle run 5-10-5 test (PRO) as an anaerobic capacity assessment test.

They concluded that PRO significantly correlates with standing long jump ($r = 0.70$) and vertical jump ($r = 0.67$; $p < 0.05$) in girls, while vertical jump, standing long jump and 20-yd sprint ($R = 0.72$) significantly correlate in males ($p < 0.01$).

PRO may be worth of inclusion into the test battery when assessing performance measures that require lower body strength and the power necessary for quick changes in direction inherent to most ground-based field sports.

Scott, Hodson, Govus and Dascombe (2017) discovered that the velocity intermittent fitness test (VIFT) is related to several tests of anaerobic performance and may, therefore, be a useful composite measure for tracking intermittent performance in team-sport athletes.

These findings indicate that VIFT is useful for tracking performance in tasks largely determined by anaerobic capacity, but may not be a sensitive indicator of performance for brief all-out efforts that are limited by anaerobic power.

Research has shown that performance during prolonged high-intensity intermittent running (similar to the running patterns performed during team sports) significantly correlated with anaerobic capacity and repeated sprint ability (Sirotic, & Coutts, 2007).

Balsadore et al. (2014) found a relationship between force production during the bench press and performance in the RAST. The study has shown that maximum power reached at bench press ($r = - 0.74$) correlated with the RAST fatigue index.

The countermovement jump and bench press power tests could be interesting to indirectly assess anaerobic capacity in activities that require repeated short sprints. Data highlights a remarkable relationship among repeated-sprint ability, countermovement jump and upper body strength in professional male basketball payers.

On the other hand, Alemdaroğlu (2012) was investigating the relationship between isokinetic knee strength, anaerobic performance, sprinting ability, agility and vertical jump performance.

The quadriceps strength significantly correlated with the peak power at all contraction velocities. However, for the mean power, a significant correlation was found only between the 60° left and 180° right knee quadriceps measurements.

CONCLUSION

In terms of influence on anaerobic capacity, motor skills-based tests are good for anaerobic capacity assessment.

Sports where athletes must move their body across a field with a quick burst of energy require a high relative peak power and anaerobic capacity.

It is good to use tests related to the activity a participant is involved in.

The main reason is that those tests show a measurement of a capacity that is elicited by that activity, and at the same time, you get results that are good for training performance monitoring.

Based on this, it can be concluded that WAnT and RAST are reliable and valid, and can be used to assess anaerobic power and predict short-distance performances.

Vertical jump is good for measuring leg muscle strength and power in activities that require a running and jumping-based ability, where the squat jump test is good as a measure of lower body concentric power and the countermovement jump test is good for measuring lower body reactive power.

The countermovement jump and bench press power tests are good for measuring anaerobic capacity in activities that require repeated short sprints, and agility tests are good when assessing performance measures that require lower body strength and power necessary for quick changes in direction inherent to most ground-based field sports.

Table 2: The basic statistical parameters of the control group.

Ref.	Population group	Sample (gender, number and age)	Anaerobic capacity (M ± S.D)	Motor skills-based tests	Results (M ± S.D)	Conclusion
Kin-Isler et al. (2008)	Amateur football players	M: 28 Y: 21.1 ±1.7	WAnT: PP (W): 825.51 ± 133.97 MP (W): 611.42 ± 74.95 FI (%): 47.62 ± 10.44	Isokinetic knee strength evaluation (1) Knee extension at 60, 150 and 240°/s; (2) Knee flexion at 60, 150 and 240°/s. Sprint performance evaluation: (1) single-sprint (20 m) and (2) repeated-sprint (12 × 20 m) tests	Knee extension 60, 150, 240 °/s and PP ($p < .01$); Knee extension 60 ($p < .05$), 150, 240 °/s ($p < .01$) and MP; Knee flexion 240 °/s and PP ($p < .05$). Sprint ability%performance decrement 10-20 m & 240 °/sknee flexion ($r = .381$; $p < .05$).	Muscular strength, particularly maximal knee extension strength is a crucial component in anaerobic performance of American football players.
Meckel et al. (2009)	Elite soccer players	M: 33 Y: 16-18	WAnT: PP (W·kg-1): 10.6 ± 0.9; MP (W·kg-1): 8.7 ± 0.4; FI (%) 36.3 ± 7.4.	Aerobic power test (20 m shuttle run); Repeated sprint test (12 x 20 m); Repeated sprint test (6 x 40 m).	Fastest sprint ($r = .618$), total sprint time ($r = .709$) & performance decrement ($r = .411$) of 2 RST ($p < .05$) Performance decrement 12x20-m RST and calculated peak VO2 ($r = -.60$, $p < 0.05$). MP sig. correlate & fastest, total time 6x40m protocol ($r = -.47$)	Anaerobic testing procedures should consist of specific protocols that mimic the athlete's specific sports activity pattern.
Zagatto et al. (2009)	Members of Army forces	M: 40 Y: 19.78 ± 1.18	WAnT vs. RAST: PP (W): 778.40 ± 115.74 vs. 695.46 ± 107.46; MP (W): 695.46 ± 107.46 vs. 629.28 ± 84.25; FI (%): 41.07 ± 9.71 vs. 36.01 ± 8.79.	Running performance of 35, 50, 100, 200 & 400 m.	RAST sig. correlates w / WAnT (PP $r = 0.46$; MP $r = 0.53$; FI $r = 0.63$) & 35, 50, 100, 200, 400 m performances scores ($p<.05$).	This procedure is reliable and valid, and can be used to assess anaerobic power and predict short-distance performances.
Zupan et al. (2009)	National Collegiate Air Force student athletes	M: 457 F: 64 Y: 18-25	WAnTMALEvsFEMALE: PP (W): 951 ± 141 vs. 598 ± 88 AC (W): 686 ± 91 vs. 445±65 FI (%): 47 ± 7.6 vs. 42 ± 7.9	Muscular power WAnT	-	The classification categories formulated will allow coaches and athletes to use these charts to evaluate power output and provide a comparison from a set of reliable standards.
Haj-Sassi et al. (2011)	Student athletes from the Exercise Science and Physical Education	M: 27 Y: 20.2±0.9	WAnT: PP (W): 664.2 ± 130.07 MP (W): 484.14 ± 92.72 FI (%): 46.57 ± 7.70	Repeated modified agility test (RMAT) (10 x 20 m max running performances w / 25 s recovery; Jump tests: Squat Jump (SJ); Countermovement Jump (CJ); Drop Jump (DJ); Five Jump Test (DJ 5JT).	RMAT total time & RMAT peak power sig. correlate w / WAnT PP and RMAT FI w / WAnT MP ($p < .05$). RMAT total time sig. correlates w / WAnT PP ($r = -.44$), MP ($r = -.72$) and Vertical jump SJ ($r = -.50$), CJ ($r = -.61$), DJdominant leg ($r = -.72$), DJnon-dominant leg ($r = -.53$) & DJ 5JT ($r = -.56$) ($p < .01$).	RMAT is a reliable and valid test for assessing anaerobic power and explosiveness in multi-sprint sport athletes.

Alemdaroğlu (2012)	First division basketball players	M: 12 Y: 25.1±1.7	WAnT: PP (W): 955.31±117.86 MP (W): 702.81±79.26 FI (%): 54.67±7.34	Isokinetic Leg Strength: Leg extensor (LE) & leg flexor (LF) muscle at 60 & 180°·s-1 Vertical Jump tests: Countermovement Jump (CJ); Squat Jump (SJ). 10-30 m sprint test (ST); T- Drill Agility Test (T-test); Multistage 20 m Shuttle Run Test (Ms20SR).	Quadriceps right 180, Quadriceps left 60, CMJ & PP ($p < .05$); QR 180, QL 60, SJ, ST 10m & PP ($p < .01$) and QR 180, QL 60, SJ & MP ($p < .05$). CJ & ST 30m, T-test ($p<.05$) and SJ ($p<.01$); SJ & T-test ($p<.05$) and CJ, ST 30m ($p<.01$); ST 30m & CJ, T-test ($p<05$) and SJ ($p<.01$); T-test & CMJ, SJ, ST 30m ($p<.05$).	There was a lack of correlation between test performances.
Chaleh et al. (2012)	Elite soccer players	M: 20 Y: 15.25 ± 1.15	Sargent vertical Jump (SvJ)	10 m sprint test (ST) 9x4 m agility test (AT)	ST sig. correlates w / AP ($r = .904$, $p = .001$); ST w/AT ($r = .976$, $p = .001$) & AP w / AT ($r = .884$; $p = .001$)	There is a significant relationship observed between speed, agility and anaerobic power.
Changela, & Bhatt (2012)	High-school basketball players	M: 27 F: 23 Y: 15.60 ± 1.14	WAnT	Vertical Jump Test	VJ MP ($r = .970$) & VJ PP ($r = .263$) w / WAnT ($p < .05$)	Vertical jump tests may be accepted as field measures of anaerobic power in high-school basketball players.
Kaminagakura et al. (2012)	Army middle distance runners	M: 11 Y: 21 ± 0.7	Maximum Accumulated Oxygen Deficit (MAOD) vs. Running-Based Anaerobic Sprint Test (RAST): PP (W): 598.6 ± 119.4 MP (W): 451.3 ± 119.2 FI (%): 40.5 ± 9.4	-	No sig. correlation btw MAOD & RAST	RAST outputs cannot be used to estimate anaerobic capacity.
Jones, & Lorenzo (2013)	School competitive youth-sport divisions	M: 53 F: 104 Y: 11.7 (8) ± 0.6 (5)	-	Lower body power: Vertical jump (VJ); Standing long jump (SLJ); Upper body power: Seated medicine ball throw (SMBT); Partial curl-up test (CURL); Speed and agility: 20-yd sprint (20 SP); Pro-agility shuttle run (PRO).	SLJ, 20 SP, CURLMALE sig. ↑ ($p = .03$, $p = .001$, $p = .02$) SMBTFEMILE sig. ↑ ($p = .001$) PROFEMALE sig. correlates w / SLJ ($r = -.70$), VJ ($r = -.67$) ($p < .05$) VJMALE sig. correlates w/SLJ ($r = .73$) and 20 SPMALE w / PRO ($r = .72$) ($p < .01$)	When designing a performance test battery for young athletes, measures of PRO, SLJ and VJ are worthy of inclusion as effective strength and power measures that will provide a reference point regarding the training of lower body power and agility.
Dal Pupo et al. (2013)	Volleyball athletes	M: 21 Y: 23.8 ± 3.8	WAnT: PP (W·kg-1): 17.75 ± 2.63; MP (W·kg-1): 9.10 ± 0.88; FI (%): 67.92 ± 7.3.	30-s continuous jump (CJ30)	Test-retest reliability CJ30 max jump height (.98), CJ30 mean jump height (.87) & CJ30 FI (.45) CJ30 mean height first 4jumps sig. correlation w/ PP ($r = 0.57$); CJ30 mean VJ height w/MP ($r = 0.70$).	The large correlation between CJ30 mean height for first 4 jumps and WAnT peak power shows evidence of the ability of the CJ30 to detect the anaerobic peak power level.

Ref.	Population group	Sample (gender, number and age)	Anaerobic capacity (M ± S.D)	Motor skills-based tests	Results (M ± S.D)	Conclusion
Balsalobre-Fernández et al. (2014)	Prime League basketball players	M: 11 Y: 24.5 ± 5.8	Running-Based Anaerobic Sprint Test (RAST)	ICountermovement Jump (CJ); Bench press test with increasing loads.	RAST FI sig. correlates w / CJ loss (r = - .77, p < .01), RAST FI w / max force BP production (r = - .86, p < .01) & CJ loss w / BP load at which pp is produced (r=-.77, p<.01).	Repeated-sprint ability, the CJ and upper-body strength remarkably relate in professional male basketball players.
Dardouri et al. (2014)	Collegiate Sport Science students	M: 29 Y: 22.5 ± 1.6	RAST: TT= 63.90 ± 2.50; PT = 6.15 ± 0.25; FI = 4.12 ± 1.40; AnSR = 11.50 ± 1.07	30m sprint test (T 30); Vertical jump (VJ); Horizontal jump (HJ); 20 m multi-stage shuttle run test (MSRT); Repeated sprint test (10 x 15 shuttle run.	TT & PT sig. correlated w / T30 (r = .63, p = .001 & r = .62, p = .001), HJ (r = -.47, p = .001 & r = -.49, p = .006) & AnSR (r = -.68, p = .001 & r = -.70, p = .001) AnSR sig. predictor of TT and PT, explaining 47% and 50% of the variance.	Anaerobic metabolism contributes mainly to the energy supply during 10 x 30m shuttle run. AnSR predict repeated sprint performance.
Çakir-Atabek (2014)	Amateur track and field athletes	M: 13 F: 11 Y: 15.79 ± 0.83	WAnT: Male vs female: PP (W): 481.18 ± 55.67 vs. 854.91 ± 205.12 MP (W): 272.52 ± 33.28 vs. 450.30 ± 97.58 FI (%): 74.9 ± 13.91 vs 79.78 ± 12.78	12 min Cooper test; Countermovement Jump (CJ); Squat jump (SJ);	All SJ & CJ variables (height, total work and anaerobic power) sig. correlated w / PP, MP (p<.05, p<.01)	Trainers may predict anaerobic performance using the jumping properties.
Andrade et al. (2015)	State and national soccer players	M: 39 Y: 17.0±1.4	MOAD: (L): 3.2 ± 0.7; RAST: PP (W): 723.7 ± 134.0; MP (W): 562.4 ± 95.9; FI (%): 39.6 ± 3.1; TT = 31.3 ± 3.1.	30 s maximal tethered running on a treadmill (30-s all-out).	No sig. correlations btw MAOD & RAST. RAST fifth effort sig. correlates w / PP (r = .73) and MP (r = .50) (p < .05).	The parameters from RAST do not have an association with MAOD, suggesting that this method should not be used to evaluate anaerobic capacity. The 30-s all-out test reinforces the RAST as an evaluation method of anaerobic metabolism.
Pavlović et al. (2015)	Students of Physical Education and Sports	M: 40 Y: 21.0 ± 0.5	RAST: East Sarajevo vs Novi Sad MP (W): 594.79 ± 32.90 vs. 574.12 ± 100.53 F I (%): 7.80 ± 3.91 vs. 8.45 ± 3.12	-	-	The obtained values of power and fatigue index point to a weaker state of anaerobic abilities of students of Novi Sad in relation to the pattern of East Sarajevo, or lower tolerance to lactate.
Burgess et al. (2016)	Amateur soccer players	M: 24 Y : 24.0 ± 3.0	WAnT	RAST: PP (W): 766 ± 106(1); 776 ± 114 (2); AP (W): 596 ± 86 (1); 584 ± 87 (2);	Criterion validity for the RAST strong for WAnT PP (r = .70, p < .001) & MP (r = .60, p = .002); RAST sig. correlates w / WAnT	The RAST test is not sensitive enough to detect individual changes below approximately 15 to 20 % and is therefore not recommended to be used to continually monitor individual performance.

Scott et al. (2017)	Recreational team-sports athletes	M: 52 Y: 24.3 ± 4.4	Anaerobic Capacity Assessment: 300 m shuttle run (300 m shuttle)	Maximal Sprint Speed Assessment: 40 m sprint test (S 40); 10 m sprint test (S 10) Change of Direction (COD) Test (505 test) Lower body power: Countermovement Jump (CJ); Repeated Sprint Ability (RST); Velocity Intermittent Fitness (VIFT): 30-15 IFT Test (30-15IFT)	Predictive relationship btw anaerobic test & VIFT; VIFT sig. predict 56 %, 51 %, 44 %, 36 % & 1 % of variance in 300 m shuttle, RST, 505 test, S 40, VJ & S 10;	VIFT is useful for tracking performance in tasks largely determined by anaerobic capacity, but may not be a good predictor of brief all-out sprinting and jumping efforts.
Ziyagil et al. (2016)	Population participating in physical activity	M: 725 F: 142 Y: 21.44 ± 2.38	-	Aerobic power test: 12 min run; Anaerobic power test: Vertical jump (VJ); Sprint Tests: 10 m and 100 m sprint.	Anaerobic powermale sig. correlates w / VJ (r = .84), S 10 m (r = .19, p < .05) & S 100 m (r = .382, p < .05), 10 m mean sig. correlates w / VJ (r = .225, p < .05) and 100 m mean (r = .53, p < .53). 100 m mean sig. correlates w / VJ (r = .394, p < .05) Anaerobic powerfemale sig. correlates w / VJ (r = .86, p < .05), S 10 m (r = .23, p < .05) & S 100 m (r = .46, p < .05), 10 m score sig. correlates w / VJ (r = .23, p < .05) and 100 m mean (r = .56). 100 m speed sig. correlates w / VJ (r = .51, p < .05)	The aerobic power increases with increasing the sprint distance. The vertical jump height, anaerobic power, 10 m sprint running speed, 100 m sprint running speed, body weight, BMI and the sum of 7 skinfolds measurements have more associations of aerobic power in males, while 100 m sprint running speed, and the sum of 7 skinfolds measurements have more associations of aerobic power in males, while 100 m sprint running speed, and the sum of 7 skinfolds measurements were strongly correlated with aerobic power in females.
Allison et al. (2017)	Military occupational specialties (MOS) school Marines	F: 62 Y: 21.9 ± 2.9	WAnT: Graduated vs not PP (W): 713.78 ± 95.38 vs. 704.13 ± 137.77; AC (W): 437.69 ± 62.27 vs. 398.75 ± 90.32;	Isokinetic shoulder, trunk and knee and isometric ankle strength Field-based fitness tests: standing broad jump (SBJ), medicine throw (MBT), pro-agility drill (PRO) Physical Fitness Test (PFT: abdominal crunches, 3-mile run time)	Sig. relationship btw absolute & normalized ankle inversion and aversion strength, normalized anaerobic capacity and faster (PRO) and PFT 3-mile run time (p < .05).	These findings provide new evidence for the importance of ankle strength, anaerobic capacity, and agility in ground combat MOS.

Table note: M – male; F – female; WAnT- Wingate Anaerobic Test; RAST - Running Anaerobic Sprint Test; PP - Peak Power; MP - Mean Power; FI - Fatigue Index; AC: anaerobic capacity; TT- total time; PT – peak time; VO2max - maximal oxygen uptake; ↑- high; ↓ - low.

REFERENCES

1. Abbasian, S., Golzar, S., Onvani, V., & Sargazi, L. (2012). The predict of RAST Test from WANT test in Elite Athletes. Research Journal of Recent Sciences, ISSN, 2277, 2502.
2. Alemdaroğlu, U. (2012). The Relationship Between Muscle Strength, Anaerobic Performance, Agility, Sprint Ability and Vertical Jump Performance in Professional Basketball Players Journal of Human Kinetics, 31, 149-158.
3. Allison, K. F., Keenan, K. A., Wohleber, M. F., Perlsweig, K. A., Pletcher, E. R., Lovalekar, M., ... & Nindl, B. C. (2017). Greater ankle strength, anaerobic and aerobic capacity, and agility predict Ground Combat Military Occupational School graduation in female Marines. Journal of Science and Medicine in Sport, 20, S85-S90.
4. Andrade, V. L., Zagatto, A. M., Kalva-Filho, C. A., Mendes, O. C., Gobatto, C. A., Campos, E. Z., & Papoti, M. (2015). Running-based Anaerobic Sprint Test as a Procedure to Evaluate Anaerobic Power. International Journal of Sports Medicine, 36(14), 1156-1162.
5. Arslan, C. (2005). Relationship between the 30-second Wingate test and characteristics of isometric and explosive leg strength in young subjects. Journal of Strength and Conditioning Research, 19(3), 658.
6. Balčiūnas, M., Stonkus, S., Abrantes, C., & Sampaio, J. (2006). Long term effects of different training modalities on power, speed, skill and anaerobic capacity in young male basketball players. Journal of Sports Science & Medicine, 5(1), 163.
7. Balsalobre-Fernández, C., Tejero-González, C. M., del Campo-Vecino, J., Bachero-Mena, B., & Sánchez-Martínez, J. (2014). Relationships among repeated sprint ability, vertical jump performance and upper-body strength in professional basketball players. Archivos de Medicina del Deporte, 31(161), 148-53.
8. BAppSci, A. K. L. T. (2011). Effect of load carriage on performance of an explosive, anaerobic military task. Military medicine, 176(9), 1027.
9. Bar-Or, O. (1987). The Wingate anaerobic test. An update on methodology, reliability and validity. Sports Medicine, 4(6), 381-394.
10. Burgess, K., Holt, T., Munro, S., & Swinton, P. (2016). Reliability and validity of the running anaerobic sprint test (RAST) in soccer players. Journal of Trainology, 5(2), 24-29.
11. Çakir-Atabek, H. (2014). Relationship between anaerobic power, vertical jump and aerobic performance in adolescent track and field athletes. Journal of Physical Education and Sport, 14(4), 643.
12. Chaleh, M., Fatemi, R., & Shahsavar, A. (2012). Relationship between speed, agility and anaerobic power of 14–16 years elite soccer players. Int J Appl Basic Sci, 3, 127-432.
13. Changela, P. K., & Bhatt, S. (2012). The Correlational Study of the Vertical Jump Test and Wingate Cycle Test as a Method to Assess Anaerobic Power in High School Basketball Players. International Journal of Scientific and Research Publications, 2(6), 1-6.
14. Cronin, J. B., & Hansen, K. T. (2005). Strength and power predictors of sports speed. Journal of Strength and Conditioning Research, 19(2), 349.
15. Dal Pupo, J., Gheller, R. G., Dias, J. A., Rodacki, A. L., Moro, A. R., & Santos, S. G. (2014). Reliability and validity of the 30-s continuous jump test for anaerobic fitness evaluation. Journal of Science and Medicine in Sport, 17(6), 650-655.
16. Dardouri, W., Selmi, M. A., Sassi, R. H., Gharbi, Z., Rebhi, A., Yahmed, M. H., & Moalla, W. (2014). Relationship Between Repeated Sprint Performance and both Aerobic and Anaerobic Fitness Journal of Human Kinetics, 40(1), 139-148.
17. Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: updated position statement paper from the national strength and conditioning association. The Journal of Strength & Conditioning Research, 23, S60-S79.
18. Fox, E. L., Bowers, R. W., & Foss, M. L. (1993). The physiological basis for exercise and sport (No. Ed. 5). Brown & Benchmark.
19. Haj-Sassi, R., Dardouri, W., Gharbi, Z., Chaouachi, A., Mansour, H., Rabhi, A., & Mahfoudhi, M. E. (2011). Reliability and validity of a new repeated agility test as a measure of anaerobic and explosive power. The Journal of Strength & Conditioning Research, 25(2), 472-480.
20. Hennessy, L., & Kilty, J. (2001). Relationship of the stretch-shortening cycle to sprint performance in trained female athletes. The Journal of Strength & Conditioning Research, 15(3), 326-331.
21. Hoffman, J. R., & Kang, J. I. E. (2002). Evaluation of a new anaerobic power testing system. The Journal of Strength & Conditioning Research, 16(1), 142-148.
22. Hopkins, W., Marshall, S., Batterham, A., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. Medicine+ Science in Sports+ Exercise, 41(1), 3.
23. Inbar, O., Bar-Or, O., & Skinner, J. S. (1996). The Wingate Anaerobic Test. John Wiley & Sons.
24. Jones, M. T., & Lorenzo, D. C. (2013). Assessment of power, speed, and agility in athletic, preadolescent youth. J Sports Med Phys Fitness, 53(6), 693-700.
25. Kaminagakura, E. I., Zagatto, A. M., Redkva, P. E., Gomes, E. B., Loures, J. P., Kalva-Filho, C. A., & Papoti, M. (2012). Can the Running-Based Anaerobic Sprint Test be used to Predict Anaerobic Capacity? Journal of Exercise Physiology Online, 15(2).
26. Keir, D. A., Thériault, F., & Serresse, O. (2013). Evaluation of the running-based anaerobic sprint test as a measure of repeated sprint ability in collegiate-level soccer players. The Journal of Strength & Conditioning Research, 27(6), 1671-1678.

27. Kin-Isler, A., Ariburun, B., Ozkan, A., Aytar, A., & Tandogan, R. (2008). The relationship between anaerobic performance, muscle strength and sprint ability in American football players. Isokinetics and Exercise Science, 16(2), 87-92.

28. Lima, M. C. S. (2007). Standardization of the tethered running in sprint athletes: Analysis of relation between power and performance in running. Master's thesis, Sao Paulo State University, Rio Claro, Brazil.

29. Maughan, R. J., Watson, J. S., & Weir, J. (1983). Strength and cross-sectional area of human skeletal muscle. The Journal of Physiology, 338(1), 37-49.

30. Mezzani, A., Corra, U., Andriani, C., Giordano, A., Colombo, R., & Giannuzzi, P. (2008). Anaerobic and aerobic relative contribution to total energy release during supramaximal effort in patients with left ventricular dysfunction. Journal of Applied Physiology, 104(1), 97-102.

31. Meckel, Y., Machnai, O., & Eliakim, A. (2009). Relationship among repeated sprint tests, aerobic fitness, and anaerobic fitness in elite adolescent soccer players. The Journal of Strength & Conditioning Research, 23(1), 163-169.

32. Medbo, J. I., Mohn, A. C., Tabata, I., Bahr, R., Vaage, O., & Sejersted, O. M. (1988). Anaerobic capacity determined by maximal accumulated O2 deficit. Journal of Applied Physiology, 64(1), 50-60.

33. Minahan, C., Chia, M., & Inbar, O. (2007). Does power indicate capacity? 30-s Wingate anaerobic test vs. maximal accumulated O2 deficit. International Journal of Sports Medicine, 28(10), 836-843.

34. Moore, A., & Murphy, A. (2003). Development of an anaerobic capacity test for field sport athletes. Journal of Science and Medicine in Sport, 6(3), 275-284.

35. Morrow Jr, J. R., Zhu, W., Franks, D. B., Meredith, M. D., & Spain, C. (2009). 1958–2008: 50 years of youth fitness tests in the United States. Research Quarterly for Exercise and Sport, 80(1), 1-11.

36. Nummela, A., Hämäläinen, I., & Rusko, H. (2007). Comparison of maximal anaerobic running tests on a treadmill and track. Journal of Sports Sciences, 25(1), 87-96.

37. Özkan, A., Kayıhan, G., Köklü, Y., Ergun, N., Koz, M., Ersöz, G., & Dellal, A. (2012). The relationship between body composition, anaerobic performance and sprint ability of amputee soccer players. Journal of Human Kinetics, 35(1), 141-146.

38. Pavlović, R., Mihajlović, I., & Radulović, N. (2015). Evaluation of anaerobic abilities of physical education and sports students applying the running anaerobic sprint test. SPORT SCIENCE - International Scientific Journal on Kinesiology, 8(2), 32-38.

39. Perez-Gomez, J., Rodriguez, G. V., Ara, I., Olmedillas, H., Chavarren, J., González-Henriquez, J. J., ... & Calbet, J. A. (2008). Role of muscle mass on sprint performance: gender differences? European Journal of Applied Physiology, 102(6), 685-694.

40. Reilly, T., Secher, N., Shell, P., & Williams, C. (1990). Physiology of sports, E&F. N. Spon.

41. Saavedra, C., LagassÉ, P., Bouchard, C., & Simoneau, J. A. (1991). Maximal anaerobic performance of the knee extensor muscles during growth. Medicine and Science in Sports and Exercise, 23(9), 1083-1089.

42. Sands, W. A., Mcneal, J. R., Ochi, M. T., Urbanek, T. L., Jemni, M., & Stone, M. H. (2004). Comparison of the Wingate and Bosco anaerobic tests. The Journal of Strength & Conditioning Research, 18(4), 810-815.

43. Scott, B. R., Hodson, J. A., Govus, A. D., & Dascombe, B. J. (2017). The 30-15 Intermittent Fitness Test: can it predict outcomes in field tests of anaerobic performance? The Journal of Strength & Conditioning Research, 31(10), 2825-2831.

44. Wilmore, J. H., & Costill, D. L. (2004). Neuromuscular adaptations to resistance training. Physiology of Sport and Exercise.

45. Vandewalle, H., Péerès, G., & Monod, H. (1987). Standard anaerobic exercise tests. Sports Medicine, 4(4), 268-289.

46. Zagatto, A. M., Beck, W. R., & Gobatto, C. A. (2009). Validity of the running anaerobic sprint test for assessing anaerobic power and predicting short-distance performances. The Journal of Strength & Conditioning Research, 23(6), 1820-1827.

47. Zemková, E., & Hamar, D. (2004). "All-out" tethered running as an alternative to Wingate anaerobic test. Kinesiology, 36(2), 165-172.

48. Zupan, M. F., Arata, A. W., Dawson, L. H., Wile, A. L., Payn, T. L., & Hannon, M. E. (2009). Wingate Anaerobic Test Peak Power and Anaerobic Capacity Classifications for Men and Women Intercollegiate Athletes. The Journal of Strength & Conditioning Research, 23(9), 2598-2604.

49. Ziyagil, M. A., Cengiz, A., Aksoy, Y. (2016). Relationship Among Sprint Performance, Body Composition, and Aerobic Power In Collegiate People/Odnos med uspesnostjo studentov v Sprintu, njihovo telesno zgradbo in aerobno mocjo. Kinesiologia Slovenica 2016; 22(2), 5.

POVEZANOST MOTORIČKI BAZIRANIH TESTOVA ZA PROCJENU ANAEROBNOG KAPACITETA SA RAZLIČITIM SPORTSKIM AKTIVNOSTIMA

Aktivnosti u kojima sportisti moraju da pomijeraju svoje tijelo preko polja sa velikim naletom energije, zahtijevaju visok nivo relativne snage i anaerobne sposobnosti. Neke od procedura koje su korištene u prethodnim studijama za procjenu anaerobne snage i/ili kapaciteta su maksimalna akumulirana potrošnja kiseonika (MAOD), Wingate test (WAnT), testovi skokova, maksimalni anaerobni test trčanja i intervalni sprint test (RAST). Cilj ovog sistematskog preglednog rada je povezanost testova zasnovanih na anaerobnim sposobnostima sa različitim sportskim aktivnostima. Pretražene su četiri elektronske baze podataka (Medline, PubMed, Kobson i Google Scholar). Uključene studije su zadovoljavale sljedeće kriterije: testove za procjenu anaerobnih kapaciteta, uticaj testova motoričkih vještina na anaerobne sposobnosti i njihovu korelaciju sa vrstom aktivnosti. Ukupno 20 studija zadovoljilo je sve uključene kriterije. Najčešće korišteni testovi za određivanje anaerobnog kapaciteta u analiziranim istraživanjima su WAnT test i RAST test, kao i njihova povezanost sa testovima motoričkih vještina kao što su testovi skokova, pokretljivosti, sprint testovi i izokinetički testovi. WAnT i RAST su pouzdani i validni testovi koji se mogu koristiti za procjenu anaerobne snage i za predviđanje performansi kod kratkih dionica trčanja. Vertikalni skok je dobar za mjerenje jačine i snage mišića nogu u aktivnostima koje zahtijevaju sposobnost trčanja i skakanja. Test skok iz čučnja sa pripremom i testovi za mjerenje energije u bench pressu su dobri za mjerenje anaerobnih kapaciteta u aktivnostima koje zahtijevaju ponavljanje kratkih sprintova, a testovi agilnosti su dobri za procjenu mjera učinkovitosti koje zahtijevaju snagu donjeg dijela tijela i snagu neophodnu za brze promjene pravca.

Ključne riječi: anaerobni kapacitet, agilnost, vertikalni skok, skok iz čučnja sa pripremom, čučanj-skok, brzina

Received: May 02, 2018 / Accepted: June 01, 2018
Correspondence to: Ivana Petrović, Faculty of Sport and Physical Education, University of Niš, Serbia
E-mail: ivanica.petrovic@yahoo.com

INSTRUCTIONS TO THE AUTHORS OF PAPERS

The aim and purpose of the journal

Sport Science is an international scientific magazine that, apart from the area of kinesiology, encompasses the areas of sports medicine, sports management and education. It is published twice a year.

The Abstract

Each paper is evaluated, so that it corresponds to the intention of the journal, and then reviewed. The authors are responsible for the content and the ethics of everything written in the Paper. The authors can be requested to give a specific statement that the paper has not been published in another publication. Sport Science does not question the copyright the authors have on the published papers, but preserves the right of distribution in accordance with the legal provisions, and without further consultation with the authors, with which the authors agree when submitting the paper. Authors are not entitled to re-release / reprint the paper, apart from a copy of the printed journal. It is necessary to include the name of the corresponding author, his or her e –mail adress and the institutional e-mail adress.

Preparation of attachments

It is recommended that the authors keep the structure of the journal that includes: the Abstract, the Introduction, the Problem and the Aim, the Methods, the Results, the Discussion, the Conclusion and the Literature. This recommendation does not bind the authors but helps ease the publishing process, and understanding of the subject matter. The attachments are not limited in size, but should not exceed 7 pages in the journal. Each page that exceeds the recommended 7 pages is paid 50 €. The text font is Verdana 9 pt, the titles in the text are in size 9 bold, with a justified line spacing or 1 created in two columns. The titles are in the text font Verdana, size 10, the authors' names are in size 9 bold, the authors' institutions in size 9 italic (University, Faculty and the country of origin). The expected size of the paper is 12 000, exceptionally 14 000, characters without tables and images. All tables should be standardized (e.g. MS Excel) by the APA standard and adjusted to the column. The images, photographs and other illustrations should be in a vector format, or a high quality printing resolution (600 dpi). Before printing, the journal has the right to edit the illustration. In such instances, the author will be consulted or informed via e-mail.

References

The reference list, as well as other forms of text formatting, will be accepted if they are made in accordance with the APA standard (American Psychological Association),and translated into English with an indication of the original language in the brackets. The attachment is sent exclusively in electronic form (e-mail, CD, disc etc.)

Delivery address for the attachments

Sport Science - Faculty of Education
University of Travnik
Aleja konzula No. 5, Travnik, Bosnia and Herzegovina
E-mail: info@sportscience.ba

Language used in the attachments

Sport Science publishes the papers in English with abstracts in Bosnian. In the event that the attachment is sent in its original form, in another international language, the author of the attachment will be consulted.

Note

Attachments that do not meet the requirements, or need to be consulted upon, will be immediately returned to the author with a warning containing the actions that need to be undertaken.

Publication of the journal

The journal is published in printed and electronic form. The electronic version is available on the web address: www.sportscience.ba

UPUTE AUTORIMA RADOVA

Namjera i svrha časopisa

Sport Science je međunarodni znanstveni časopis koji pored područja kineziologije obuhvata i područje sportske medicine, sportskog menadžmenta i edukacije. Izdaje se dva puta godišnje.

Opće odredbe o prilozima

Svaki rad se vrednuje u odnosu na to odgovara li intenciji časopisa, a zatim se upućuje na recenzije. Autori snose odgovornost za sadržaj te etičnost svega što je radu. Od autora se može zatražiti posebna izjava da rad nije objavljen u nekoj drugoj publikaciji. Sport Science ne dovodi u pitanje autorska prava autora objavljenih radova, ali zadržava pravo distribucije u skladu sa pravnim odredbama i bez dodatne konsultacije sa autorima,a sa čime autori predajom rada postaju saglasni. Autori nemaju pravo na reizdanje/reprint, osim jednog primjerka štampanog časopisa. Potrebno je dostaviti naziv autora za korespodenciju, njegov mail i institucionalni mail.

Priprema priloga
Preporučuje se da se autori pridržavaju forme koja uključuje: Sažetak, Uvod, Problem i cilj, Metode, Rezultati, Rasprava i zaključak, Literatura, Abstract. Ova preporuka ne obavezuje autore priloga, ali olakšava put do publiciranja i kasnijeg lakšeg razumijevanja materije. Prilozi nisu ograničeni veličinom, ali ne bi trebali prelaziti 7 stranica u časopisu. Svaka stranica rada koji prelazi 7 stranica, plaća se 50 €. Font teksta je Verdana 9, naslovi u tekstu bold 9, prored 1, obostrano poravnanje teksta, kreirano u 2 kolone. Naslovi su font Verdana 10, autori 9 bold, institucije autora 9 italic (Univerzitet, Fakultet i Država iz koje dolaze). Očekivana veličina je 12.000 znakova bez tabela i slika (izuzetno 14.000). Sve tabele trebaju biti standardne (npr. MS Excel) po APA standardu i prolagođene koloni, a slike, fotografije i druge ilustracije u vektorskom formatu ili rezoluciji koja osigurava kvalitetnu štampu (600 dpi). Časopis ima pravo radi pripreme za štampu urediti ilustraciju, o čemu se konsultira ili informira autora putem e-maila.

Navodi referenci

Navodi literature, kao i drugi oblici formatiranja teksta, bit će prihvaćeni po APA standardu (American Psychological Association), prevedeni na engleski sa navodom originalnog jezika u zagradi. Prilog se šalje isključivo u elektronskom obliku (e-mail, CD, disk,...).

Adrese za dostavu priloga

Sport Science - Edukacijski fakultet
Univerzitet u Travniku
Aleja konzula 5, Travnik, Bosna i Hercegovina
E-mail: info@sportscience.ba

Jezik priloga

Sport Science objavljuje radove na engleskom jeziku uz sažetke na bosanskom jeziku. U slučaju da je prilog poslan u izvornom obliku na nekom drugom međunarodnom jeziku, autor priloga će u vezi sa tim biti konsultiran.

Napomena
Prilozi koji ne ispunjavaju uslove ili je za njih potrebna dodatna konsultacija bit će istom vraćeni autoru s upozorenjem o radnji koju je potrebno poduzeti.

Objava časopisa
Časopis izlazi u printanom i elektronskom obliku. Elektronska verzija dostupna je na web adresi: www.sportscience.ba