UNIVERSITY OF NIŠ

ISSN 1451-740X (Print)
ISSN 2406-0496 (Online)
COBISS.SR-ID 113549324

FACTA UNIVERSITATIS

Series
PHYSICAL EDUCATION AND SPORT
Vol. 18, Nº 2, 2020

Scientific Journal **FACTA UNIVERSITATIS**
UNIVERSITY OF NIŠ
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SERIES **PHYSICAL EDUCATION AND SPORT**

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FACTA UNIVERSITATIS, Series Physical Education and Sport is indexed in Sport database SPORTDiscus, SPONET (Germany), DOAJ (Sweden), Serbian Citation Index (Serbia).

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The cover photo: https://www.istockphoto.com/
Publication frequency – one volume, four issues per year.

Published by the University of Niš, Republic of Serbia

Financial support: Ministry of Education, Science and Technological Development of the Republic of Serbia
Printed by "UNIGRAF-X-COPY" – Niš, Republic of Serbia

ISSN 1451-740X (Print)
ISSN 2406-0496 (Online)
COBISS.SR-ID 113549324

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Vol. 18, Nº 2, 2020

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FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 271 - 282
https://doi.org/10.22190/FUPES200713025B

Research article

AN INVESTIGATION OF SEASONAL VARIATIONS IN THE FITNESS TEST PERFORMANCE OF LAW ENFORCEMENT RECRUITS

UDC 796.012 (1-927)

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Abstract. *The purpose of this research was to determine whether different seasons could influence fitness test performance in law enforcement recruits. Retrospective examination was conducted on data from four classes, which included 375 recruits (302 males, 73 females) from an agency. The classes were fitness tested during four different seasons in southern California (Fall: n=89, temperature=22-28°C, humidity=20-32%; Winter: n=84, temperature=18-26°C, humidity=8-11%; Spring: n=102, temperature=22-29°C, humidity=23-50%; Summer: n=100, temperature=21-25°C, humidity=39-71%). Fitness testing occurred in the week prior to academy and included: the vertical jump (VJ); push-ups and sit-ups completed in 60 s; and the 20-m multistage fitness test (20MSFT). A one-way ANOVA was used with Bonferroni post hoc ($p<0.05$) adjustment to calculate any between-class differences. There were no significant between-class differences for the VJ ($p=0.197$) and sit-ups ($p=0.352$). Winter and Summer recruits completed 16% and 19% significantly more push-up repetitions than Spring recruits ($p\leq0.029$). Winter recruits completed 16-22% significantly more MSFT shuttles than Fall, Spring and Summer classes recruits ($p\leq0.009$, 16%, 22%, and 18%, respectively). Variability in fitness test performance across the seasons may be due to class-to-class fitness variations in recruits. However, recruits in the Winter class were clearly superior in the 20MSFT, which is an aerobic maximal running test. Hotter temperatures can increase cardiovascular strain, while humidity can decrease sweat evaporation rates, which can impact a test such as the 20MSFT. Law enforcement staff may need to consider ambient temperatures and humidity during fitness tests due to potential negative effects on recruit performance.*

Key words: *Ambient Temperature, Humidity, Multistage Fitness Test, Police*

Received July 13, 2020 / Accepted August 19, 2020
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INTRODUCTION

Law enforcement can be a physically challenging profession. Occupational tasks include dragging an incapacitated person to safety, engaging in a foot pursuit, and using force to apprehend an offender (Dawes et al., 2017b; Lockie et al., 2018a, Lockie et al., 2020d). Although most of the job entails low-intensity activity (e.g. sitting in a vehicle), these almost sedentary actions can be interspersed with high-intensity activities (e.g. transitioning from sitting in a vehicle to pursuing a suspect on foot) (Anderson, Plecas, & Segger, 2001; Decker, Orr, Pope, & Hinton, 2016). Additionally, law enforcement officers typically have little to no control over the environment in which their job must be performed (e.g. patrol areas can be rural or urban, and officers need to work in all weather conditions). As a result of these demands, law enforcement agencies (LEAs) will often conduct fitness testing to measure the physical readiness of recruits prior to hiring. The tests are meant to assess underlying fitness characteristics that contribute to survivability during academy training (Dawes et al., 2019; Lockie et al., 2019a; Shusko et al., 2017), and also underpin job task performance (Dawes et al., 2017a; Lockie et al., 2018a).

Testing during the hiring process (Cesario et al., 2018; Bloodgood et al., in press), or as part of academy training (Lockie et al., 2018a; Lockie, Dawes, Orr, & Dulla, 2020a), typically occurs on set dates throughout a calendar year. Depending on the facilities available to the LEA, testing may be performed outdoors (Lockie et al., 2018a; Lockie et al., 2019a; Lockie, Dawes, Orr, & Dulla, 2020a; Lockie et al., 2020b; Lockie et al., 2020c; Lockie et al., in press). Outdoor testing is subject to variable weather conditions which could potentially affect candidate (an individual applying to a LEA) or recruit (an individual hired by a LEA who is completing law enforcement training) performance. Ambient temperatures typically vary during each season, and could have the potential to alter physical performance (Maughan, Otani, & Watson, 2012; Parkin, Carey, Zhao, & Febbraio, 1999; Zhao et al., 2013). For example, warmer ambient temperatures can increase heat stress within the body, which decreases time to muscular fatigue (Maughan et al., 2012; Zhao et al., 2013). Cooler ambient temperatures can result in decreased internal body temperature, increased cardiac output, and decreased glycogen utilization (Gonzalez-Alonso et al., 1999; Parkin et al., 1999). As a result, candidates or recruits who complete fitness testing in cooler temperatures could perform at a higher standard compared to recruits who are tested in warmer conditions.

In addition to ambient temperature, relative humidity could also affect fitness test performance in law enforcement candidates and recruits. Humidity prevents the absorption of sweat from the body, which in turn raises core temperature (Gonzalez-Alonso et al., 1999). As core temperature rises, the muscles become warmer and can fatigue at a faster rate (Maughan et al., 2012). Fitness tests that include maximal running or stress aerobic capacity may be particularly impacted in humid conditions (Zhao et al., 2013). Accordingly, law enforcement candidates and recruits who perform fitness testing in more humid conditions could be adversely affected compared to recruits who complete their testing in conditions with less humidity. This should be a consideration to LEA staff if candidates need to meet a minimum fitness standard in order to be hired (Brewer, Buckle, & Castle, 2013). A candidate could suggest that they had less than ideal testing conditions that negatively impacted their chance of employment. Furthermore, during the academy, fitness test performance can be used as a way to reward recruits for their efforts (Lockie et al., 2018a; Lockie et al., 2020a), and in some cases could influence graduation

rates (Lockie et al., 2019a). Environmental conditions could affect whether a recruit can achieve these accolades. However, there has been no research investigating whether ambient conditions can influence fitness test performance in law enforcement populations.

Collectively, these studies suggest that recruits who complete outdoor fitness testing in cooler temperatures and less humidity (e.g. during the Winter) may have better physical fitness test performance compared to those who complete similar tests in warmer temperatures and more humid conditions (e.g. during the Summer).

The purpose of this research was to ascertain whether seasonal differences in temperature and relative humidity impacted LEA recruit performance during typical law enforcement fitness tests. It was hypothesized that recruits who were tested in the Winter and Fall (Autumn) would performance better than recruits tested in the Summer and Spring.

METHODS

Participants

Retrospective examination of data for recruits from four classes from one LEA in the USA was conducted. Data were collected by staff working for the LEA and was released with consent from that organization to the researchers. A convenience sample comprised 375 recruits (age: 27.38±6.54 years; height: 1.72±0.10 m; body mass: 80.17±14.56 kg) was analyzed, which consisted of 302 males (age: 27.17±6.05 years; height: 1.75±0.08 m; body mass: 84.04±13.16 kg) and 73 females (age: 28.26±8.25 years; height: 1.61±0.06 m; body mass: 64.19±7.44 kg). The characteristics of the participants in this study, in addition to the ratio between males and females, was typical of law enforcement populations (Bloodgood et al., in press; Cesario et al., 2018; Lockie et al., 2018b; Lockie et al., 2020a; Lockie et al., 2020c). Based on the archival nature of this investigation, the institutional ethics committee approved the analysis of pre-existing data (HSR-17-18-370). Recruits completed the fitness assessments as part of their physical training for this agency. The study still followed the recommendations of the Declaration of Helsinki (World Medical Association, 1997).

Procedures

The LEA from this case analysis was located in Southern California where seasonal temperatures remain relatively constant across a year (18°C/64.4°F-29°C/84.2°F). Data from classes from each season within a 10-month period were selected for analysis to cover the four seasons. The Fall class was tested in October 2017. The Winter class was tested in December 2017. The Spring class was tested in May 2018, while the Summer class was tested in June 2018. The researchers had no control of when the classes were conducted as they were part of the regular schedule for the LEA. Accordingly, the classes were selected as they fell within the seasons considered for this study.

The data were collected by staff working on behalf of one LEA. Testing for each class was conducted in the week before the beginning of the training academy. The tests completed were part of a larger battery conducted by the LEA staff (Lockie et al., 2020c). However, as will be explained, the test data selected for this analysis were due to greater applicability across different law enforcement populations. Before testing, the age, height, and body mass of each recruit were chronicled. A portable stadiometer (Seca,

Hamburg, Germany) was used to measure height; electronic digital scales (Health o Meter, Neosho, Missouri) were utilized to measure body mass. Testing was conducted outdoors on asphalt or concrete surfaces at the LEA facility on a day scheduled by the staff. As described by Lockie et al. (2020c), testing generally occurred between 09:00-14:00, and recruits typically did not eat in the 2-3 hours prior to their testing session as they were completing employee-specific paperwork. Recruits rotated through the tests in small groups of 3-4, except for the 20-m multistage fitness test (20MSFT) which was completed in groups of 14-16. Additionally, recruits consumed water as required during testing; no control was placed on how much water was consumed by recruits.

Vertical Jump (VJ)

The vertical jump (VJ) was selected for analysis as it provides an indirect metric for lower-body power (Lockie et al., 2014a; Lockie, Schultz, Callaghan, & Jeffriess, 2014b; Lockie et al., 2018b), and has been found to relate to law enforcement-specific tasks (Dawes et al., 2017a), academy survivability (Orr et al., 2016; Dawes, Lockie, Orr, Kornhauser, & Holmes, 2019), and has been used across different law enforcement populations (Moreno et al., 2019; Myers et al., 2019; Cocke, Dawes, & Orr, 2016; Crawley, Sherman, Crawley, & Cosio-Lima, 2016; Orr, Pope, Peterson, Hinton, & Stierli, 2016; Dawes et al., 2017a; Dawes et al., 2019; Lockie et al., 2020c). A Vertec apparatus (Perform Better, Rhode Island, USA) was employed to measure jump performance with recognized protocols (Lockie et al., 2018b; Lockie et al., 2020c). Initially, the recruit stood side-on to the Vertec (on the recruit's dominant side), reached up and while keeping their heels grounded, displaced as many vanes as possible to establish the zero reference. Then, with no preparatory step or restrictions placed on the range of countermovement, the recruit then jumped as high as they could. Height was recorded from the highest vane that was moved. VJ height was calculated in inches by subtracting the standing reach height from the jump height, and converted to cm. Each recruit completed two trials, with a between-trial rest time of about 60 s, with the best trial analyzed.

Push-ups

Push-ups were included as a measure of upper-body muscular endurance as better performance in this test has been related to academy survivability (Shusko et al., 2017; Dawes et al., 2019), occupational task performance (Lockie et al., 2018a; Orr, Caust, Hinton, & Pope, 2018), and is a customary test in law enforcement research across a range of populations (Cocke et al., 2016; Orr et al., 2018; Dawes et al., 2019; Lockie et al., 2019d; Myers et al., 2019; Lockie et al., 2020a). To perform the push-up assessment, recruits completed as many repetitions as they could in 60 s. A tester placed a fist on the floor underneath the recruit's chest to ensure the right depth (Lockie et al., 2019d). Female recruits were always paired with a female tester. To begin the test, the tester began timing with a stopwatch and the recruit lowered themselves by flexing their elbows until their chests contacted the tester's fist. They then extended their elbows to return to the initial position. The recruits completed as many push-ups as possible with this technique in the time period.

Sit-ups

Sit-ups were included as a measure of abdominal muscular endurance as they are also a customary test in law enforcement (Cocke et al., 2016; Orr et al., 2018; Dawes et al., 2019; Lockie et al., 2019d; Myers et al., 2019; Lockie et al., 2020a), and have been related to performance in job tasks (Lockie et al., 2018a; Orr et al., 2018). To perform the maximal sit-up test, recruits completed as many repetitions as they could in 60 s. Recruits initially laid on their backs, and flexed their knees to approximately 90°. They were to keep their heels flat on the ground, and their arms crossed over their chest. The feet were then anchored to the ground by a tester. To begin the test, the tester initiated timing with a stopwatch and recruits lifted their shoulders from the ground, and while keeping their arms crossed, touched their elbows to their knees. The recruit then returned towards the start position until their shoulder blades touched the ground. Recruits completed as many repetitions as they could using this technique in the time period.

20-m Multistage Fitness Test (20MSFT)

The 20MSFT is a standard test of maximal aerobic capacity in different law enforcement groups (Moreno, Lockie, Kornhauser, Holmes, & Dawes, 2018; Orr et al., 2018; Dawes et al., 2019; Lockie et al., 2020b; Lockie et al., in press). Better aerobic capacity has been related to academy survivability (Shusko et al., 2017; Dawes et al., 2019; Lockie et al., 2019a) and numerous job tasks (Dawes et al., 2017a; Lockie et al., 2018a), and thus was important to include in this study. The 20MSFT was done by recruits on an asphalt surface outdoors, which was the typical venue for this LEA. Recruits ran between two lines spaced 20 m apart (which were indicated by markers). The running pace for the 20MSFT was standardized by audible cues (i.e. beeps) played from an iPad device (Apple Inc., Cupertino, California) connected to a portable speaker (ION Block Rocker, Cumberland, Rhode Island). The speaker was located in the middle of the testing area in a way that it would not interfere with the recruits. The test was stopped when the recruit was unable to reach the lines twice in a row in accordance with the cues, or by volitional exhaustion. The 20MSFT test was scored according to the final level and stage achieved by the recruit, with the level and stage data used to calculate the final number of shuttles completed.

Statistical Analysis

Statistical analyses were computed using the Statistics Package for Social Sciences (Version 25.0; IBM Corporation, New York, USA). Descriptive statistics (means and standard deviation [SD]) were calculated for each variable. A one-way analysis of variance (ANOVA), with Bonferroni post hoc adjustment for multiple pairwise comparisons, was used to derive any differences between the four classes. The one-way ANOVA was used due to robustness of this analysis and the size of the sample (Gamage & Weerahandi, 1998; Lockie, Dawes, Kornhauser, & Holmes, 2019b; Lockie et al., 2020a). Significance was set at $p<0.05$ a priori. Within each class, the sexes were combined for this analysis. This approach has been adopted in previous law enforcement and police research (Cesario et al., 2018; Lockie et al., 2018a; Lockie et al., 2019b; Lockie et al., 2020c).

RESULTS

Mean temperatures and humidity levels across the testing times for each day for each class were retrieved from the National Weather Service database (https://www.weather.gov/). This can be viewed in Table 1. Despite the temperatures being similar, humidity levels between the seasons varied, with Summer having the highest humidity levels (39-71%) and Winter having the lowest humidity levels (8-11%). Table 2 shows the data for all the classes. The Fall class had 71 males and 18 females, while the Winter class had 73 males and 11 females. The Spring had 75 males and 27 females, and the Summer class had 83 males and 17 females. There were no significant between-class differences for age (p=0.203) and body mass (p=0.479). The Fall class was significantly taller than the Spring (p=0.001) and Summer (p=0.004) classes, but not the Winter class (p=0.320).

Table 1 Ambient temperatures and humidity percentages across the four seasons on the testing days

	Fall	Winter	Spring	Summer
Temperature (°C)	22-28	18-26	22-29	21-25
Humidity (%)	20-30	8-11	23-50	39-71

Table 2 Descriptive data (mean ± SD) age, height, body mass, and fitness test performance between classes conducted in different seasons

	Fall (N = 89)	Winter (N = 84)	Spring (N = 102)	Summer (N = 100)
Age (years)	28.37 ± 6.91	27.89 ± 7.73	26.88 ± 6.43	26.59 ± 4.99
Height (m)	1.76 ± 0.09	1.73 ± 0.09	1.71 ± 0.10*	1.72 ± 0.10*
Body Mass (kg)	79.78 ± 14.89	81.76 ± 14.00	78.57 ± 14.45	80.82 ± 14.86
Vertical Jump (cm)	51.49 ± 12.89	54.20 ± 12.30	53.33 ± 14.75§ϕ	55.58 ± 12.64
Push-ups (no.)	41.21 ± 16.02	45.16 ± 13.41*	38.54 ± 15.38	44.99 ± 17.78*
Sit-ups (no.)	35.06 ± 8.62	35.79 ± 10.17	36.66 ± 12.94	37.71 ± 9.77
20MSFT (shuttles)	52.86 ± 20.31§	61.69 ± 17.98	49.62 ± 16.72§	51.68 ± 17.50§

Legend: * Significantly (p<0.05) different from the Fall class; § Significantly (p<0.05) different from the Winter class; ϕ Significantly (p<0.05) different from the Summer class.

There were no significant differences between the classes for the VJ (p=0.197) and sit-up test (p=0.352). For push-ups, recruits in the Winter and Summer completed 16% and 19% significantly more repetitions than recruits in the Spring (p=0.029 and 0.024, respectively). Recruits in the Winter completed 16%, 22%, and 18% significantly more MSFT shuttles than recruits in the Fall (p=0.009), Spring (p<0.001), and Summer (p=0.001) classes, respectively.

DISCUSSION

This study provided a preliminary investigation as to whether there were seasonal variations in the fitness test performance of recruits from one LEA. Anecdotally, there appear to be few LEAs that take a record of ambient temperature and humidity during testing or training sessions. This is despite the fact that ambient temperature (Kruk, Pekkarinen, Manninen, & Hanninen, 1991; Guy, Deakin, Edwards, Miller, & Pyne, 2015)

and humidity (Maughan et al., 2012; Zhao et al., 2013) can negatively impact physical performance. Different ambient temperature and humidity could affect the physical performance of candidates and recruits and influence how successful they are in completing fitness tests and exercises. The results detailed that there were select disparities in the fitness tests selected for analysis in this study among classes conducted in different seasons. The Winter and Summer recruits completed more push-ups than the Spring recruits, while the Winter recruits completed more 20MSFT shuttles than all the other classes. While these results may have been in part due to the variation in fitness test performance that can be seen across different law enforcement recruit classes (Lockie et al., 2018c; Lockie et al., 2018d; Lockie et al., 2020a), the 20MSFT results have important implications for LEA training staff.

There were no significant disparities between the four classes in age and body mass. However, the Fall class had a mean height that was significantly taller than the Spring and Summer classes. As the human resources department of a LEA generally controls the intake of recruits to a particular class, there can be a wide variety of recruits allocated to academy classes (Lockie et al., 2020a). Nonetheless and as stated, the characteristics of all classes was typical of law enforcement populations from the literature (Cesario et al., 2018; Lockie et al., 2018b; Lockie et al., 2020a; Lockie et al., 2020c; Bloodgood et al., in press). Thus, specific to the LEA analyzed in this study, it can be stated that all recruit classes were typical of previous classes. Accordingly, the results from the analysis of the seasonal variations in the fitness tests has application across law enforcement recruits.

The most notable results for this study concerned the 20MSFT. The recruits from the Winter class completed significantly more shuttles than recruits from all other classes. Previous research has shown that increases in ambient temperature have a significant effect on aerobically-based tasks (Ely, Cheuvront, Kenefick, & Sawka, 2010; Zhao et al., 2013). Performing aerobic-based exercise in warmer temperatures results in a gradual slowing of pace and a reduced ability to produce a final burst of energy to complete a task (Ely et al., 2010). A rise in thermoregulatory skin flow, which increases with hotter ambient temperatures, exacerbates cardiovascular strain, which adversely impacts a recruit's ability to withstand the demands of continuous aerobic exercise (Periard, Caillaud, & Thompson, 2012). Hotter ambient temperatures can also lead to dehydration with insufficient fluid intake (Gonzalez, Calbet, & Nielsen, 1999; Jones, Cleary, Lopez, Zuri, & Lopez, 2008; Zhao et al., 2013). Dehydration, in conjunction with a rise in skin temperature, impairs aerobic capacity, which is decreased incrementally with warmer skin temperature (Sawka, Cheuvront, & Kenefick, 2012). Not only does a rise in skin temperature affect performance, but also a rise in core body temperature. Higher core temperatures can lead to a reduction in motor drive performance during aerobic exercise (Nielsen, Savard, Richter, Hargreaves, & Saltin, 1990). Collectively, these results could highlight some of the reasons why the recruits from the Winter class performed significantly better in the 20MSFT than the other classes. LEA training personnel should be cognizant of the resultant weather-related influences on aerobic fitness test performance, which could produce lower test scores and performance in warmer seasons. It is possible that given the relationships between the 20MSFT with longer distance runs such over 2.4 km (Lockie et al., 2020b; Lockie et al., in press), and shorter distance runs over 300 m (Moreno et al., 2018), if recruits perform more poorly in the 20MSFT in warmer and more humid conditions, they would also do so in the other running tasks. This could affect candidate performance during the hiring process if they complete outdoor running tests, and recruit performance in physical training sessions.

For push-ups, recruit classes in the Winter and Summer performed better than the Spring class. The Winter group's superior performance could be in part attributed to the cooler ambient temperatures (18-26°C) and lower humidity levels (8-11%). As discussed previously, the cooler temperature may have been a result of lower core body temperatures which allowed recruits to decrease their rate of fatigue (Gonzalez-Alonso et al., 1999; Parkin et al., 1999). While Spring's humidity was lower than Summer's, the Spring session had a higher peak ambient temperature (29°C) compared to Summer (25°C). This may not be typical of other parts of the USA, but is not uncommon in southern California. Muscular endurance tests, such as the 60-s push-up test, have been associated with cardiorespiratory fitness (Vaara et al., 2012; Cesario et al., 2018). Research has shown that cardiorespiratory capacity decreases as ambient temperature increases (Zhao et al., 2013), which could partially explain the decrement in push-up performance. Although the natural variation that occurs in recruit classes could also contribute to these results (Lockie et al., 2018c; Lockie et al., 2018d; Lockie et al., 2020a), LEA training staff should recognize that ambient temperature may impact maximal push-up performance.

There were no differences in performance observed between all four seasons for sit-ups. The VJ is a lower-body power test (Lockie et al., 2014b; Lockie et al., 2018b), and its short duration and dependence on the stretch-shortening cycle of the muscles (Marković, Dizdar, Jukić, & Cardinale, 2004) may contribute to why it is less impacted by variations in temperature and humidity. This may be especially true in a climate such as southern California. The sit-ups results could be in part due to the ability for the recruit to rest in the supine position before continuing on with the test. This could limit the effects of any temperature or humidity-related fatigue to manifest, which may have occurred for the push-up test. Indeed, during the push-up test, recruits were not allowed to drop their knees to rest. Sex disparities may also be less in the sit-up test compared to the push-up test (Ryman Augustsson et al., 2009). This could mean any disparities in upper-body strength (Bloodgood et al., in press; Cesario et al., 2018; Lockie et al., 2019d; Lockie et al., 2020a) and tolerance to environmental stressors (Burse, 1979) may be lessened for female recruits, limiting variation across the seasons. Although these suggestions are somewhat speculative, the current data suggests that abdominal muscular endurance measured by sit-ups, and lower-body power measured by the VJ, were less affected by ambient temperature and humidity.

There are limitations to this research that should be documented. Ambient temperature and humidity were not directly measured during each class, so the values collected retrospectively may not have been exactly what recruits experienced on their day of testing. Due to scheduling, recruits were also tested at different times of the day. Although typical for this agency due to recruit class size (Lockie et al., 2018b; Lockie et al., 2019c; Lockie et al., 2020b; Lockie et al., 2020c Lockie et al., in press), this meant different recruits experienced different ambient conditions, even though they were tested in the same season. Further, different surfaces used for exercise can influence the temperature experienced by individuals (Petrass, Twomey, Harvey, Otago, & LeRossignol, 2015), and this was not considered in this study. Hydration was not controlled during testing, which although typical for this LEA (Lockie et al., 2018b; Lockie et al., 2020c), could have affected the fitness test performance of recruits. The temperatures and humidity presented were specific to the Los Angeles County region of southern California. This region tends to be more temperate than other parts of the USA, which is evidenced by the consistent temperatures across the seasons (although humidity did vary). These results were from fitness testing sessions, and not from physical training sessions. Even though it could be expected that

performance in aerobic-based exercises during physical training could show similar decrements similar to that for the 20MSFT across the seasons, this cannot be confirmed from the results of this study. This would be worthy of further analysis, especially if certain agencies use performance in physical training sessions as part of their graduation requirements (Lockie et al., 2019a).

CONCLUSION

In conclusion, the study results suggested that ambient temperature and humidity could influence performance in upper-body muscular endurance (push-ups) and aerobic fitness (20MSFT) tests. Lower-body power (VJ) and abdominal muscular endurance (sit-ups) appeared to be less affected by seasonal changes in ambient temperature and humidity. The variation that commonly occurs between law enforcement recruit classes could have influenced these results. Nevertheless, the fact that the Winter class was clearly superior in the 20MSFT has important implications for LEA training staff. It can be surmised from the current data detailed that aerobic fitness tests and exercise performance could be influenced by ambient temperature and humidity. Training staff should recognize that poorer performance in hotter and more humid conditions could affect potential employment if an aerobic fitness test is completed outdoors in different seasons, in addition to potentially poorer performance in physical training sessions.

Acknowledgments: *This research project received no external financial assistance. None of the authors have any conflict of interest. The authors would like to thank the training instructors for facilitating this research, and the California State University, Fullerton tactical research team for collating the data.*

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ISTRAŽIVANJE SEZONSKIH VARIJACIJA FITNES PERFORMANSI REGRUTA POLICIJSKIH SNAGA

Svrha ovog istraživanja bila je da se utvrdi da li različita godišnja doba mogu da utiču na fitnes performanse regruta policije. Retrospektivno istraživanje obavljeno je na osnovu podataka iz četiri klase u koje je uključeno 375 regruta (302 muškarca, 73 žene). Klase regruta su testirane tokom četiri različita sezonska doba u južnoj Kaliforniji (jesen: n=89, temperatura=22-28° C, vlaga=20-32%; zima: n=84, temperatura=18-26° C, vlažnost=8-11%; proleće: n=102, temperatura=22-29° C, vlažnost=23-50%; leto: n=100, temperatura=21-25° C, vlažnost=39-71%). Ispitivanje performansi fitnesa je obavljeno tokom nedelje pre akademije i obuhvatalo je: vertikalni skok (VS); sklekove i trbušnjake izvedene za 60 s; i 20-metarski beep fitnes test (20MSFT). Korišćena je one-way ANOVA sa Bonferroni post hoc ($p<0.05$) metodom u cilju utvrđivanja međuklasnih razlika. Nisu utvrđene statistički značajne razlike za VS ($p=0.197$) i trbušnjake ($p=0.352$). Zimski i letnji regruti su uradilii značajno više sklekova od proljetnih regruta ($p\leq0.029$, 16% i 19%, tim redosledom). Zimski regruti su istrčaki značajno više 20MSFT deonica od regruta iz jesenjih, prolećnih i letnjih klasa ($p\leq0.009$, 16%, 22%, i 18%, tim redosledom). Promenljivost u performansama fitnesa tokom godišnjeg doba može da bude posledica varijacija između klasa regruta. Ipak, regruti zimske klase bili su očigledno superiorniji u 20MSFT, koji predstavlja aerobni test maksimalnog trčanja. Niže temperature mogu da povećaju kardiovaskularno naprezanje, dok vlaga može da smanji stopu isparavanja znoja, što može da utiče na test kao što je 20MSFT. Pripadnici policije će možda morati da uzmu u obzir temperaturu i vlažnost vazduha tokom testova fitnesa zbog potencijalnih negativnih efekata na rezultate testova.

Ključne reči: *temperatura vazduha; vlažnost; beep fitnes test; policija*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 283 - 293
https://doi.org/10.22190/FUPES200610026S

Research article

GENDER DIFFERENCES IN LEARNING MOTOR SKILLS FOLLOWING A VIDEO DEMONSTRATION IN PRIMARY SCHOOL CHILDREN

UDC 796.015:372.4-057.874

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Abstract. *The first aim of the study was to determine if there are significant gender differences in newly applied motor skills tests in primary-school children concerning the protocol applied. The second aim was to determine how the newly implemented protocol using a video demonstration of the task affects the differences in outcome between boys and girls compared to the standard motor skills assessment protocol without a video demonstration. The total number of participants was 327, consisting of 186 boys and 141 girls aged 10.5 years. The students were divided into two subgroups based on the protocol applied. The sample of variables consisted of four motor skills assessment tests: the shuttle-run, partial curl-up, 90° push-ups, back-saver sit-and-reach (right and left leg) tests. A three-factor variance analysis investigated the effects of protocol and gender on the result in each test. Statistically significant differences between boys and girls were obtained in the initial measurement and after applying the protocols in the mentioned tests. In the back-saver sit-and-reach (right leg) test, the difference was not significant in the initial measurement with the standard protocol, while it was significant after it was applied. In the curl-up test, there were no differences in scores between boys and girls when using both protocols. Differences in the outcomes after the application of the video demonstration protocol were evident in both genders, and a markedly significant increase occurred in the application of the tests 90° push-ups and curl-up tests, which assess strength.*

Key words: *Students, Primary Education, Test Protocol, Demonstration*

Received June 10, 2020 / Accepted September 2, 2020
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INTRODUCTION

The importance of motor abilities comes to light when performing both everyday and kinesiological activities. Differences in the level of motor abilities are attributed to individual differences (Mišigoj-Duraković, 2008). Individual differences in the dynamics of growth and development are a source of variability in the forms, functions and all abilities of the human body (Malina, Bouchard, & Bar-Or, 2004 according to Mišigoj-Duraković, 2008). With the onset of school age, most nerve structures are already developed and a fundamental movement pattern has been established, making this age ideal for the adoption of basic abilities (Mišigoj-Duraković, 2008). Learning or adopting new motor knowledge often requires coordination and control of limb movements, but also of the whole body when performing, constrained by time and space with the ultimate goal of mastering the shown task. Different forms of information may be given to the participant in order to help reach a solution (Magill, 1993; Magill & Schoenfelder-Zohdi, 1996). In any situation where a particular type of motor knowledge is to be adopted and learned, the performer is provided with information on the proper form of movement or technique. This information is most often related to the coordination of the performer's bodily movements, including the sequence, form and timing of the movements of an individual limb (Wulf, 2007). When it comes to physical and health education classes (TZK), the training practice most often consists of descriptions and "live" demonstrations, and it is on this principle that metric protocols to assess the level of motor skills in students were applied (Findak, Metikoš, Mraković, & Neljak, 1996; Metikoš, Mraković, Prot, & Findak, 1990; Mraković, Findak, Gagro, Juras, & Reljić, 1986; Novak, 2010; Prskalo, 2011). The development and application of information and communication technology in all social spheres of life has not bypassed the field of education. It resulted in the application of technologically advanced protocols a decade or more ago, significantly improving the process of learning and the adoption of motor skills. Thus, particular task adoption protocols, that use a model video showing the performance, were applied, and studies that compared such a mode of presenting information with a method consisting of a model point-light demonstration, confirmed the advantage of the video performance (Horn, Williams, Scott, & Hodges, 2005; Hayes, Hodges, Scott, Horn, & Williams, 2007; Rodrigues, Ferracioli, & Denardi, 2010), while the difference between the two modes has not been confirmed in research (Horn, Williams, & Scott, 2002).

Furthermore, the information presented via a model video performance and the effectiveness of such information presentation mode compared to some other protocols have been confirmed (Guadagnoli, Holcomb, & Davis, 2002; Maryam, Darush, & Mojtaba, 2009; Vrbik, 2015; Vrbik, Krstičević, Sporiš, & Madić, 2015). Differences and relations between the boys' and girls' motor abilities levels have been the subject of interest of many researchers. Different results on gender differences have been obtained in this area of research, and some authors have confirmed the existence of gender differences in motor skills among primary school students (Malina et al., 2004; Pejčić & Malacko, 2005; Katić, Srhoj, & Pažanim, 2005; Delaš, Miletić, & Miletić, 2008). With regards to the research that has confirmed the benefit of a model video performance presentation as an efficient way of information presentation, and research confirming the existence of differences in boys' and girls' motor skills, the question of the difference in the cognitive processing of information, and thus the impact on differences in results arises.

Based on all of the above, two aims have been set for this study. The first aim is to determine if there are significant gender differences in newly applied tests for assessing motor skills in primary-school boys and girls concerning the protocol applied. The second aim is to determine how the newly implemented protocol using a video demonstration of the task affects the differences in outcome between boys and girls compared to the protocol of motor skills assessment without video demonstration.

METHODS

The sample of participants

The participants in this research were third and fourth grade students from four elementary schools that belong to the urban area of the towns Petrinja and Sisak (Croatia). The total number of students that participated in the research was 327, consisting of 186 boys and 141 girls, aged 10.5 years, with an average height of 145 cm and an average mass of 38.7 kg. The students were divided into two subgroups, based on the protocol applied: the Standard Protocol (N=183; 110 male and 73 female) and Video demonstration protocol (N=144; 76 male and 68 female). All the participants in this research attended regular physical education classes and did not previously have experience with most of the given motor tasks, and were completely healthy during the tests. The research was approved by the Scientific and Ethical Committee of the Faculty of Kinesiology, the University of Zagreb, the Senate of the Zagreb University, while the head-masters of the schools allowed participation before the beginning of the research. Additionally, the parents of each child signed a written agreement for participation in the research and they were informed about the object and the aim of the research.

The sample of variables

The sample of variables in this research included four tests for motor skill assessment (the shuttle-run, partial curl-up, 90° push-up, back-saver sit-and-reach).

The Shuttle-run: a participant stands outside the start line in a high starting position, head turned in the direction of the movement. At the sign "Ready! Steady! Go!", the student runs to get the sponge, picks it up, runs back to the start-finish line, puts the sponge behind the line, runs back to get the second sponge, takes it and runs back behind the start-finish line. The task is done when the participant puts the second sponge behind the start-finish line (Malina et al., 2004; Welk & Meredith, 2010; Novak, 2010; Vrbik, 2015).

The Curl-up: a student is lying on the mat with his/her knees bent at 140°, hands extended along the body, palms facing the mat. Under his/her feet, a measuring tape is put in line with the top of the middle finger, and a piece of paper is put under his/her head. The student starts doing the task at the given mark, lifting the head and shoulders while sliding, hands on the measuring tape, head back on the paper every time. The test is finished when a 75% lift of the upper body is achieved, when the student repeats a mistake for the second time while doing the activity, or is not able to continue the performance of the motor activity (Welk & Meredith, 2010; Novak, 2010; Vrbik, 2015).

The 90° push-ups: a student is in the position of the back press, hands shoulder width apart or a bit wider, legs straight and spread a little, feet on the mat, back straight. The student goes down with the hands towards the mat until the upper arm is parallel with the

floor, and then lifts back to the starting position. The task is done when the student is not able to continue the task or the second correction is done during the performance (Welk & Meredith, 2010; Vrbik, 2015).

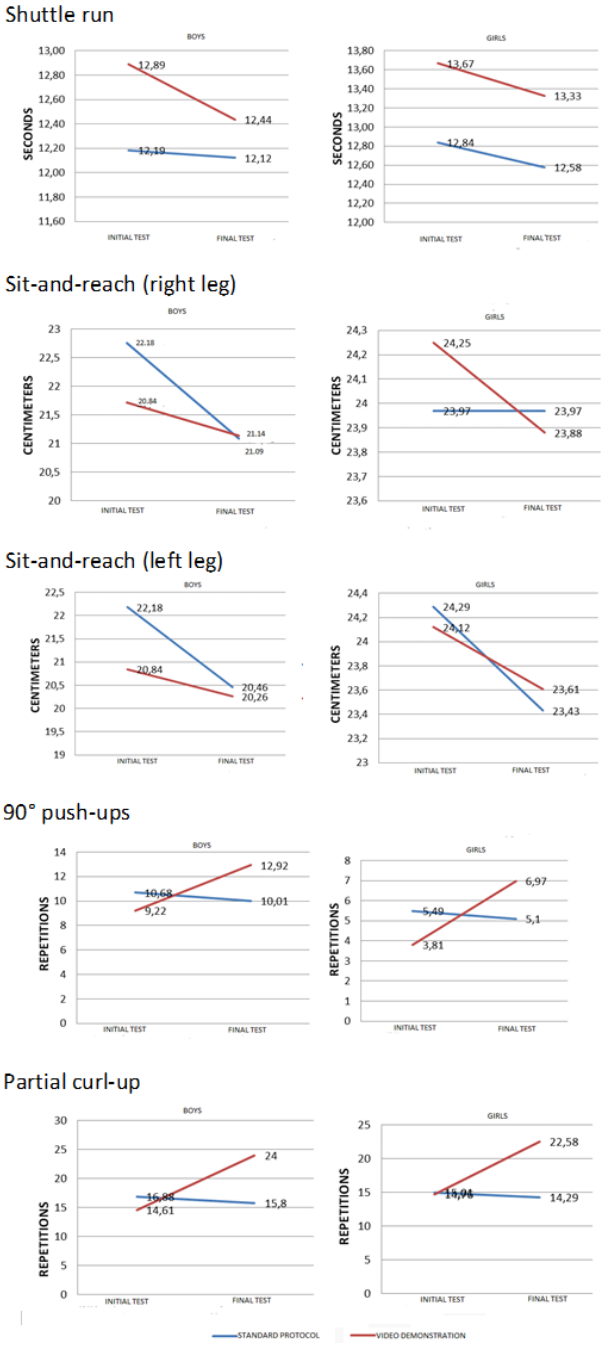
The Back-saver sit-and-reach: a student sits in front of the measuring device, one leg fully extended, while the other is bent at the knee with the foot on the mat. The arms are extended in front, above a measuring scale, palms together, both facing the mat. With both palms the student bends forwards over the measuring tape and holds the last position for one second (Welk & Meredith, 2010; Vrbik, 2015).

The tests back-saver sit and reach, and shuttle-run were repeated three times, while the other tests were done once. The research was conducted during the regular physical education classes of the 2013/2014 school year, in May and the beginning of June. In the same period, lasting two weeks, the experiment was done in both groups in two treatments. The first treatment included the initial testing of all the students in the tasks. The second treatment consisted of testing after the treatment in each task, using the method of random choice and applying different metric protocols. Before the experiment, both groups of participants prepared by doing a 5-minute warm-up that included joint rotations and basic games appropriate for the age of the students.

Statistical analysis. SPSS (version 20.0, SPSS Inc., Chicago, IL) was used for the statistical analysis. Means and standard deviations of all the variables were calculated. The normality of the distribution was tested using the Kolmogorov-Smirnov test, and it showed appropriate normality of the distributions for all the studied variables. An analysis of variance was used to determine the difference between each test used to assess motor skills in each individual protocol. To determine the differences in the experimental protocols, but also between genders and measurements, a three-way factor analysis of variance with repeated measures was conducted. The magnitude of the effect of an individual protocol in an individual test was obtained as part of an analysis of variance that calculates the partial eta squared, and Cohen's d from the formula $ES = \frac{\text{Mean after protocol} - \text{Mean initial measurement}}{\text{Standard deviation initial measurement}}$. The level of significance was set at the level $p \leq 0.05$ and all data are reported as means±SD.

RESULTS

The Kolmogorov-Smirnov test was used to determine the normality of data distribution for each variable by gender and protocol. The test confirmed that the distributions were not significantly different from the normal distribution. The results of the arithmetic mean (± SD) of boys and girls in each test in both protocols at the initial measurement and after application of the protocol, as well as the differences obtained, are shown in Table 1. Statistically significant differences between the boys and girls were obtained at the initial measurement and after application of the protocols in the shuttle run, 90° push-ups, and the left leg back-saver sit-and-reach tests. In the right leg back-saver sit-and-reach test, no significant difference was obtained in the initial measurement with the standard protocol, although the value of the arithmetic means shows a higher value in girls. In the test estimating core strength, the curl-ups, the values of arithmetic means in both protocols showed equal values in boys and girls. The effects of individual protocols on boys and girls before and after treatment are shown in Graph 1.



Graph 1 The effects of individual protocols on boys and girls before and after treatment

The resulting differences in the video demonstration protocol results were evident in both genders, and a marked increase was observed in strength assessment tests (the curl-ups, 90° push-ups).

Table 1 Differences between boys and girls in selected tests after each protocol

			Baseline	Sig.	After intervention	Sig.
Test	Protocol	Gender	Mean±SD	p	Mean±SD	p
Shuttle run	Standard protocol	M	12.19 ± 1.13	0.000	12.12 ± 1.21	0.009
		F	12.84 ± 0.93		12.58 ± 0.98	
	Video demonstration	M	12.89 ± 1.20	0.000	12.44 ± 1.04	0.000
		F	13.67 ± 1.38		13.33 ± 1.30	
Sit-and-reach (right leg)	Standard protocol	M	22.76 ± 5.34	0.134	21.09 ± 4.93	0.000
		F	23.97 ± 4.89		23.97 ± 5.26	
	Video demonstration	M	21.72 ± 5.65	0.005	21.14 ± 5.39	0.002
		F	24.25 ± 5.44		23.88 ± 5.43	
Sit-and-reach (left leg)	Standard protocol	M	22.18 ± 5.35	0.012	20.46 ± 5.10	0.000
		F	24.29 ± 4.96		23.43 ± 5.25	
	Video demonstration	M	20.84 ± 6.05	0.000	20.26 ± 5.96	0.000
		F	24.12 ± 5.76		23.61 ± 5.54	
90° push-ups	Standard protocol	M	10.68 ± 8.56	0.000	10.01 ± 7.48	0.000
		F	5.49 ± 6.01		5.10 ± 4.95	
	Video demonstration	M	9.22 ± 7.08	0.000	12.92 ± 8.78	0.000
		F	3.81 ± 5.04		6.97 ± 7.89	
Partial curl-up	Standard protocol	M	16.88 ± 11.47	0.240	15.80 ± 11.16	O.437
		F	15.01 ± 9.38		14.29 ± 9.37	
	Video demonstration	M	14.61 ± 9.47	0.930	24.00 ± 14.66	0.513
		F	14.76 ± 11.20		22.58 ± 16.34	

Legend: F-female; M-male; SD-standard deviation; Sig.-significance.

DISCUSSION

Variance analysis showed that there were significant gender differences in all motor abilities tests for both protocols applied, except in the core strength test of curl-ups, which showed no significant differences in either of the protocols. The lack of gender difference in this test is equivalent to the conclusion reached by Malina and associates (2004), stating that the differences in the strength of the abdominal muscles of the torso at that age are negligible and that they become significant only in adolescence. The obtained differences are significant for the boys in tests used to assess upper torso agility and strength (the shuttle run and 90° push-ups), while the result is significant for the girls in the flexibility assessment test (the right leg and left leg sit-and-reach test).

Malina and associates (2004) confirmed that the agility measured by the shuttle run test improved significantly in boys and girls between the ages of 5 and 8, and continued to improve with less effect but continuously until the ages of 13 or 14 in girls, and the age of 18 in boys. At that age, there is also a difference evident in upper body strength tests, which indicates a linear improvement from the ages of 5 to 13 and 14 in boys. Girls are significantly more flexible than boys at that age, and the differences are most pronounced during adolescent growth momentum and sexual maturation. In the strength assessment

and torso endurance tests (the curl-ups), linear improvements occur from the ages of 6 to 13 in boys, and up to 14 in girls. Gender differences during this period are negligible and they begin to manifest only in adolescence. Similar research findings and conclusions were outlined by Zurc, Pišot, and Strojnik (2005), whereby they point out that significant differences diminish between the ages 7 and 12, whereas later on in boys the abilities increase rapidly until the age of 17, while in girls they remain at the level reached at the age of 12. Prskalo, Jenko, Petračić, Šerbetar, and Šuker (2007) found that there were differences between boys and girls aged 9 and 10. Result differences confirm the research findings to date that indicate better results for girls in flexibility tests and in explosive strength tests for boys. In this research, when presenting information on the performance of a new motor task that was used to assess the level of motor abilities of primary and secondary school students, two different metric protocols were used. Regardless of the protocol applied, the research, following the previous research on primary school children's motor abilities, confirmed the existence of differences between boys and girls in all of these tests, except in the test assessing core strength (the curl-ups).

Furthermore, the result differences after applying the video demonstration protocol are evident in both genders, and a markedly large increase occurred in the strength assessment tests (the curl-ups and 90° push-ups) (Graph 1), which supports this method of protocol application, and was confirmed in the research of Vrbik et al. (2015). The administration of the video demonstration protocol for the agility test (shuttle run), produced increases of 3.5% in boys and 2.5% in girls compared to increases in the standard protocol of 0.5% and 2.02% for boys and girls, respectively. Administration of both protocols in the flexibility test (the back-saver sit-and-reach test), resulted in a decrease in both boys and girls. After the administration of the video demonstration protocol, the evaluation of the effect of each protocol on the result showed there was also a slight decrease in this test with both genders compared to the standard protocol. In the strength dimension assessment tests, substantial result differences were established after the administration of the video demonstration protocol, and consequently, of the scope of the effect of the protocol. The effects value of ES=0.52, which, according to Cohen's effect size index represents the mean index value (Pallant, 2009), is equivalent to a 40.1% boys' improvement in the 90° push-ups video demonstration test, while an improvement of 82.9% in girls, also with a mean effect value of 0.63, represents a significant increase in the results compared to a 6.3% and 7.1% increase in boys and girls respectively after the administration of the standard protocol, which speaks enough of the difference and the benefit the video demonstration protocol has produced. The video demonstration protocol produced a similar effect in the "Lifting the torso out of a brief lying position with legs folded" test. There was a large effect value achieved by Cohen's index of 0.99 with a 64.3% improvement in boys, and a medium to high effect by Cohen's index of 0.7 resulting in a 52.9% improvement in girls, over the standard protocol where there was a 6% improvement in boys and a 4.8% improvement in girls.

As stated earlier, there are differences in anthropological characteristics between boys and girls of a primary school age, and this research has confirmed some of them. Additionally, it confirmed that there are gender differences in the way the information presented was then processed and adopted. In most tests, there was a significantly higher percentage increase in boys than in girls' scores, when administering the video demonstration protocol. When performing a complex motor task, third and fourth grade boys are more likely to use explosive and repetitive strength combined with flexibility and static strength. Furthermore, Katić and associates (2005) concluded that core strength in third-grade students has a major

impact on the frequency of movement; that is, the integration of strength and speed. They also found a greater advantage of boys in motor learning than in motor performance, and this advantage is even greater during adolescence. The participants' age and effort during exercise are a significant factor in determining gender differences in motor performance (Dorfberger, Japha, & Karni, 2009). The morphological-motor functioning in boys changes over the years, in the third grade, the general motor factor responsible for the overall motor functioning is already formed, while in the fourth grade the morphological development takes the leading role in the overall morphological-motor development (Lasan, Pažanin, Pejčić, & Katić, 2005). In girls, according to Katić, Bala, & Barović (2012), motor-cognitive functioning transitions from the cortical level to the subcortical, and at the age of 10 to 14, cognitive functioning is significantly implied by their motor efficiency, and is associated with a motor unit involving regulation of muscle tone and agility/coordination, whereas, in boys, there is an association between cognitive ability and the speed regulator of upper extremity movement (Katić et al., 2012). Observing movement has been confirmed to cause brain activity similar to that of performing movement. Through film and video observation, the cognitive performance perspective can be increased, enhanced and improved. Improving the cognitive model through observation and learning has been confirmed to improve the performance of the movement itself (Pike, 2008). Students' perception thereby plays an important role in learning effectiveness (Hayes et al., 2007). It has also been determined that boys have an advantage over girls when it comes to motor learning, and that it also improves during adolescence (Dorfberger et al., 2009). Based on previous research, a significant explanation for the differences in motor test results can be sought through the influence of the social factor, since the development of motor skills is part of a child's socialization process (Zurc et al., 2005), while at the same time previous participation in the performance of particular motor activities significantly affect the learning speed of a complex motor task (Katić et al., 2012). When conducting testing, it is necessary to establish objective conditions for assessing the level of fundamental motor abilities by age and gender. The effectiveness of the demonstration and the information given in the form of instructions depends on the student's existing skills related to the type of task or skills already learned (Hodges & Franks, 2002); therefore, the goal should be to strive towards the adaptation of the task to a student's capabilities and abilities. It is for this reason that the differences in motor abilities and their impact on learning and performance, especially in jumps and runs, should be taken into account during the teaching process (Delaš et al., 2008). Students can adopt a relative movement pattern after only five observations and three performance attempts, but when the student is restricted to using the demonstration during early practice, they immediately begin to process the newly adapted solution rather than seek an entirely different one (Horn et al., 2005). Given the number of displays – task demonstrations, which is five displays for the video demonstration protocol compared to 1 display for the standard protocol, with the same number of student-watched performances as they wait for their performance, a greater number of display views results in more accurate cognitive processing of the task performance. Therefore, the performance of the movement itself is significantly more accurate (Horn & Williams, 2004). More accurate movement performance results in better technique, and therefore less energy and information consumption during the performance of the task, which also has an impact on the result. Also, one of the factors that influence the result is certainly motivation. Considering the gender of the model that demonstrated the task, in some previous studies cited by Horn and Williams (2004), the participants had no motivation to perform the task when the model was a person of the opposite sex. In this

study, compared to some of the earlier ones cited by Horn and Williams (2004), the results obtained are contrary to their claims, and thus closer to the conclusion that the gender of the model did not affect the performance of the participants, because in the video demonstrates the model is a female, whereas in the standard protocol the model was male. This was confirmed by the good results boys achieved in the video demonstration protocol, whereby they were probably additionally motivated, and wanted to show they can perform better than a female (model). Contrary to this reasoning, the assumption is that girls perceived the video performance model as an equal to themselves, and it is certainly an important fact that in all the classes that participated in the survey, the teacher was female. With regards to the standard protocol, there were no significant changes in the girls' and boys' results, and therefore the influence of the model's gender can be disregarded. This is supported by the fact that the demonstration of tasks by male models is not new to the students, and that this is something that they have all encountered before. When observing an expert performance display, depending on previous familiarity and knowledge, attention and the ability to notice details and specific movement parts increases (Keats, 2008), and regardless of gender, a certain degree of attention is required in everything we do.

CONCLUSION

In light of the objectives set, the following facts can be ascertained as the conclusion to this research. The first one is that boys, at the age of 10.5, scored better on agility and strength tests regardless of the protocol used. Girls achieved better results in the flexibility test in both protocols administered, and there were no significant result differences obtained in the core strength assessment test (the curl-ups), in either protocol used. Another finding of the study is that following the video demonstration protocol, the boys achieved more significant result differences, and thus the effect of the video demonstration protocol was higher compared to the standard protocol in boys and girls. Greater scope of the effects and differences in the results were achieved on the shuttle run and curl-up tests in boys compared to girls in the video demonstration protocol and boys and girls in the standard protocol. In the 90° push-ups test, a similar scope was achieved by both boys and girls in the video demonstration protocol, and this difference is much larger compared to the results achieved with the standard protocol. Also, in both girls and boys, there was a result decrease in the back-saver sit-and-reach test with both protocols applied, although the difference in the decrease was also smaller for video demonstration protocols for both genders, compared to the standard protocol. In order to see if the effects of the video demonstration protocol applied were retained among the boys, a retention measurement should be administered in future research. Additionally, in order to improve the diagnostic procedure in the field of kinesiology, and in order to obtain representative tests appropriate for the students' age, a larger battery of tests should be administered.

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RAZLIKE PO POLU PRILIKOM UČENJA MOTORIČKIH VEŠTINA VIDEO DEMONSTRACIJOM DECE OSNOVNOŠKOLSKOG UZRASTA

Prvi cilj studije bio je da se utvrdi postoje li značajne razlike po polu u novoprimenjenim testovima motoričkih sposobnosti dece osnovnoškolskog uzrasta u vezi sa primenjenim protokolom? Drugi cilj bio je da se utvrdi na koji način novoimplementirani protokol pomoću video demonstracije zadatka utiče na razlike u ishodu između dečaka i devojčica u poređenju sa standardnim protokolom za procenu motoričkih sposobnosti bez video demonstracije? Ukupan broj učesnika bio je 327, tj., 186 dečaka i 141 devojčice uzrasta 10.5 godina, podeljenih u dve podgrupe na osnovu primenjenog protokola. Uzorak varijabli sastojao se od četiri testa za procenu motoričkih sposobnosti: šatl-ran, parcijalni trbušnjaci, sklekovi do 90°, test gipkosti u sedu sa dohvatom (desna i leva noga). Trofaktorskom analizom varijanse istraživani su efekti protokola i pola na rezultat u svakom od testova. Utvrđene su statistički značajne razlike između dečaka i devojčica na inicijalnom merenju. U testu gipkosti u sedu sa dohvatom (desna i leva noga) standardnim protokolom razlika na inicijalnom merenju nije bila statistički značajna, dok je bila značajna nakon primene video demonstracije. U testu parcijalnih trbušnjaka nije bilo razlike u rezultatima između dečaka i devojčica u oba protokola. Razlike u ishodima nakon primene protokola video demonstracije bile su evidentne u oba pola, a statistički značajan porast utvrđen je u primeni testu sklekovi do 90° i testu parcijalnih trbušnjaka, kojima se procenjuje snaga mišića.

Ključne reči*: učenici, osnovno obrazovanje, test protokol, demonstracija*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 295 - 303
https://doi.org/10.22190/FUPES200530027S

Research article

DIFFERENCES IN THE MOTOR COMPETENCE OF YOUNGER SCHOOL AGE CHILDREN

UDC 796.012-053.2

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Abstract. *The aim of this study was to examine the differences in motor competence among children of different school ages, as well as whether there is a negative trend in the decline of these values with increased age. The research was conducted in a school environment, the sample consisted of 151 male and female children, age 7-11 years, divided into four approximately equal subsamples: first grade children N=36 (7.4±0.3 years, Mean±SD), second grade children N=41 (8.5±0.3 years, Mean±SD), third grade children N=40 (9.4±0.3 years, Mean±SD) and fourth grade children N=34 (10.4±0.3 years, Mean±SD). The Körperkoordinations test (KTK) assesses the coordination of the whole body and is intended for children aged 5-14 years. The test is internationally standardised and consists of 4 subtests from which the following variables emerged: single-leg hopping, walking backwards, two-legged lateral jumping, lateral movement platforms and Total KTK. The multivariate analysis of variance (MANOVA) revealed statistically significant differences between children of all ages in all tested variables, in the total (P=.00) and individual (p=.00) system of variables. These findings also indicated a negative trend of declining motor competence of children with increasing age. A similar trend was observed in the individual variables of the KTK battery. The increased involvement of physical education teachers and children in physical education classes is recommended in order to increase the development of children's motor competence through regular physical activities on a daily basis.*

Key words: *Motor Competence, KTK, Primary School Children*

Received May 30, 2020 / Accepted September 4, 2020
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INTRODUCTION

The ability to perform different motor tasks is defined as motor ability. when performing motor tasks children develop different motor skills that present a movement pattern which develops through physical activity and excercise. Motor skills that are manifested during physical activities are locomotor skills, manipulative skills and balance skills (Lubans, Morgan, Cliff, Barnett, & Okely, 2010). Locomotor skills represent movements that include different activities in the pattern (running, single and double leg hopping, jumping), manipulative skills are abilities to maintain objects (catching and throwing objects of different sizes and shapes), and balance skills are those referring to balance of the whole body and extremities in space and time (Lubans et al., 2010). For the locomotor skills, coordination that represent synergic work of muscles or muscle groups is essential; it creates a movement, which can be defined as a motor competency (Magill, 2011). Previous research shows the decay of the motor competence of younger school age children (Vandrope et al., 2011; Hardi, Barnett, Espinel, & Okely, 2013; Tester, Ackland, & Houghton, 2014). These findings can potentially create a problem in the further development of motor skills since motor competence is related to health and obesity (Logan, Robinson, Rudisill, Wadsworth, & Morera, 2014; Cvejić, & Ostojić, 2017; Batez, Milošević, Simić, & Obradović, 2019) and can negatively affect success in school, participating in physical activity and social interactions (Piek & Skinner, 2001). On the other hand, high motor competence can be a positive predictor of physical activity and a good Body Mass Index (Boreham, & Riddoch, 2001; Lubans et al., 2010; Batez et al., 2019) as well as adopting good lifestyle habits in further development. Motor competence can be estimated by many tests (Cools, Martelaer, Samaey, & Andries, 2009; Klingberg, Schranz, Barnett, Booth, & Ferrar, 2018), while some authors state that the two most common tests are (Logan et al., 2017): the Körperkoordinations test (KTK) and The Test of Gross Motor Development-2 (TGMD-2). The selection of tests depends on the aim and whether the goal is a qualitative (TGMD-2) or quantitative (KTK) outcome. One of the tests that is widely used in European research and which can accurately estimate the status of the motor competence of kids (5-14 years) is the standardised KTK battery of tests (Kiphard & Schilling, 1974; 2007). The KTK test estimates the ability to control the whole body and coordination, it is a simple test and it is easy to conduct it (Cools et al., 2009). Data collection takes approximately 20 minutes and the reliability of the test is high (Valaey, & Vandroemme, 1999; Bardid, Rudd, Lenoir, Polman, & Barnett, 2015; Batez et al., 2019). The aim of this study was to examine the differences in motor competence among children of different school ages, as well as whether there is a negative trend in the decline of these values with increasing age among children from Serbia.

METHODS

The sample

The research was conducted in a school environment, and the sample consisted of 151 males and females, age 7-11, divided into equally distributed subsamples: first grade N=36 (7.4±0.3 years, Mean±SD), second grade N=41 (8.5±0.3 years, Mean±SD), third grade N=40 (9.4±0.3 years, Mean±SD) and fourth grade N=34 (10.4±0.3 years, Mean±SD) schoolchildren. The number of children was limited by the current capacities of the primary school "Laza Kostić" in Kovilj. The parents and guardians of the children signed a written consent of

participation. All of the tests and procedures were performed according to the Declaration of Helsinki. Children with an acute and chronic health issues did not participate in the tests.

Table 1 Decimal age of the sample by grades

Class	N	Min	Max	M	SD
1	36	7.0	8.0	7.4	0.3
2	41	7.9	9.1	8.5	0.3
3	40	9.1	9.9	9.4	0.3
4	34	9.5	11.0	10.4	0.3

Legend: N-number of participnats; Min-minimum values; Max-maximum values; M-mean, SD-standard deviation.

The sample of variables and measuring instruments

The instrument that has been used in the data collection is the KTK battery of tests and it has high reliability (r=0.90-0.97) (Batez et al., 2019) as well as intra reliability (r=0.80-0.96) (Bardid et al., 2015). The test is internationally standardised and if has subtests from which the variables that have been used later in the data analysis were derived:

- single-leg hopping over a 5 cm high foam obstacle (frequencies);
- walking backwards three times along three different wooden beams (frequencies);
- two-legged lateral jumping over a low obstacle within a 15-second time frame (frequencies);
- lateral movement platforms across the floor for 20 seconds (frequencies) and
- Total KTK (frequencies).

Organization of measurements

Well trained scientists collected the data. The participants wore sport clothes and they were barefoot during the tests. Each test was explained verbally and demonstrated before the execution. Children had a chance to take several trials before the data collection. Evaluation of the results of all four KTK subtests was carried out by adding up the points from every test individually. The values were converted into the MQ (motor coefficient) value (depending on the gender and the decimal age of the participants). Each subtest represents an individual value that added up together make the Total KTK. Based on the Total KTK, the MQ of children was graded into one of the five groups:

- very low level of coordination (MQ≤70);
- low level of coordination (MQ=71-85);
- normal level of coordination (MQ=86-115);
- high level of coordination (MQ=116-130);
- very high level of coordination (MQ≥131).

Data processing methods

For all the variables, minimum (Min) and maximum (Max) values, mean values (M), standard deviation (SD), skewness (Sk) and kurtosis (Ks) were calculated. The normality of the distribution was conducted using the Shapiro-Wilk test (SW). To test the differences between the motor competence of children of different ages, the MANOVA and LSD post hoc test were used. The data analysis was conducted using IBM SPSS Statistics, version 20.0 (Inc., Chicago, IL, USA). The level of significance was set at $p \leq .05$.

RESULTS

The results presented in Table 2 show that the motor competence data were normally distributed, and this is supported by the lower values of the SW test. Based on the average values of the variable Total KTK, a low level of coordination among first grade children was observed. By individually investigating the variables of the KTK battery test, it is obvious that Walking backwards, Lateral movement platforms are in this category but they have a bormal level of coordination in the other two variables (Single-leg hopping, Two-legged lateral jumping). Children in the second grade showed better results, where in the Total KTK they showed normal coordination. In the rest of the four variables, the lowest values were in the variables Walking backwards (MQ=77.1) while the best results were in the variable Two-legged lateral jumping (MQ=109). Children in the third grade have decay of MQ values compared to other ages. Total KTK variable shows that children have a low level of coordination (MQ=74) and that value has been observed in other variables (Single-leg hopping, Walking backwards and Lateral movement platforms) while the best scores were obtained for Two-legged lateral jumping (MQ=94.2) as well as among second grade children. Fourth grade children indicate a similar trend, Total KTK indicates that they are in the category of low coordination, except the variable Two-legged lateral jumping (MQ=88.5) where higher values like in the other age groups were noticed.

Table 2 The main descriptive indicators of the motor competence of younger school age children

Class	Variable	Min	Max	M	SD	Sk	Ks	SW	p
	Single-leg hopping (freq.)	65	108	87.1	9.8	-0.2	-0.3	0.9	.79
	Walking backwards (freq.)	64	106	81.0	9.8	0.1	-0.2	0.9	.37
1	Two-legged lateral jumping (freq.)	74	120	93.3	12.2	0.5	-0.5	0.9	.07
	Lateral movement platforms (freq.)	60	107	80.0	12.4	0.3	-0.5	0.9	.19
	Total KTK (freq.)	61	100	81.0	10.5	0.0	-0.8	0.9	.63
	Single-leg hopping (freq.)	65	105	82.8	10.9	0.1	-0.4	0.9	.14
	Walking backwards (freq.)	57	110	77.1	12.3	0.7	0.6	0.9	.11
2	Two-legged lateral jumping (freq.)	62	136	109.0	17.9	-0.5	-0.4	0.9	.04
	Lateral movement platforms (freq.)	58	123	92.7	15.2	-0.4	-0.0	0.9	.39
	Total KTK (freq.)	51	118	87.3	15.4	-0.4	-0.0	0.9	.36
	Single-leg hopping (freq.)	48	93	75.1	11.3	-0.5	-0.1	0.9	.17
	Walking backwards (freq.)	51	100	71.7	13.6	0.3	-0.8	0.9	.11
3	Two-legged lateral jumping (freq.)	50	130	94.2	17.7	-0.4	-0.2	0.9	.35
	Lateral movement platforms (freq.)	51	114	78.7	15.1	0.0	-0.1	0.9	.27
	Total KTK (freq.)	42	102	74.0	13.8	-0.3	-0.1	0.9	.74
	Single-leg hopping (freq.)	44	94	71.7	11.9	-0.4	-0.2	0.9	.70
	Walking backwards (freq.)	52	105	81.5	11.6	-0.4	0.9	0.9	.24
4	Two-legged lateral jumping (freq.)	58	115	88.5	14.7	0.0	-0.5	0.9	.69
	Lateral movement platforms (freq.)	45	97	73.9	12.4	-0.4	0.1	0.9	.35
	Total KTK (freq.)	48	97	72.7	10.9	-0.3	0.3	0.9	.47

Legend: Min- minimum values; Max-maximum values; M-mean; SD-standard deviation; Sk-skewness; Kz-kurtosis; SW-Shapiro-Wilk test of normality of distribution; p-significance of the SW test set at level $p \leq .05$.

Table 3 shows the differences in the variables among different grades. The results show significant differences in the total system (F=8.3; P=.00). Moreover, there are differences in

the individual variables: Single-leg hopping (f=15.0; p=.00), Walking backwards (f=5.3; p=.00), Two-legged lateral jumping (f=11.7; p=.00), Lateral movement platforms (f=12.7; p=.00) and Total KTK (f=10.5; p=.00). The interesting detail observed in the means is a plateau, a slight increase followed by a decrease in the MQ values with an increase in age. The Total KTK for the first grade (MQ=81.0), the second grade (MQ=87.3), the third grade (MQ=74.0) and the fourth grade (MQ=72.7) schoolchildren show this finding. These findings indicate a negative trend of decline in the motor competence of children with increasing age. A similar trend was observed in the individual variables of the KTK battery.

Table 3 Differences in the motor competence between children of different ages

Variable	Class	M	SD	f	p
Single-leg hopping (freq.)	1	87.1	9.8	15.0	.00
	2	82.8	10.9		
	3	75.1	11.3		
	4	71.5	11.9		
Walking backwards (freq.)	1	81.0	9.8	5.3	.00
	2	77.1	12.3		
	3	71.7	13.6		
	4	81.5	11.6		
Two-legged lateral jumping (freq.)	1	93.3	12.2	11.7	.00
	2	109.0	17.9		
	3	94.2	17.7		
	4	88.8	14.8		
Lateral movement platforms (freq.)	1	80.0	12.4	12.7	.00
	2	92.7	15.2		
	3	78.7	15.1		
	4	73.8	12.6		
Total KTK (freq.)	1	81.0	10.5	10.5	.00
	2	87.3	15.4		
	3	74.0	13.8		
	4	72.7	10.9		
		F=8.3	P=.00		

Legend: M-arithmetic mean; SD-standard deviation; F-Wilks test of multivariate analysis of variance; P-statistical significance of multivariate analysis of variance; f-univariate analysis of variance test; p-statistical significance of univariate analysis of variance.

The differences between the pairs of all age groups (grades) are presented in Table 4 with the aim of finding significant differences. The post hoc LSD test shows the presence of differences in all the age groups. For the variable Single-leg hopping significant differences were found among first, third and fourth grade schoolchildren in the favour of first graders. Similar differences were found between second and fourth grade schoolchildren in favour of the second graders. For the variable Walking backwards significant differences were found between first and third grade schoolchildren in favour of the first graders. Similar results were found between second and third grade schoolchildren with better results for those in the second grade. For the variable Two-legged lateral jumping significant differences were found between first and second graders in favour of the older children. Furthermore, second grade schoolchildren were better than children in the third and fourth grade. For the variable Lateral movement platforms significant differences were found between first and second graders.

High values on this test were achieved by the second graders which influenced the differences with third and fourth graders in favour of the younger children. For the variable Total KTK, significant differences were found between first and second graders in favour of the second graders as well as differences between first and third and fourth graders, respectively, in favour of the younger children. Higher values achieved by second graders caused bigger differences compared to third and fourth graders in favour of the second graders.

Table 4 Differences between pairs of all ages of children in motor competence

Variable	(I) Class	(J) Class	MD (I-J)	SE	p
Single-leg hopping (freq.)	1	2	4.2	2.5	.09
		3	12.0	2.5	.00
		4	15.6	2.6	.00
	2	1	-4.2	2.5	.09
		3	7.7	2.5	.00
		4	11.3	2.6	.00
	3	1	-12.0	2.5	.00
		2	-7.7	2.5	.00
		4	3.6	2.6	.16
	4	1	-15.6	2.6	.00
		2	-11.3	2.6	.00
		3	-3.6	2.6	.16
Walking backwards (freq.)	1	2	3.8	2.7	.16
		3	9.3	2.8	.00
		4	-0.4	2.9	.88
	2	1	-3.8	2.7	.16
		3	5.4	2.7	.04
		4	-4.3	2.8	.12
	3	1	-9.3	2.8	.00
		2	-5.4	2.7	.04
		4	-9.7	2.8	.00
	4	1	0.4	2.9	.88
		2	4.3	2.8	.12
		3	9.7	2.8	.00
Two-legged lateral jumping (freq.)	1	2	-15.7	3.7	.00
		3	-0.8	3.7	.81
		4	4.5	3.8	.24
	2	1	15.7	3.7	.00
		3	14.8	3.6	.00
		4	20.2	3.7	.00
	3	1	0.8	3.7	.81
		2	-14.8	3.6	.00
		4	5.3	3.7	.15
	4	1	-4.5	3.8	.24
		2	-20.2	3.7	.00
		3	-5.3	3.7	.15

Variable	(I) Class	(J) Class	MD (I-J)	SE	p
Lateral movement platforms (freq.)	1	2	-12.6	3.2	.00
		3	1.3	3.2	.68
		4	6.2	3.4	.07
	2	1	12.6	3.2	.00
		3	14.0	3.1	.00
		4	18.8	3.3	.00
	3	1	-1.3	3.2	.68
		2	-14.0	3.1	.00
		4	4.8	3.3	.14
	4	1	-6.2	3.4	.07
		2	-18.8	3.3	.00
		3	-4.8	3.3	.14
Total KTK (freq.)	1	2	-6.2	3.0	.04
		3	7.0	3.0	.02
		4	8.3	3.1	.01
	2	1	6.2	3.0	.04
		3	13.3	2.9	.00
		4	14.6	3.0	.00
	3	1	-7.0	3.0	.02
		2	-13.3	2.9	.00
		4	1.2	3.0	.67
	4	1	-8.3	3.1	.01
		2	-14.6	3.0	.00
		3	-1.2	3.0	.67

Legend: MD-differences of arithmetic means; SE-standard error; p-statistical significance of LSD post hoc test.

DISCUSSION

After completing the research, which aimed to determine whether there are differences in motor competence between children of different school ages, as well as whether there is a negative trend of a decrease in these values with an increase in age in the population of children from Serbia, the results showed that there are statistical significant differences in all variables between children of different ages. Further analyses revealed that the differences were mainly observed in favour of younger children (first and second graders) compared to older (third and fourth graders). The second part of the research established a negative trend i.e. decay of the motor competence of children with increasing age, where younger children obtained better results compared to older ones, in the Total KTK variables. This has also been found in the previous studies (Vandorpe et al., 2011; Hardi et al., 2013; Tester et al., 2014; Ushtelenca, & Jarani, 2017; Adriyani, Iskandar, & Camelia, 2020). One of the reasons for these findings can be the lack of physical activities, insufficient physical education classes and lack of care of the whole society to solve this problem (Milojević, Marković, Gadžić, & Stanković, 2014). Another important piece of data is the MQ value, which is worse at all ages in relation to the average level of motor competence (MQ≈100) (Bardid et al., 2016; Škrkar, 2020), according to the standards found 45 years ago (Kiphard & Schilling, 1974). Our findings indicate that it is essential to develop a strategy that will allow bigger participation of children in order to stop this negative trend and bring children to at least an average level of development of motor competence. One

very important factor is more active participation and activation in the physical education classes of all teachers where they should have a careful and strategic development of individual classes in terms of planning and programming the teaching units (Zrnzević & Zrnzević, 2017). Therefore, changing the frequency and concept of its content could affect the improvement of children's motor competence, which could quickly and efficiently solve the set motor tasks in class. Other factors that would increase the motor competence of children are enrolment in sport clubs and decreasing the sedentary way of life. If that does not happen, technological development of the modern age will affect children's motor development and will cause even less physical activity (Kowalski, Crocker, & Donen, 2004) where children will develop more problems with cognitive development and social aspects of life (Piek, & Skinner, 2001).

CONCLUSION

The main finding of this research is that we have shown the presence of differences in motor competence in favour of younger children. Also, a negative trend of decay of the competences with increased age has been established, as well as a lower level of the competences compared to the standards set 45 years ago. It is highly recommended to increase the participation of teachers and children during physical education classes with the aim of improving the development of the motor abilities and competences of children through regular classes on a daily basis. We would like to acknowledge several limitations of this study. The sample size could be larger and could include more schools and more children. We did not have any insight into the efficiency of the physical education classes and the compliance. The last limitation is that we used only certain tests. Future studies could include more tests to confirm the reliability of these tests. The KTK battery of tests can be used to identify individuals that are experiencing delayed motor development and based on that can be prescribed individual work in terms of improving their motor competence.

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RAZLIKE U MOTORIČKIM KOMPETENCIJAMA DECE MLAĐEG ŠKOLSKOG UZRASTA

Cilj rada bio je da se utvrdi da li postoje razlike u motoričkim kompetencijama između dece različitog školskog uzrasta, kao i da li postoji negativan trend u opadanju tih vrednosti sa povećanjem uzrasta dece iz Srbije. Istraživanje je realizovano u školskoj sredini, uzorak ispitanika sačinjavalo je 151 učenik muškog i ženskog pola, uzrasta 7-11 godina, podeljenih u četiri približno jednaka subuzorka: učenici prvog razreda N=36 (7.4±0.3 years, Mean±SD), učenici drugog razreda N=41 (8.5±0.3 years, Mean±SD), učenici trećeg razreda N=40 (9.4±0.3 years, Mean±SD) i učenici četvrtog razreda N=34 (10.4±0.3 years, Mean±SD). Instrument koji se koristio u istraživanju je KTK baterija testova, koja procenjuje koordinaciju celog tela, a namenjena je za decu uzrasta 5-14 godina. Test je međunarodno standardizovan i sastoji se od 4 podtesta iz kojih su proistekle sledeće varijable: Jednonožno preskakanje, Hodanje unazad, Bočni sunožni skokovi, Bočno premeštanje platforimi i Ukupan KTK. Multivarijatna analiza varijanse (MANOVA) pokazala je da postoje statistički značajne razlike između učenika svih uzrasta u svim testiranima varijablama, u ukupnom (P=.00) i pojedninačnom sistemu varijabli (p=.00). Ovi nalazi su takođe ukazali i na negativan trend opadanja motoričkih kompetencija dece sa povećanjem uzrasta. Sličan trend je primećen i u pojedinačnim varijablama KTK baterije. Preporuka je da je evidentno potrebno veće angažovanje nastavnika i učenika na časovima fizičkog vaspitanja sa ciljem pospešavanja razvoja motoričkih kompetencija dece kroz redovne fizičke aktivnosti na nastavi.

Ključne reči: *motoričke kompetencije, KTK, osnovna škola*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 305 - 310
https://doi.org/10.22190/FUPES200520028S

Professional article

EDUCATIVE ASPECTS OF DOPING PREVENTION IN SCHOOL-AGED CHILDREN AND ADOLESCENTS

UDC 796.011.5:178
796-053.2

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Abstract. *The aim of this study was to provide an overview of doping prevention strategies in school-aged children and adolescents. To preserve the spirit of sport, the Anti-Doping Code requires that each anti-doping organization should develop and implement education and prevention programs for athletes, including the young and support staff. Education programs that encourage respect, equity, and inclusion, are closely related to fairness and should be implemented in school-aged children. The focus on school-aged children is essential, since early adolescence is a critical stage associated with a distorted body image (muscle dysmorphia), which in turn can lead to deliberate use of prohibited substances (mostly androgenic anabolic steroids) or methods. Since adolescents are focused on the "here" and "now", the conception of anti-doping programs should emphasize the adverse effects of doping at the early stage of use, as well as a high probability of health consequences. Encouraging prevention should raise awareness of the recipients about adverse effects, which in turn should produce anti-doping behavior. Moreover, the goal of preventive actions should be the development of self-esteem, which equals the observance of rights and values of other people, and the ability to refuse through the strategy termed "A way to say: No".*

Key words: *Sports, Prohibited Substances and Methods, Anti-Doping Programs*

INTRODUCTION

Anti-doping programs are implemented with the aim to preserve the essential value of sport. That essential value is often termed “the spirit of sport” and it represents the bedrock of Olympism (International Olympic Committee, 2012). Doping is fundamentally opposed to the spirit of sport. To preserve the spirit of sport, the Anti-Doping Code requires that each anti-doping organization should develop and implement education and prevention programs for athletes, including the young and support staff (United Nations Educational Scientific and

Received May 20, 2020 / Accepted July 21, 2020
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Cultural Organization-UNESCO, World Anti Doping Agency-WADA, Olympic Foundation for Culture and Heritage, International Council of Sport Science and Physical Education, & Foundation-ICSSPE, 2019). The objective of information and education anti-doping programs is to prevent the use of prohibited substances and prohibited methods in sports. The focus of information programs should be oriented towards providing fundamental information to athletes, including updated and accurate information on substances and methods on the Prohibited List, anti-doping rule violations, consequences of doping, doping control procedures, athletes' and athlete support staff's rights and responsibilities (WADA, 2019). Education programs should be directed towards athletes and support staff, with special attention paid to the approach to young people through school programs (WADA, 2020). Prevention programs should be oriented primarily towards young individuals, and should be appropriately conceived to match their age, schools, sports clubs, parents, adult athletes, sports officials, coaches, medical support staff, and the media.

The aim of this study was to provide an overview of doping prevention strategies in school-aged children and adolescents. Theoretical considerations of the problem.

THEORETICAL CONSIDERATIONS OF THE PROBLEM

Prevention among school-aged children

The leading international partner organizations initiated a number of activities in 2019 under the common name "Sport values in every classroom", directed towards children aged 8 to 12 years (UNESCO et al., 2019). The aim of this global campaign was to instill the values of respect, equity and inclusion in school-aged children.

Respect involves acceptance of the customs and cultures which differ from one's own; accepting someone or something without attempting to change or harm it; and showing politeness, honour, and care for someone or something. In line with this, activities address attitudes and behaviors that should foster dignity, care for oneself and others, and encouragement of thinking about emotions, ethical (moral) dilemmas, as well as rights and duties (UNESCO et al., 2019).

Equity in sports refers to an equal approach, recognition of inequity and taking steps to resolve it. Equity requires continual cultural and structural changes in sport, ensuring equal accessibility to all members of a society, regardless of their age, ability, gender, race, ethnic background, sexual orientation, or socioeconomic status (Lyras & Hums, 2009). Equity activities foster openness to different people and things, and overcome prejudice, moving forward in the understanding and acceptance that all people are equal. Such activities promote equality of opportunity to all people, allowing them to fulfill their potentials and understand the importance of the concept of equal opportunities for all.

Inclusion is closely associated with righteousness. Both these values act towards overcoming differences, insisting upon equal rights for all, regardless of individual characteristics. Collectively, education programs that encourage respect, equity, and inclusion are closely related with fairness and should be implemented among school-aged children.

Prevention in adolescence

Adolescence is a period of transition from immaturity of childhood to maturity of adulthood. It starts with the first signs of puberty, and is completed when a person reaches an

appropriate level of maturity and independence (Kipke, 1999). During adolescence, numerous physiological, cognitive, social and emotional changes occur; these changes are individual and that is the reason why adolescence cannot be clearly delineated – it may last from the age of 11 or 12, to the age of 20 or even 25. Adolescence and puberty are not synonymous, since puberty refers to physical and physiological changes associated primarily with the development of reproductive functions under the influence of hormones (Galvan, 2017).

Adolescence is a critical stage associated with a distorted body image, which in turn can lead to deliberate use of prohibited substances [mostly androgenic anabolic steroids (AAS)] or methods. AAS, synthetic derivatives of the male hormone testosterone are among the most commonly used drugs by amateur and recreational (non-competitive at the international or national level), adolescent athletes who suffer from muscle dysmorphia (Cerea, Bottesi, Pacelli, Paoli, & Ghisi, 2018). Muscle dysmorphia is a pathological condition in which an individual believes that one's body is not sufficiently muscular, that it is smaller or weaker than it objectively is. Even an insignificant loss of muscle mass is very difficult to accept by individuals with muscle dysmorphia. Furthermore, Baker et al. (2019) have noted that muscle dissatisfaction is greater than height dissatisfaction. The users follow dosage regimens involving different AAS, their combinations, but also other pharmaceutical substances for which they believe can supplement the desired effects upon their skeletal muscles or to reduce adverse effects (Mullen, Whalley, Schifano, & Baker, 2020). Although AAS misuse is often used to manage muscle dysmorphia, recent evidence suggests (Jampel, Murray, Griffiths, & Blashill, 2016) that boys who perceive themselves as overweight may also be at risk for AAS misuse, with the aim to reduce their fat mass and preserve or increase lean body mass. Growing evidence suggests that AAS users develop dependence syndrome (around 30%), involving constant use of these substances despite the occurrence of adverse effects (Kanayama, Brower, Wood, Hudson, & Pope Jr, 2009).

A lack of self-esteem and a distorted body image increase the probability of AAS misuse in order to achieve the desired outward appearance as fast as possible (Mitić & Radovanović, 2011; Griffiths, Jacka, Degenhardt, Murray, & Larance, 2018). In addition, a lack of social intelligence and/or teasing by their adolescent peers may underpin the increased risk of AAS misuse. In that case, a person undertakes all the steps to enhance physical appearance, including doping, and upon that forms their personality and functioning. As a result, athletes compensate for low self-esteem with their physical appearance. Long-term use or excessive doses of AAS, or other performance enhancing drugs, may produce health risks (Kersey et al., 2012), requiring drug withdrawal and consequent loss of muscle mass. Since muscle mass is the bedrock of psychological functioning in dependent users and in view that psychosocial competences have not been developed to face life outside the training room, serious psychological crises may occur. Psychological treatments are essential in order to prevent or treat depressive disorders and suicidal thoughts occurring after the loss of that false support of personal functioning. Adolescents with depression are in six times greater risk of substance abuse compared to healthy peers (Costello, Egger, & Angold, 2005 in Grujičić & Pejović Milovančević, 2019).

The probability that amateur and recreational (non-competitive at the international or national level) adolescent athletes will misuse performance-enhancing drugs is greater if there is an opinion that: 1) the consequences of doping occur only rarely and only for some individuals, 2) the adverse effects occur only after several years of doping, 3) the adverse effects of doping disappear soon after the cessation of doping, 4) physical and psychic consequences are not so serious, and 5) that doping-related warnings are exaggerated.

Therefore, the conception of anti-doping programs oriented towards adolescents should emphasize the adverse effects of doping at early stage of use (since adolescents are focused on the "here" and "now"), as well as the high probability of health consequences (Mitić & Radovanović, 2011). Encouraging prevention should raise awareness of the recipient about the adverse effects, which in turn may produce anti-doping behaviour (Donovan, Egger, Kapernick, & Mendoza, 2002). The information about the harmful effects of doping substances should be as flexible (tailored to fit the target population: risk factors, developmental stage) and vivid as possible, with most striking examples of the doping practices (Backhouse, Patterson, & McKenna, 2012). Adolescents should be adequately warned about all possible consequences of doping, using adequate photographs and video material and, if feasible, engaging individuals readily recognized by adolescents from the media or the like.

Doping in sport is a widespread problem not only in amateur and recreational adolescent athletes, but also among athletes in the transition to official competitive levels (national or international). That is the reason why during training sessions priority should not be given to winning at all costs; instead, the conditions and environment should be created for the adolescent to develop properly in the physical, psychological and social sense. Certain psychological factors in an individual definitely have a significant impact on the probability of use of doping substances. One of these is fear of failure, manifested as the constant anxiety of a person that they will fall short of one's own and other people's expectations. Fear of failure in adolescents is often a combination of stress, anxiety and perfectionism (Gustafsson, Sagar, & Stenling, 2017). In this context, perfectionism implies that a person is often unable to discriminate between real and idealized standards. Another factor is low self-esteem, reflected in a doubt in one's own abilities, which a person tries to overcome by a desired outward appearance and aggressivity. The third factor is denoted as the "superman complex", and it involves an adventuristic understanding of doping, with an exaggerated underestimation of the long-term adverse effects of doping. The presence of the factor can often be heard in statements such as "I will only try it", "it is not that harmful", "adverse effects may not occur in my case". Professors of physical education and coaches should have special training to be able to recognize behavioral symptoms in their students or clients as potential users of doping substances. The most common symptoms in adolescent users of doping substances are frequent mood changes, excessive physical training, obsession with dieting, rapid increase in physical abilities, total body mass and muscle mass, aggressivity and various risk behaviors (Mitić & Radovanović, 2013).

CONCLUSION

In the last three decades, the use of doping substances by adolescent athletes (recreational, amateur, in the transition to official competitive levels) has become a widespread problem. Since the use of doping frequently starts in the period of early adolescence, school-based doping prevention programs should be introduced. All the adverse effects of doping on physical and psychological health should be explained in detail in a flexible, vivid and concrete way, stressing the seriousness and long-lasting nature of these effects. The goal of preventive actions should be the development of self-esteem, which equals the observance of rights and values of other people, and the ability to refuse through the strategy termed "A way to say: No".

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EDUKATIVNI ASPEKTI DOPING PREVENCIJE KOD DECE ŠKOLSKOG UZRASTA I ADOLESCENATA

Cilj ovog rada bio je da pruži pregled strategija prevencije dopinga kod dece i adolescenata. Da bi se očuvao sportski duh, Antidoping kodeks zahteva da svaka andidoping organizacija razvija i implementira edukativne i preventivne programe za sportiste, mlade i pomoćno osoblje. Edukativni programi koji podstiču poštovanje, jednakost i inkluziju usko su povezani sa pravednošću i trebalo bi ih implementirati kod dece školskog uzrasta. Usredsređenost na decu školskog uzrasta je od suštinskog značaja, budući da je rana adolescencija kritična faza povezana sa iskrivljenom slikom telesnog izgleda (mišićnom dismorfijom), što može dovesti do namerne upotrebe zabranjenih supstanci (najčešće androgenih anaboličkih steroida) i metoda. Obzirom da su adolescenti fokusirani na "ovde" i "sada", koncenpcija antidoping programa treba naglasiti da štetne posledice nastaju vrlo brzo nakon početka korišćenja doping supstanci i da je verovatnoća javljanja štetnih posledica po zdravlje velika. Podsticanje prevencije treba da podigne svest o štetnim efektima, tako da se oni teže odluče za njihovu upotrebu. Takođe, cilj preventivnog delovanja treba da bude na razvoju samopoštovanja, koje je jednako poštovanju prava i vrednosti druge osobe, kao i sposobnosti odbijanja kroz tzv. strategiju „način da se kaže: Ne".

Ključne reči*: sport, zabranjene supstance i metode, antidoping programi*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 311 - 322
https://doi.org/10.22190/FUPES200515029C

Research article

THE RELATIONSHIP BETWEEN BREAKFAST CONSUMPTION AND BASKETBALL SHOOTING PERFORMANCE

UDC 613.2:796

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Abstract. *The purpose of this study is to explore a possible relationship between breakfast consumption and basketball shooting performance. Eighteen male subjects (height=191.5±10.1 cm, mass=93.8±12.1 kg, age=27.5±10.6 years) with considerable amount of basketball playing experience were divided into two groups, with (BF) and without (No-BF) four-day breakfast consumption in a three-week cross-over study design. Subjects completed free throw, 2-point, and 3-point shooting drills on the fourth day of each week. Food intake records were collected during each treatment phase. Paired sample t-tests were used to examine the difference in basketball shooting performance (free throw, 2-point, and 3-point drills) and dietary intake patterns (calories, carbohydrates, proteins, and fats) between BF and No-BF testing weeks. Cohen's D effect sizes were calculated to determine the magnitude of the breakfast consumption as an experimental factor. The average amount of calories, carbohydrates, proteins, and fats that the subjects consumed during the breakfast omission week was significantly lower when compared to the breakfast consumption week. Even though the overall basketball shooting performance was improved during the breakfast consumption week, only the average free throw shooting accuracy revealed statistically significant results. However, the effect sizes for almost all the dependent variables exhibited small to moderate magnitudes. Considering that basketball players are always looking for ways to improve their shooting performance, a well-balanced diet with habitual breakfast consumption may be a beneficial method for individual and team performance enhancement, which can ultimately lead to increased chances of a successful game outcome.*

Key words: *Sport, Performance, Accuracy, Nutrition, Fatigue*

Received June 15, 2020 / Accepted August 31, 2020
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INTRODUCTION

For a long time, breakfast has been considered one of the most important meals of the day (Mahoney, Taylor, Kanarek, & Samuel, 2005; Affenito, 2007; O'Neil et al., 2014; Clayton & James, 2016). It is defined as a meal that breaks an overnight fast and it should be optimally consumed within two to three hours from waking up (O'Neil et al., 2014). Previous research suggested that the energy contribution of breakfast to the entire daily calorie intake should be approximately 20-35% (O'Neal et al., 2014). Interestingly, besides having caloric value similar to all other main meals consumed during the day, breakfast consumption has been associated with improvements in the overall diet quality (Affenito, 2007; O'Neal et al., 2014). It is recommended that a well-balanced and optimally prepared breakfast should contain all three major macronutrients with greater emphasis placed on featuring rich complex carbohydrate sources (O'Neal et al., 2014). Mahoney et al. (2005) findings further support previously mentioned literature while also highlighting that adding protein and fiber-rich food items may additionally contribute to prolonged energy supply.

Frequently, when we think about sports performance enhancement, we place the main emphasis on the development of physiological characteristics and commonly disregard the existent cognitive influence. Speed of perception, response time, balance, coordination, selective attention, and visuospatial orientation are some cognitive components that can play a potential role in determining the capability of an athlete to compete at a specific level of competition (Parlić et al., 2018). Even though more work needs to be done in addressing cognitive improvements of various sport-specific tasks, there is a considerable amount of research supporting a strong relationship between breakfast consumption and cognitive performance quantified by improvements in academic performance (Mahoney et al., 2005; Hoyland, Dye, & Lawton, 2009; Cooper, Bandelow, & Nevill, 2011; Copper, Cooper, Bandelow, Nute, Morris, & Nevill, 2012; O'Neil et al., 2014). Cooper and colleagues (2011) found that breakfast consumption enhanced cognitive function when compared to breakfast omission. Besides the self-reported increase in energy levels and a decrease in fatigue perception, significant improvements in the accuracy of cognitive tests such as the visual search test and Stroop test were observed for subjects assigned to *ad libitum* breakfast consumption trials (Cooper et al., 2011). Similar findings emerge in a follow-up study conducted on adolescent school children denoting that breakfast with a low glycemic index was the most beneficial for improvements in the accuracy of cognitive ability tests when compared to breakfast with a high glycemic index and breakfast omission (Cooper et al., 2012). To couple with previous research findings, Mahoney et al. (2005) found that together with improvements in standardized cognitive test scores, breakfast consumption can be highly beneficial for strengthening performance on complex visual tasks. In one of the studies conducted on high school children, researchers found that visuospatial performance following breakfast consumption significantly improved when compared to breakfast omission (Widenhorn-Müller, Hille, Klenk, & Weiland, 2008). So, considering that breakfast consumption can significantly improve cognitive abilities, athletes participating in various sporting events might benefit from well-balanced and regular breakfast consumption. Alongside cognitive performance improvements, it is important to reflect on a decent quantity of research projects addressing the positive relationship between breakfast consumption and positive mood states (Benton & Parker, 1998; Widenhorn-Müller et al., 2008; Veasey, Haskell-Ramsay, Kennedy, Tiplady, & Stevenson, 2015). The

inability of athletes to achieve optimal mood states may have a negative impact on their overall well-being which can further diminish peak athletic performance capabilities. Hence, considering that basketball is a complex game that besides optimal physical and physiological characteristics requires a considerable amount of cognitive involvement, breakfast consumption might be able to positively impact one of the key tasks that require high precision and accuracy - basketball shooting.

Another important factor that needs to be considered is the ability of breakfast to contribute to the overall calorie requirements necessary to support all energy needs. Previous research found that breakfast omission is associated with diminished daily calorie intake and reduction in exercise performance (Clayton, Barutcu, Machin, Stensel, & James, 2015; Clayton & James, 2016). If the exercise session is scheduled in the morning, the optimal time frame to consume breakfast is 1-4 hours before the start of exercise (Clayton & James, 2016). The decreased amount of daily energy contribution caused by breakfast omission is unlikely to be compensated throughout the rest of the day which may have a negative effect on athletes looking to improve their performance (Clayton & James, 2016). Basketball is a game based on repetitive stop-and-go motions, where considerable emphasis is placed on precision, accuracy, timing, and agility (Hoffman & Maresh, 2000). Due to the nature of the game, the energy requirements are supplied from both aerobic and anaerobic sources which mainly include fat and carbohydrate dietary sources (Hoffman & Maresh, 2000). Decreased fat consumption has been linked with impaired endurance performance (Venkatraman, Feng & Pendergast, 2000) while also being associated with an overall decrease in calorie consumption (Horvath, Eagen, Fisher, Leddy & Pendergast, 2013). Despite non-ergogenic benefits, pre-exercise fat consumption has been positively correlated with the reduction of carbohydrate utilization during exercise (Hargreaves, Hawley & Jeukendrup, 2004). Although various styles of coaching can potentially influence the overall energy requirements, carbohydrates have been considered the main fuel source (Baar et al., 2013). However, unlike fat, carbohydrate energy sources are limited energy supplies and are highly dependent on the amount of glycogen stored in skeletal muscles and the liver. Previous research has shown that insufficient levels of muscle and liver glycogen content are associated with the quicker onset of fatigue and a decrease in the overall power output and work capacity (Clayton et al., 2015; Williams & Rollo, 2015). While carbohydrates present the main energy source for various sports involving repetitive stop-and-go motions such as basketball, we need to be aware of protein contribution to the overall energy production process, more from an energy support standpoint than as an energy supplier. To this point in time, there is a considerable amount of scientific literature addressing the importance of post-exercise protein consumption, while pre-exercise protein consumption stays vastly underexamined (Ormsbee, Bach, & Baur, 2014). Based on current research knowledge, it is suggested that pre-exercise protein consumption can further improve glycogen synthesis and positively contribute to the overall energy metabolism during exercise (Ormsbee et al., 2014).

To analyze and find ways to optimize basketball performance, we should be aware of performance variables that are highly linked to the final game outcome. Researchers found that in both balanced and unbalanced games 2-point field goals were able to successfully discriminate between the winning and losing team (Lorenzo, Gómez, Ortega, Ibáñez, & Sampaio, 2010). The winning team had a higher number of successful 2-point shooting attempts, while the overall shooting percentage was also superior when compared to the losing team (Lorenzo et al., 2010). This may lead us to assume that a

winning ability could be related to greater fatigue resistance capabilities as the winning team had more offensive opportunities while also being able to achieve greater overall shooting accuracy. While the findings of Pojskić, Šeparović, & Užičanin (2009) further support the importance of proficient 2-point shooting performance, they also indicate that successful shooting performance of bench players as well as those in the starting line-up can be a valuable factor in distinguishing between victorious and defeated teams. During elite basketball championship performance analysis, researchers found that 3-point percentage was one of the crucial determinants for the successful final game outcome (Trninić, Dizdar, & Lukšić, 2002). Additionally, with similar methods of in-game analysis as mentioned in the previous studies, Csataljay, O'Donoghue, Hughes, & Dancs (2009) found that the ability to secure free throw opportunities as well as a higher percentage of the successfully executed free throw of shots at the elite level of basketball competition was highly related to a greater final score of the game. Even though other factors can significantly impact the final game outcome such as turn-overs, steals, and offensive and defensive rebounds, based on the previously mentioned findings we can conclude that a successfully executed free throw, 2-point, and 3-point shots can serve as a solid predictor of the final game outcome (Ibáñez, Sampaio, Sáenz-López, Giménez, & Janeira, 2003; Csataljay et al. 2009; Pojskić et al. 2009; Lorenzo et al., 2010; García, Ibáñez, De Santos, Leite, & Sampaio, 2013).

Given the combination of all positive properties that breakfast may have on an individual, it is logical that basketball players consume a well-balanced breakfast on a daily basis to potentially increase their cognitive abilities and achieve optimal energy levels necessary for delayed onset of fatigue. To our knowledge, there are no research projects that observed the potential effect of breakfast consumption on basketball shooting performance.

Hence, the purpose of this study is to explore a possible relationship between breakfast consumption and basketball shooting performance, i.e., to explore if basketball shooting performance during the free throw, 2-point, and 3-point shooting drills can be augmented after breakfast consumption.

METHODS

Subjects

Eighteen male subjects (height=191.5±10.1 cm, mass=93.8±12.1 kg, age=27.5±10.6 years) with a considerable amount of basketball playing experience volunteered to participate in this research study. Subjects with any metabolic conditions or musculoskeletal injuries were excluded from participating in the study. All procedures performed in this research study were previously approved by the University's Institutional Review Board Committee.

Diet Protocol

The study was designed over three weeks starting with a pre-testing procedure. The first week was designed as a familiarization week where the subjects were not exposed to any intervention. The following week, the subjects were randomly assigned into two groups. Group 1 performed basketball shooting drills during the second week without breakfast

consumption (No-BF), while Group 2 consumed breakfast (BF) for four consecutive days. During the third week of the intervention both groups switched treatment in a cross-over fashion. The subjects were asked to keep the same dietary pattern as their typical diet routine, including *ad libitum* eating patterns during meals. In addition, during the pre-testing week the subjects were individually trained on how to complete proper dietary records including meal timing, portion size, and type of preparation. The subjects were asked to record any kind of food and fluid consumed throughout the day. The breakfast that the subjects were instructed to consume was mostly composed of carbohydrates with smaller amounts of protein. The number of macronutrients provided during breakfast was specifically determined by the mass of the subject. Based on the International Society of Sport Nutrition guidelines, the breakfast that the subject was suggested to consume should be composed of 0.75-1.2 g/kg of carbohydrates, 0.2-0.3 g/kg of protein and a small percentage of fat content (Kreider et al., 2010). The subjects were provided with a detailed list of appropriate breakfast options that correspond to the previously mentioned criteria. Food intake records were collected each week on Thursday at the same individualized time. Three-day complete dietary records (Monday-Tuesday-Wednesday) were used for dietary analysis. The Nutritional Data System for Research (NDSR Software, Minneapolis, MN) was used to analyze all food intake records in order to obtain an estimate of calories and macronutrients that the subjects consumed during each day.

Exercise Protocol

Upon completion of a standardized warm-up procedure, the subjects were asked to complete three shooting drills that have been previously validated for shooting accuracy and fatigue (Pojskić, Šeparovic, & Užičanin, 2011). The first drill was a free-throw shooting drill designed to test shooting accuracy without a fatigue component. The subjects were asked to shoot three sets of 10 free-throws (4.57 m) with a three-minute break between the sets. The two-point shooting drill was designed to test shooting accuracy with a fatigue component. The subjects were asked to shoot from five different spots marked with plastic cones for a period of 60 seconds. Each subject started at the cone numbered “1” under the basket and ran to the cone numbered “2” at the right corner where he received the ball from the passer. After the shot, the subject quickly returned to cone numbered “1” and ran to the cone numbered “3” at the “45-degree spot” where he received the ball from the passer again. All cones were positioned exactly five meters away from the rim (right corner, right 45 degrees, center, left 45 degrees and left corner). The pattern of the drills was repeating in both directions until the 60 seconds ran out. The three-point shooting drill was designed to test shooting accuracy with a fatigue component in the same pattern as the second drill, except the cones where the subjects are shooting from are positioned on a women's three-point line (6.325 m). A stopwatch was used to measure the time for the athlete to perform a specific basketball shooting drill. During every shooting drill a rebounder was present in order to preserve the subject’s energy and assure an optimal focus directed towards the shooting motion. All shooting testing procedures were done on Thursday each week at the same individualized time. All subjects performed the shooting drills with a standardized size seven basketball. The research assistant recorded the number of shots made and attempted for each drill. In order to eliminate any kind of distraction potentially caused by other players on the court, the subjects performed the shooting drills individually.

Variables Sampled

This study was focused on observing twelve dependent variables, four dietary intake and eight basketball shooting performance variables. The *free throw average* variable represents the average number of free-throw shots made during each set of 10 free-throws. The *2-point attempts* and the *3-point attempts* variables represent the overall number of 2-point and 3-point shots attempted during the 60-second time period, respectively. In a similar manner, the *2-point shooting percentage* and *3-point shooting percentage* variables represent the shooting accuracy for 2-point and 3-point shooting drills expressed as a percentage of the total number of 2-point and 3-point shots attempted. The *overall attempts* variable represents a combined number of shots that each subject attempted during 2-point and 3-point shooting drills. The *overall made shots* variable represents the sum of made free-throw, 2-point, and 3-point shots, while the *overall shooting percentage* variable represents the shooting accuracy across all basketball shooting drills expressed as a percentage of the total number of attempted shots. The *calories* variable, expressed in kilocalories (kcal), represents the average amount of nutritional energy consumed, while the *carbohydrate*, *protein*, and *fat* variables, expressed in grams (g), represent the average amount of each macronutrients consumed during each of the intervention periods.

Statistical Analysis

Paired sample t-tests were used to examine the difference in basketball shooting performance (free throw, 2-point, and 3-point drills) and dietary intake patterns (calories, carbohydrates, proteins, and fats) between BF and No-BF testing weeks. Cohen's D effect sizes were calculated to determine the magnitude of the breakfast consumption as an experimental factor. Due to the exploratory nature of this study, the statistical significance level was set to $p<0.10$. Statistical analysis was conducted with the SPSS statistical package Version 25.0 (SPSS Inc. Chicago, IL, USA).

RESULTS

Mean values and standard deviations (X±SD), p-values, and Cohen's D effect sizes for each of the basketball shooting performance and dietary intake variables are presented in Table 1. The only statistically significant difference in basketball shooting performance was observed for the free throw shooting accuracy. Despite noticeable differences in the accuracy and fatigue components of the 2-point and 3-point shooting drills, no other statistically significant differences in basketball shooting performance variables were observed. However, Cohen's D effect size magnitudes for all of the shooting performance variables examined in this study demonstrated small to moderate magnitudes, except for the 2-point shooting percentage. The average amount of calories, carbohydrates, proteins, and fats that the subjects consumed during the BF week was significantly greater when compared to the No-BF testing week. Based on Cohen's D effect sizes, the differences in dietary data-dependent variables between the BF and No-BF week demonstrated moderate to strong magnitudes.

Table 1 Mean values and standard deviations (X±SD), p-values, and Cohen's D effect sizes for dietary intakes and basketball shooting performance variables

Dependent variables	BF	No-BF	p-value	Cohen's D
Free throw average	8.0 ± 1.4	7.3 ± 1.9*	0.06	0.47
2-point attempts	11.2 ± 0.19	11.0 ± 1.1	0.26	0.31
2-point shooting %	57.4 ± 17.0	55.9 ± 21.3	0.78	0.09
3-point attempts	9.7 ± 0.7	9.5 ± 1.0	0.45	0.22
3-point shooting %	47.9 ± 20.8	40.9 ± 23.3	0.43	0.34
Overall attempts	20.9 ± 1.4	20.5 ± 2.0	0.26	0.31
Overall made shots	35.1 ± 7.2	32.6 ± 10.0	0.19	0.35
Overall shooting %	68.7 ± 13.6	64.0 ± 18.3	0.19	0.35
Calories (kcal)	2034.6 ±595.0	1659.9 ±363.2*	0.02	0.63
Carbohydrate (g)	226.7 ± 67.4	186.5 ± 54.4*	0.02	0.60
Protein (g)	101.1 ± 37.3	81.7 ± 17.8*	0.03	0.52
Fat (g)	80.3 ± 30.9	63.6 ± 18.7*	0.06	0.54

Legend: BF-breakfast consumption testing week; No-BF-breakfast omission testing week; statistical significance set at the level $p<0.10$.

DISCUSSION

To our knowledge this was the first study that examined the relationship between breakfast consumption and basketball shooting performance. Despite the considerable amount of research focused on emphasizing the importance of breakfast for optimal energy availability and cognitive functioning, there is a remaining gap in scientific literature addressing the relationship between breakfast consumption and sports performance. Based on the findings of this study we were able to observe a potential positive effect of breakfast on basketball shooting performance. While noticeable improvements were present for each of the shooting drills examined in this study during the BF testing week, only free throw shooting accuracy unveiled a statistically significant difference. Considering that previous research found that winning teams successfully performed more free throw shots compared to the opponent (Trninić el al., 2002; Ibáñez et al., 2003; Lorenzo et al., 2010), we may be able to assume that breakfast consumption can have a positive impact on the increased winning probability. This may be especially beneficial within the modern style of basketball play where the meaningful emphasis is placed on long-distance 3-point shots and 2-point scoring opportunities around the basket. Dribbling down the lane for a lay-up or a dunk opportunity seems like a more efficient way of scoring than shooting mid-distance 2-point shots. Besides the increase in the field goal scoring opportunity, this approach can greatly increase the chances of foul commitment by the defender and put the offensive player in the position to shoot more non-contested free throw shots as a high probability scoring opportunity. Thus, if breakfast consumption is capable of eliciting positive effects on free throw shooting performance through improvements in cognitive abilities and sustained fatigue resistance mechanisms, we may assume that the team will be in a better position to secure the successful game outcome.

Besides solely being focused on the interpretation of statistically significant results, we need to be aware of the effect sizes as an index used to quantify the practical significance of the research findings (Hojat & Xu, 2004). When we refer to practical significance, we are mainly addressing how useful the results are in the real world, while

statistical significance is mainly based on examining whether the outcome of the results is due to the chance or sampling variability (Kirk, 1996). In 2007, Atkinson emphasized the importance of practical significance, especially in the sport and exercise science field, while suggesting that inferences should be based more on an estimation of true effect sizes than solely on statistical significance. There are many examples in sport where small advancements in performance variables can be crucial for an athlete's success and may be able to determine the difference between a successful inferiorly qualified athlete or team. So, knowing that basketball is a game of percentages, moderate effect sizes observed for the majority of the basketball shooting drills examined in this study may lead us to assume that breakfast consumption could be a useful choice that athletes should habitually implement in order to optimize their basketball shooting accuracy and improve fatigue resistance. Based on our findings, basketball players were able to increase their 3-point shooting percentage by approximately 7% during the BF week when compared to the No-BF testing week. If we take into account that a good 3-point shooting percentage is generally considered to fall within the 30-40% range, improvements induced by breakfast consumption such as observed in this study may be able to serve as an effective contributor for achieving peak basketball shooting performance. Based on the previous research findings, besides 3-point shooting performance being one of the crucial factors for determining a successful game outcome (Ibáñez et al., 2003; Csataljay et al. 2009), Lorenzo and colleagues (2002) discovered that successful teams had an approximately 5% greater 3-point shooting percentage when compared to unsuccessful teams. Even though improvements in the 3-point shooting percentage was greater when compared to the 2-point shooting drill, the subjects were still able to maintain approximately 2% higher basketball shooting accuracy during the BF week when compared to the No-BF week. Hence, if improvements in shooting performance such as observed in this exploratory research study can be translated into a real game setting, we can conclude that regular consumption of well-balanced breakfast may have a positive relationship with the improvements in individual basketball shooting performance that would ultimately lead to the enhanced team winning probabilities.

Based on the daily dietary food records analysis, drastic statistically significant differences, as well as effect sizes, were observed for the overall daily calorie, carbohydrate, fat, and protein intakes between the BF and No-BF testing weeks. Our data is in agreement with previous research findings obtained from a cohort of recreationally active adult males suggesting that the overall energy intake was suppressed for approximately 19% during the breakfast omission trial (Clayton et al., 2015). When researchers examined the impact of breakfast omission on the overall daily calorie intake within a cohort of elementary school children, they found that students who skipped breakfast had an approximate 400 calory deficiency in their total daily energy consumption (Nicklas, Bao, Webber, & Berenson, 1993). Furthermore, these individuals were also unable to make up for the difference in caloric intake throughout the day (Nicklas et al., 1993). Even though the subjects who participated in this exploratory research study were adult male basketball players, we were able to perceive a similar pattern of decline in the total daily energy consumption during the breakfast omission week as well as an inability to overcompensate for the missed energy intake opportunity. In one of the recent research studies, Nikić, Pedišić, Šatalić, Jakovljević, & Venus (2014) found that the mean caloric intake of elite-level junior basketball players was significantly higher when compared to the non-athletic population. These findings are completely predictable when taking into account that supplementary caloric intakes are required to support additional physical activity requirements and delay the onset of fatigue. Thus, based on our findings, we

may be able to assume that insufficient energy availability during the No-BF week induced with breakfast omission could be positively correlated with the decrease in the free throw, 2-point, and 3-point basketball shooting performance.

Besides the overall caloric intake, Clayton and colleagues (2015) analyzed the total daily macronutrient energy contribution and found that subjects who regularly consumed a well-balanced breakfast had significantly higher carbohydrate, protein, and fat intakes. These findings are in complete agreement with our dietary data analysis. During the No-BF testing week the subjects had a statistically significant decrease in all three macronutrients examined. Even though fat and protein sources play an important role in the overall energy metabolism, our focus should be mainly aimed at carbohydrates as the main energy source for stop-and-go sports, such as basketball (Hoffman & Maresh, 2000; Baar et al., 2013). A considerable amount of previous research has shown that insufficient carbohydrate consumption is related to decreased glycogen synthesis, which ultimately leads to decrease in sports performance and quicker onset of fatigue (Balsom et al., 1999a; Balsom et al., 1999b; Clayton et al., 2015; Williams & Rollo, 2015). Although muscle glycogen concentration was not examined in this exploratory study, a significant decrease in carbohydrate consumption was observed during the No-BF week. The overall number of shots attempted during the 2-point and 3-point shooting drills designed to test basketball shooting fatigue resistance did not demonstrate statistical significance; however, the effect sizes revealed moderate magnitudes. This may lead us to assume that breakfast may have a potential positive influence on the improvements in basketball shooting performance by delaying the onset of fatigue and allowing players to maintain their optimal shooting accuracy. In practical in-game settings, during close games having an opportunity to take an extra shot may significantly contribute to overall winning probability, especially if the shot is taken by a player with a decent shooting percentage. On the other hand, previous research indicates that the overall daily fat consumption is greater during breakfast omission (Ruxton & Kirk, 1997). Our data does not agree with previously mentioned findings as the difference between the overall daily carbohydrate and fat intake during the BF week was almost identical when compared to the No-BF week. Even though both macronutrients declined in magnitude during the No-BF week, their proportion to the overall energy intake remained unchanged.

Considering that this was the first study that examined the effect of breakfast consumption on basketball shooting performance, certain limitations are present and should be addressed in future research studies. An inability to observe statistically significant differences in basketball shooting performance might be attributed to the narrow time period that the subjects were exposed to BF or No-BF testing trials and the level of fatigue induced by the shooting drills examined in this study. Further research should examine the effect of breakfast consumption/omission throughout a longer time span and greater intensity fatiguing protocols which may magnify the positive underlying patterns observed in this research study. Also, further research should attempt to observe the effect of breakfast consumption/omission on in-game shooting performance as well as some of the other key performance variables such as turnovers, steals, and offensive and defensive rebounds.

CONCLUSIONS

To our knowledge this is the first study that examined the relationship between breakfast consumption and basketball shooting performance. Based on our findings we can conclude that there is an underlying positive relationship between breakfast consumption and basketball shooting performance. Considering that basketball players are always looking for ways to improve their shooting performance, a well-balanced diet with habitual breakfast consumption may be a beneficial method for individual and team performance enhancement, which can ultimately lead to increased chances of a successful game outcome.

Acknowledgment: *The authors would like to thank all the subjects that volunteered to participate in this research study as well as the University's Athletic Department for allowing us to use their sports facilities and equipment.*

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ODNOS IZMEĐU KONZUMACIJE DORUČKA I KOŠARKAŠKIH PERFORMANSI

Svrha ovog istraživanja je da se istraži moguća povezanost između konzumacije doručka i performansi u košarci. Osamnaest muških ispitanika (visina=191.5±10.1 cm, masa=93.8±12.1 kg, starost=27.5±10.6 godina) sa znatnim iskustvom igranja košarke podeljeno je u dve grupe, sa doručkom (BF) i bez doručka (No-BF), tokom četiri dana nedeljno u okviru tronedeljnog istraživanja. Ispitanici su izvodili slobodna bacanja i šuterske drilove za 2 i 3 poena, četvrtog dana tokom svake nedelje. Zapisi o unosu hrane prikupljani su tokom svake od faze istraživanja. T-test za uparene uzorke korišćen je za utvrđivanje razlike u performansama košarkaškog šutiranja

(slobodna bacanja, šuterski drilovi za 2 i 3 poena) i obrascima ishrane (kalorije, ugljeni hidrati, proteini i masti) između BF i No-BF testiranja na nedeljnom nivou. Utvrđene su veličine Cohenovog D efekta kako bi se odredila veličina konzumacije doručka kao eksperimentalnog faktora. Prosečna količina kalorija, ugljenih hidrata, proteina i masti koje su ispitanici konzumirali tokom nedelje bi izostavljali doručak bila je znatno niža u poređenju sa nedeljom u kojoj su konzumirali doručak. Iako su ukupne performanse šutiranja na koš poboljšane tokom nedelje konzumiranja doručka, samo su u prosečnim izvođenjima preciznih slobodnih bacanja utvrđeni statistički značajni rezultati. Međutim, veličina efekata za gotovo sve zavisne varijable pokazala je male do umerene veličine. S obzirom na to da košarkaši uvek traže načine za poboljšanje šuterskih performansi, dobro uravnotežena ishrana sa uobičajenom konzumacijom doručka može da predstavlja korisnu metodu za poboljšanje individualnih i timskih performansi, što u krajnjem može dovesti do povećanih šansi za uspešan ishod utakmice.

Ključne reči: *sport, performanse, tačnost, ishrana, zamor*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 323 - 334
https://doi.org/10.22190/FUPES200114030M

Research article

PHYSICAL AND HEALTH EDUCATION IN THE MODERN PRIMARY SCHOOL

UDC 796.01:371.214.727.1

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Abstract. *From the aspect of personality development, physical and health education (PHE) has a special role and is of particular importance in primary school since it is the period of the most intense growth and development of children. Given the specific characteristics of this age group and the potential that PHE has during this period, this paper aims to determine primary school students' opinions on the achievement of the main objectives of PHE. The sample is intentional and includes 160 fifth grade and eighth grade students. The study used a three-level assessment scale whose items related to the four main objectives of physical and health education expressed by age-adjusted formulations. The results of the research show that the pedagogical objective of physical education is the most dominant one, while health and hygiene, and the recreational objective are less present in the teaching process. The educational objective of PHE and its achievement in the classes is the most sensitive issue of the primary school practice studied. The findings have served as a basis to draw a number of conclusions and pedagogical implications aimed at improving the status of the issue analyzed by this study.*

Key words: *Physical and Health Education, Contemporary Primary School, Personality, Objectives, Primary School Education.*

INTRODUCTION

Keeping in mind the characteristics of the modern era, its pace and lifestyle discernibly determine its quality, so it can be said that movement and physical activity (PA) are the main manifestations of human life, as well as that these pervasive human activities are followed by the most complex mechanisms of human consciousness. Physical and health education (PHE), as an important field within pedagogy, contributes both to

Received January 14, 2020 / Accepted September 9, 2020
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the biological and reproductive, as well as to the overall development of an individual, and, more broadly, it affects the overall progress ofcivilization. PA is actually an important "part of the cultural and civilizational heritage of the society, since their effects influence the collective health, stability and development" (Ivanić, 2001: 22). Today, society is faced with numerous and rapid changes that affect each person, which results in a lack of time to engage in PA. This necessarily results in various physical deformities, mental and emotional impairment and impaired social interaction. Of particular concern in this context of physical education (PE) is that the above mentioned impairments are most commonly encountered in primary school children, which is the period when it is needed to create habits related to this field of education, as these habits last a lifetime. For this reason, there have been an increasing number of experts who have contributed to the popularization of healthy life and active lifestyle trends, which clearly indicates the need for the reorganization of the teaching process, which would result in the curriculum and the entire physical health education striving to achieve this goal. With regard to this, there are four dimensions of the definition of the concept of the contemporary approach to physical and health education: the dimension of the cultural heritage of physical education, the dimension of sports education, the dimension of physical movement education and the dimension of health education. The main goal of these dimensions is to raise awareness among primary school students of the importance of using physical and health principles based on different teaching tasks that affect the development of health, movement culture, motor skills, etc.

Numerous studies confirm the role and importance of PE for student personality development, emphasizing that it positively influences school success, educational aspirations, activist attitudes, self-esteem and the work ethic (Landers, Feltz, Obermeier, & Brouse, 1978; Andrews, 1998; Broh, 2002; Marsh & Kleitman, 2003). Therefore, this paper studies PHE in primary school as the period of the most intense development of an individual.

The aim of this paper is to determine the opinions of primary school students regarding the achievement of the main physical and health education objectives.

METHODS

The sample is intentional and includes 160 fifth-grade and eighth-grade students selected by PE teachers as those who excel in this subject. The study used a three-level assessment scale whose items related to the four main objectives of physical and health education expressed by age-adjusted formulations. The items were formulated according to the objectives as follows: (1) Pedagogical objective: PE affects the overall development of a student's personality by fostering tolerance, consistency, confidence, a competitive spirit, cooperation, mutual support and understanding; (2) Health and hygiene objective: PE affects the improvement of health, proper nutrition and hygiene habits of students; (3) Recreational objective: PE classes encourage students to engage in recreational sports and PA; (4) Educational objective: In PE classes, students acquire the knowledge, skills and habits of PA and develop psychomotor skills. In the conducted research, students' gender and age were used as independent variables. The sample characteristics with respect to the analysed independent variables are shown in Table 1.

Table 1 The sample characteristics with respect to the analysed independent variables

Gender	Female		Male		Total
	N	%	N	%	
	64	40.00	96	60.00	160
Grade	5th grade		8th grade		Total
	N	%	N	%	
	49	30.63	111	69.38	160

RESULTS

PE objectives and their achievement in the classroom were analysed in relation to the variables of the participants' gender and age.

Table 2 The opinions of students regarding the achievement of the physical and health education (PHE) objectives (based on gender)

PE affects the overall development of a student's personality by fostering tolerance, consistency, confidence, competitive spirit, cooperation, mutual support and understanding.	Female		Male	
	N	%	N	%
Completely	56	87.50	69	71,88
Not at all	0	0.00	5	5.21
Partially	8	12.50	22	22.92
Total	64	100.00	96	100.00
	χ^2=6.756, df=2 p<0.05, C=0.2			
PE affects the improvement of health, proper nutrition and hygiene habits of students	N	%	N	%
Completely	41	64.06	51	53.13
Not at all	12	18.75	20	20.83
Partially	11	17.19	25	26.04
Total	64	100.00	96	100.00
	χ^2=2.22, df=2, p=0.33, C=0.12			
In PE classes, students acquire the knowledge, skills and habits of PA and develop psychomotor skills	N	%	N	%
Completely	18	28.13	28	29.17
Not at all	29	45.31	35	36.46
Partially	17	26.56	33	34.38
Total	64	100.00	96	100.00
	χ^2=1.517, df=2, p=0.468, C=0.1			
PE classes encourage students to engage in recreational sports and PA	N	%	N	%
Completely	19	29.69	38	39.58
Not at all	18	28.13	26	27.08
Partially	27	42.19	32	33.33
Total	64	100.00	96	100.00
	χ^2= 1.887, df=2, p=0.389, C=0.1			

Legend: PE - Physical Education; PA - Physical Activity

The research on students' opinions on the PE objectives shows that there is a statistically significant difference in the participants' understanding of learning objectives achievement depending on the participants' gender $\chi^2=6.756$, df=2 $p<0.05$. It is evident that students of both genders recognize the pedagogical objective of PE as the most dominant one, with girls emphasizing this task more than boys (female: 87.50%, male: 71.88%). It is interesting to mention that none of the girls had a negative opinion about the achievement of the pedagogical objective of physical and health education. The Contingency coefficient obtained (C=0.2) indicates a poor, that is, low correlation.

Table 3 The opinions of students regarding the achievement of the physical and health education (PHE) objectives (based on age)

PE affects the overall development of a student's personality by fostering tolerance, consistency, confidence, competitive spirit, cooperation, mutual support and understanding.	5th grade		8th grade	
	N		%	
Completely	41	83.67	84	75.68
Not at all	2	4.08	3	2.70
Partially	6	12.24	24	21.62
Total	49	100.00	111	100.00
	$\chi^2=2.079$, df=2, p=0.354, C=0.11			
PE affects the improvement of health, proper nutrition and hygiene habits of students	N	%	N	%
Completely	28	57.14	64	57.66
Not at all	14	28.57	18	16.22
Partially	7	14.29	29	26.13
Total	49	100.00	111	100.00
	$\chi^2=4.714$, df=2, p=0.095, C=0.17			
In PE classes, students acquire the knowledge, skills and habits of PA and develop psychomotor skills	N	%	N	%
Completely	16	32.65	30	27.03
Not at all	17	34.69	47	42.34
Partially	16	32.65	34	30.63
Total	49	100.00	111	100.00
	$\chi^2=0.916$, df=2, p=0.663, C=0.07			
PE classes encourage students to engage in recreational sports and PA	N	%	N	%
Completely	19	38.78	38	34.23
Not at all	11	22.45	33	29.73
Partially	19	38.78	40	36.04
Total	49	100.00	111	100.00
	$\chi^2= 0.921$, df= 2, p=0.631, C=0.08			

Legend: PE - Physical Education; PA - Physical Activity

From the perspective of the health and hygiene objective, there is no statistically significant difference in students' opinions on this issue with respect to their gender $\chi^2=2.22$, df=2, p=0.33. Although a positive attitude about the achievement of this PE objective is the prevalent one (53.13% and 64.06%), the fact that almost 20% of the participants of both

genders only partially (17.19% and 26.04%), or not at all (18.75% and 20.83) do not recognize the achievement of the health and hygiene objective of PE is also worth analysing.

According to the data obtained during the research, the educational objective of PE is the least present, because only about one third of the participants (28.13% and 27.19%) claim that this objective is met. On the other hand, the negative response is the most common one in both groups of participants (45.31% of the girls and 36.46% of the boys). It is apparent that boys have a more even distribution of all three responses than girls. Although the perceived difference can be analysed from the gender perspective, it still does not have a statistically significant character: χ^2=1.517, df=2, p=0.468.

The recreational objective of PE that should encourage students to engage in recreational PA and sports is not sufficiently recognized among primary school students. Although there was no statistically significant difference in students' opinions on this particular objective (χ^2= 1.887, df=2, p=0.389), it is evident that it is mostly girls who partially recognize this objective (42.19%), unlike boys who most frequently had a positive response (39.58%).

The research on primary school students' opinions on the PE objectives depending on the participants' age shows no statistically significant difference in the participants' opinion about any of the four analysed objectives. The participants had a generally positive opinion about the achievement of the pedagogical objective, with the younger students more frequently having very positive opinions (83.67% vs. 75.68%), unlike the older ones who mostly said that this objective is partially present (21.62% vs. 12.24 %). The perceived difference does not have a statistically significant character (χ^2=2,079, df=2, p=0,354).

The health and hygiene objective of PE is perceived by the students of both age groups in an almost identical way. The most frequent answer about the achievement of the health and hygiene objective was affirmative in both groups of participants (57.14% and 57.66%). The difference between the two groups of participants is not statistically significant (χ^2=4.714, df=2, p=0.095, C=0.17), although the younger students were more likely than their older peers to choose the negative answer about the achievement of this objective (28.57% vs. 16.22%).

The recreational objective of PE is perceived by the students of both age groups in almost the same way. Fifth grade students emphasize a positive and partially positive attitude (38.78%), while eighth grade students show a slight inclination towards a partially positive attitude (36.04% vs. 34.23%). Both groups of participants most rarely had a negative opinion about the recreational objective of PE (22.45% and 29.73%, respectively).

DISCUSSION

PHE is an important field of pedagogy that successfully ensures the overall personality development as an imperative of modern education. However, according to Šekeljic (2014: 245), many authors dealing with this topic are united in their opinion that: (1) school age children from this modern age are less physically active than children who lived in the past; (2) the children's level of PA constantly decreases with their agde; (3) the level of PA of children depends on the season (less PA is recorded in winter); (4) boys are more physically active than girls; (5) there are diferences between between girls in the type and intensity of PA; (6) there are differences between boys and girls from

urban and rural areas in the type and intensity of physical activities (children from urban areas are less physically active).

Given the fact that the primary school period is the period of the most intense development of students' personality, this paper is focused on the study of physical and health education in the modern primary school. The operationalization of the goal of this paper was conducted through the theoretical grounding of this issue and the empirical study of the achievement of PE objectives in primary school.

In order to emphasize the importance and significance of physical and health education in primary school children, it is necessary to focus on the reasons that prevent, limit or impede the constant stimulation of their activity. The reason for this can be found in the organization of education itself, such as students sitting for several hours and insufficient PA and exercise, and it is "crucial for the overall genesis of children's perception of exercise, the development of their physical, psychological and emotional competencies, but also the perspective of their development" (Višnjić, Jovanović, A., Miletić, 2003: 13). Exercise is "a systematic display of a large number of disciplines based on scientific knowledge, methods and claims, which implies that even though it is not a science, PE must not be contested and neglected in the overall personality development" (Martinović, 2003:17). For exercise in school to have real meaning and impact, all its phases need to be properly carried out. This includes the pre-exercise phase, the exercise phase, and the post-exercise activities. Such exercise is complete and has a positive effect on strengthening and stretching the muscles, bones, joints, as well as initiating the respiratory system, endocrine glands, digestive system and cardiovascular system. These exercises must be planned and well thought out, and each exercise must have its purpose and effect on a particular part of the body. Regardless of whether exercise equipment is provided in schools, it is necessary to combine different exercises, of different intensity and different number of repetitions. In accordance with that, a didactic and methodical organization of the lesson is crucial in order for the lesson to have an introductory phase, central phase, as well as a final phase, whose goal would be to develop the physical and health related abilities in students. An equally important teaching objective is to raise awareness of the importance of exercise and of knowledge related to health.

As for the cognitive development of primary school children, Piaget laid the key foundations. His most significant findings included "the conclusion that children up to 2 years of age have a limited set of data, abilities, skills and capacities (the sensorimotor stage); children between 2 and 11 years of age are at the preoperational stage, and the concrete operational stage starts at the age of 11 or 12, while the formal operational stage starts from the age of 12" (Stanisavljević & Radonjić, 2009: 19). It can be said that students at this stage of development know that they have to take care of their health, and also that not engaging in physical activity can have consequences. Primary school children recognize the benefits of PA but do not see the broader picture that exercise has a number of other benefits for their body. Therefore, "parents, as well as teachers, and the entire system of education, whose role is to constantly emphasize the benefits of regular exercise, play an important role" (Nikolić, 2011: 27).

The concept of motor development is based on the development of intellectual abilities, because "for a child to develop an understanding of how to do something physical, it is necessary to be able to acquire, process and apply the perceived information" (Trajkovski, Tomac, & Marić, 2014: 25). Motor development depends on the child's stage of development and the intensity of the child's progress, but also on how the child

acquires motor skills. That is why it is extremely important for children at an early age to establish exercise habits so that all parts of the body develop properly. The impact of motor development on children's health plays a crucial role, as "all manipulative activities are believed to be crucial for the physical, social and psychological health of children" (Rajović, 2016: 9).

Affective development of primary school children can be linked to the child's health and upbringing, but we have to mention the attitude of various authors that bodily (physical) changes play an important role in experiencing emotions. It is for this reason precisely that "the overall affective development leads to the development of emotionally intelligent reactions that are the product of cognitive, psychological and mechanical maturation" (Brković, 2011: 285). This author also claims that children's affective reactions: can easily change, can be slow and difficult to change, and that they depend on the child's maturity level; therefore, he believes that children will have a proper emotional reaction to the principles of PHE if they are taught to control their own emotions and recognize good emotions, as opposed to bad and unnecessary emotions.

Pedagogical literature provides different approaches to the structure of the PHE objectives, which include health improvement, the development of skills, habits and motivation, as well as the development of the emotional and volitional side of the personality. However, according to the majority of authors, the main objectives of this field of education are: pedagogical, educational, health and hygiene, and recreational.

The pedagogical task of physical and health education is reflected in the overall development of students' personality. This means that the pedagogical aspect of PE must provide each student with a sense of social responsibility for their own actions, as well as with guidance on proper social actions. That is why these lessons encourage "the search for ways to empower each student's potential, the emancipation through the process of adjustment to the community, the effort to enable them to understand their dependency on society and to accept the responsibility to actively maintain and improve their individual and social life, but also to become independent and an autonomous personality at the same time" (Tadić & Bodroški-Spariosu, 2017: 19). PE and its contents and learning methods provide numerous pedagogical effects. "Curriculum of PE provide a broad framework for the development of socio-moral, intellectual, aesthetic and other values and abilities of students" (Kulić, Rajčević, Arsić, & Minić, 2019: 158). It has been proven that "sports and PA contribute to the development of physical and aesthetic body qualities and to strengthening personality traits such as consistency, self-confidence, discipline and tolerance" (Petrović, Cenić, & Dimitirjević, 2018: 422), persistence, perseverance, willingness to cooperate, moral stability, independence, etc. The course curriculum is aimed at introducing the students to the principles of moral behaviour, which means developing in them moral attitudes about behaviour in class, but also in all sports activities, which further establish the norms of human action in social interactions. Therefore, PHE classes aim at providing the students with a view of the world, that is, at showing them everything that surrounds them and with teaching them how to live and work in a given social environment.

PE classes encourage the stimulation of students' social development through teamwork among students; however, the teachers also have an important role as they create scenarios and opportunities for the development of students' social skills through the development of mutual relationships by engaging in various activities (Jevtić, Đorić, & Milošević, 2019: 262).

According to Pismensky and Alyanov (2016), participation in physical and sports activities contributes to the improvement of intellectual abilities, as well as the formation of positive emotional and volitional traits. Primary school students need to develop an awareness that PHE classes are "the basis for the development of intellectual skills, since learning about the way each sport should be observed, how to understand the game, rules and principles, fundamentally prompt permanent intellectual development" (Stanisavljević & Radonjić, 2009: 29). One of the roles of PHE should be to increase the ability to work, and as such, it is associated with work education. The essence of this connection lies in the students' understanding of the purpose of work and the practical use of knowledge they acquire in school, but also the importance of continuing education and self-improvement at work. This will help them to understand their own needs and goals which would further lead to "the transformation of the process of pedagogical management of physical development into self-development, education into self-education, training into self-improvement" (Vilensky, 2016: 7). The PHE curriculum in the modern primary school must also meet the students' needs for beauty, which is where we can see its connection with aesthetic education, which must not be neglected. It is through these contents that students are taught how to perceive, understand, and experience their own and others' aesthetic values. The best example of this connection is the emphasis that regular exercise will result in a well-shaped body, which further evokes a sense of joy and satisfaction in the student. By summarizing the pedagogical objectives of physical and health education, it can be concluded that it refers to the development of human relationships among students, healthy psycho-physical development that enables the removal of obstacles in their period of growing up and prepares them for future life. It is certain that PHE in primary school is designed so that students recognize their abilities and qualities, and to encourage them to further improve themselves. This supports the self-development objective that is mentioned by a large number of authors who study PHE, relying on Maslow's theory of self-actualization (Daniels, 1982).

The educational task of PHE refers to the acquisition of knowledge, skills and habits and the development of psychomotor abilities of students. Knowledge of psycho-physiological concepts, as well as of the mechanisms of influence of physical activities on the health and development of the individual, and the formation of children's personality are particularly important for achieving this objective. The most important goal of PE classes at the primary school age should be to teach the students about the rhythm of work and rest, about hygiene, as well as about the proper functioning of the body as a whole. When it comes to the health aspect, this primarily involves their knowledge of "the benefits of a healthy diet, but they still do not adhere to all the norms, that is, they do not apply the principles of a healthy diet in everyday life" (Mirković, 1998: 604). According to Kulić et al. (2019: 158), the most important skills and habits developed in students are various locomotor, non-locomotor and manipulative skills, many of which are applied in sports games, gymnastics, various sports activities, etc., such as: walking, throwing, climbing, jumping, running, etc. Abilities development refers to strength, endurance, speed, body dexterity, coordination of movements, etc. This objective can be achieved through numerous games organized at school. According to Milanović (2004), these are: walking and running games (wolf and fox, running and overtaking, who will be the first to get to the opposite side, running through the forest, who is more agile and faster); jumping, hopping and skipping games (fast jumps, long jumps, jumping in sacks, jump from one circle drawn on the ground into another); climbing, crawling, pulling games (slide games, steal the ball, crawl under the bridge game); throwing,

catching, passing the ball games (palm to palm, hiding the ball, who can throw the farthest, hopscotch); games of precision, orientation, dexterity (sheep and wolf game, strike me, ball in the hoop, the fastest catcher, hopper); water games; snow games; classroom games; music games; counting-out games.

The health and hygiene related objective of PHE is to improve the health of each student. Health is influenced by "PA, proper nutrition, hygiene and regular medical check-ups" (Kragujević & Rakić, 2004: 135). All the factors that directly or directly affect health, such as: nutrition, hygiene, living conditions, physical activity, the rhythm of work and rest, the awareness of the importance of health improvement, knowledge of diseases and harmful effects of alcohol, cigarettes, stimulants, narcotics, etc. can be found in the PE curricula in modern primary schools. The notion of hygiene refers to the awareness of the importance of body cleanliness. Personal hygiene and health hygiene play a "preventative role in maintaining health and improving the quality of life by eliminating the impairment factors by adhering to its rules" (Kragujević, 2006: 150). Primary school children have an increased need for food, so the increased consumption of unhealthy food is a problem. Fast food directly affects muscle mass and how the digestive system works, which has a negative effect on the overall development. This is why physical and health education classes are designed to make students familiar with their own body, its needs, and ways to meet those needs properly. PE lessons should teach students that PA has a positive effect on the digestive system, the skeletal system, the muscular system, the blood system, the nervous system, as well as the endocrine system. PHE classes are of great pedagogical value, because nowadays, health is not only discussed from the aspect of absence of diseases, but from the aspect of functional ability, affirmation and stimulating an active lifestyle. What we are witnessing is that a large number of students do not actively participate in physical and sports activities due to a lack of motivation and interest, which in turn results in numerous deformities as well as in poor functioning of the body as a whole. That is why "a healthy lifestyle" is considered the most important goal of PE in European countries (European Commission, 2013: 21).

When speaking about *the recreational objective of PHE*, it should be emphasized that students start with recreation quite early, from the moment they become able to independently perform certain motor activities. Certain contemporary studies by different pedagogues and psychologists believe that the regular recreational activities of children help to eliminate social and psychological disorders. Therefore, the recreation topic is currently becoming more and more relevant as awareness of the need and importance of exercise and recreation creates healthy habits and foundations which serve as guidelines for the students' future development. "These activities are not only seen as active rest, but participating in them also allows students to acquire knowledge and habits that they will practice in their leisure time as well" (Kragujević, 2005: 124). According to Tobolka & Latov (2000) if children are engaged in sports and regular recreational activities in school and extracurricular programs from early childhood, the ratio of body proportion, muscles and body fat is balanced, but there are also changes in sleep and wake cycles. Recreational activities, therefore, improve cognitive, affective and social development. Through regular sports activities, students learn how to act in competitions, respect their opponents, control their feelings in victory and defeat, learn about fellowship and team spirit.

Bearing in mind the positive effects above mentioned, it is important to emphasize that organized PHE in Serbia mostly takes place in schools in PE classes and in a number of different extracurricular physical and sports activities. The contents of PHE are an integral part of the curriculum and are related to enhancing and improving students' health. The curriculum also includes sections relating to tradition, so national games and

sports are present too, as well as a number of elective physical and sports activities. Given its role and importance, it is important to note that the concept of PE requires continuous monitoring and innovation to keep pace with the ever-changing needs of young people in contemporary society. These tendencies are widespread and manifested in different demands for change such as the following: "some school programs include additional PE classes or additional activities (active breaks, activities before or after classes), others are based on curriculum changes. Increasing frequency and duration is not always possible, given the competitive requirements of the curriculum, so it is important to stimulate PA within classes and breaks, and to develop strategies for more efficient use of PE classes" (Cvejić & Ostojić, 2017: 438). In order to improve the PE of young people in Serbia, one part of the PE program is organized through extracurricular activities (camping, swimming, excursions), organized by sports associations and clubs.

CONCLUSION

Based on the results of the research, the following conclusions can be drawn: 1) Primary school education is characterized by the achievement of the pedagogical, educational, health and hygiene, and the recreational objective of PHE; 2) In practice, the pedagogical objective of PHE was the most frequently recognized, as students see it as a tool to develop their personality; 3) Better operationalization and actualization of the pedagogical objectives of PE depend on raising awareness about its role and importance in boys who, due to their specific development at this age, show less interest in this aspect of physical education. Reduced interest in pedagogical values and a focus on rivalry, a sense of victory and superiority in boys significantly reduces sensitivity to the pedagogical aspect of physical education. In this regard, it is important to raise awareness of the pedagogical values of PE in boys and to put it in the service of proper and overall personality development, 4) Primary school education practice indicates the need for a guided pedagogical and didactic-methodical intervention with regard to reinforcing the health and hygiene, and recreational objective of PE. Although there is no doubt that these objectives will be met, the results nevertheless show that the existing level of their achievement should be improved because these aspects of PE ensure the development of healthy lifestyle abilities, skills and habits that are a prerequisite for proper growth and development of young people; 5) The educational objectives of PHE and their achievement in class are the most sensitive issue of the primary school practice studied. Primary school students do not sufficiently recognize the physical and health education lessons as a tool to acquire knowledge, skills and habits regarding physical activity, and to develop psychological and physical abilities. As this objective creates the basis for a successful achievement of the main goals and objectives of physical and health education, as well as the basis for future lifelong continuing development and education, it is important to act systematically in this field. PE teachers in primary schools should be provided with expert assistance and encouraged to improve their skills which would help them to efficiently meet the educational objectives of PE, by mastering the techniques of indirect influence of education which allow the teachers to convey the necessary knowledge which is the basis of these activities to the students, and the potential for future progress and advancement during various PA; 6) The prerequisite for the quality and success of PHE is an integrated approach to teaching, which implies the unity of pedagogical, health and hygiene, educational and recreational development and improvement of each student.

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FIZIČKO I ZDRAVSTVENO VASPITANJE U SAVREMENOJ OSNOVNOJ ŠKOLI

Sa aspekta razvoja ličnosti, fizičko-zdravstveno vaspitanje (FZV) ima posebnu ulogu i značaj u periodu osnovnoškolskog obrazovanja, kao periodu najintenzivnijeg rasta i razvoja dece. S' obzirom na osobenosti ovog uzrasta i potencijal koji FZV u njemu ima, rad ima za cilj da utvrdi stavove učenika osnovoškolskog uzrasta o ostavrivanju osnovnih zadataka FZV. Uzorak je nameran i obuhvata 160 učenika petog i osmog razreda. U istraživanju je korišćena trostepena skala procene čiji su se ajtemi odnosili na četiri osnovna zadatka FZV izraženih formulacijama prilagođenim uzrastu učenika. Rezultati sprovedenog istraživanja pokazuju da je u nastavnoj praksi dominantan vaspitni zadtak FZV, dok su zdravstveno-higijenski i rekreativni zadaci manje prpoznatljivi. Obrazovni zadaci FZV i njihovo ostavarivanje u nastavi predstavljaju najosetljivije pitanje istraživane osnovnoškolske prakse. Utvrđeni rezultati su poslužili kao osnova za izvođenje niza zaključaka i pedagoških implikacija usmerenih na unapređivanje istraživanog problema.

Ključne reči*: fizičko-zdravstveno vaspitanje, savremena osnovna škola, ličnost, zadaci, osnovnoškolsko obrazovanje*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 335 - 344
https://doi.org/10.22190/FUPES191014031N

Narrative review article

KINANTHROPOLOGICAL ANALYSIS OF THE CORE

UDC 531.31
796.015

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Abstract. *The aim of this research is to investigate existing research dealing with the topic of the structure, functional and morphological status of the muscles that make up the body's core, as well as how improving the core affects the advancement of sports technique and its efficiency. The term core most commonly refers to the trunk, or more precisely, to the lumbar region. Core muscles play a significant role in lower limb alignment and stability, associated with poor alignment and injuries. The development of the core strength to improve the efficiency of sports performance is a controversial issue that has yielded different results. The analysis of the scientific journal articles revealed that the specificity of the program for increasing lumbar stabilization with the appropriate sport or skill is of the utmost importance. Therefore, it is necessary to specialize training facilities so that they are suited to a specific sport branch or discipline.*

Key words: *Core Stability, Strength, Training, Sport Performance.*

INTRODUCTION

Optimal body stability is the basis of human movement, which applies equally to sports and everyday activities (Fitarelli, Ramos, Scudiero, Rabello, & Rodrigues, 2020). The musculature of the core acts as a link that functionally connects the upper and the lower body – the upper and lower extremities. This functional relationship between the core and the extremities is based on the kinetic chain theory (Pontillo et al., 2020). In biomechanical terms, this muscular whole provides dynamic and kinematic aspects of human locomotion, including maintaining the balance or stability of the body in its various positions. Certain research suggests that there is a connection between an increased likelihood of injury and core stability (Panjabi, 2003; Akuthota & Nadler, 2004; Peate, Bates, Lunda, Francis, & Bellamy, 2007;

Received October 14, 2019/ Accepted July 08, 2020
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Akuthota, Ferreiro, Moore, & Fredericson, 2008; Smith, Nyland, Caudill, Brosky, & Caborn, 2008; Desai & Marshall, 2010; Sung, Yoon, & Lee, 2010). Topological positioning and functional incorporation are the reasons for labeling this muscle in its entirety with the term "core" (Fitzgerald, Ake, & Snyder-Mackler, 2000; Myklebust et al., 2003; Akuthota & Nadler, 2004; Myer, Ford, Brent, & Hewett, 2006; Akuthota et al., 2008; Kuszewski, Gnat, & Gogola, 2018; McGill, Grenier, Kavčić, & Cholewicki, 2003).

Most often, a stability function is added to the core muscles, which depends on the interaction of active, passive and neutral elements. Bliven and Anderson (2013) consider neural elements crucial for the optimal core stability in dynamic activities. In order to achieve a quality assessment of this body region, a multiple approach is necessary. According to Bliven and Anderson (2013), the functional elements of the core musculature are probably related to daily activities and sports training.

The significance of a stable core is most often associated with the improvement of the sports performance and as a prevention of injuries. However, reservations are necessary, due to modest precise evidence (Silfies, Ebaugh, Pontillo, & Butowicz, 2015). On the other hand, there are some indicators in favor of reducing injury rates when integrating core stabilization exercises into rehabilitation programs. There is still no consensus among experts on which exercises and programs contribute the most to improving core stabilization.

The promotion of knowledge about the musculature of the core, its contribution to the quality of motor competence and its contribution to the quality of human ontogenetic development is a hypothetical contribution to integrating activities aimed at the development and preservation of the function of this muscle region in the daily routine of the life of today (Fitzgerald et al., 2000; Santana, 2001; Cook, 2003; McGill et al., 2003; Boyle, 2004; Verstegen & Williams, 2004; Akuthota & Nadler, 2004; Willardson, 2007; Akuthota et al., 2008).

The aim of this research is to investigate existing research dealing with the topic of the structure, functional and morphological status of the muscles that make up the body's core, as well as how improving the core affects the advancement of sports technique and its efficiency.

THEORETICAL CONSIDERATIONS OF THE PROBLEM

Morphological status

The nucleus consists of muscles located between the lower edge of the chest and the upper edge of the iliac bone (Akuthota et al., 2008; Cruz-Montecinos et al., 2019; Resende et al., 2019). The core musculature works like "a private strap" surrounding the lumbar region. The transverse abdominis muscle has a significant effect on the medial and posterior parts of the thoraco-dorsal fascia. In addition, the deep part is closely connected to the lumbar-spinal processes via the posterior layer. In fact, the thoracic-back fascia acts as a "corset" around the lumbar region (McGill, 2001), which provides, as previously mentioned, a kinetic link between the lower and upper extremities (Akuthota et al., 2008). The action of core muscles activates the proprioceptors in the dorsal fascia, which provides information about the position of the trunk (Akuthota & Nadler, 2004).

Muscle fibers of slow contraction (SC) and fast contraction (FC) form the core. SC form the primary local musculature (internal musculature). The composition of the internal musculature is suitable for intersegmental control of the vertebrae - they respond

to changes in body posture and external load. Major local muscles include the transverse abdominal muscle (TrA), multifidus, inner obliques, deep spinal muscles, and pelvic floor muscles. The multifidus has been found to atrophy in individuals with chronic lumbar pain (Akuthota & Nadler, 2004). The external musculature is predominantly composed of FC muscle fibers. Superficial muscles play a role in large overall movement. The main external muscles are: the levator scapulae, the outer obliques, rectus abdominis, and quadratus lumborum - considered by McGill et al. (2003) to be the main muscle stabilizers of the spine.

However, the abdominal muscles are vital components of the core. The transverse abdominal muscle stands out in particular by its stabilization of function because its fibers are arranged horizontally (except for the lowest positioned fibers, which follow the fibers of the inner oblique abdominal muscle), creating a band around the abdomen. By retracting the navel, it activates the TrA in isolation. Clinical research has shown that in healthy individuals, TrA and multifidus are activated 30ms before shoulder and upper extremity movement and 110 ms before leg movement - to stabilize the lower spine (Hicks, Fritz, Delitto, & Mishock, 2003). However, in patients with lower back pain, contraction of these two muscles is delayed before limb movement (Barnet & Gilleard, 2005). These patients have impaired standing postural control in static or dynamic balance postures (Foroughi, Sobhani, Yoosefinejad, & Motealleh, 2019). The increase in intraabdominal pressure occurs by activation of the inner obliques and the TrA – acting over the thoracic fascia, thus creating a pressure around the trunk, similar to the hoop. The benefit of this increase is spinal "fixation" (McGill, 2001). The external oblique abdominal muscle (superficially the largest abdominal muscle) controls the anterior pelvic tilt. The abdominal muscles and multifidus need to engage a very small percentage of their total muscle capacity to stabilize the spinal segments (Grenier & McGill, 2007; Akuthota et al., 2008).

The pelvic floor muscles are essential for the general functionality and stability of the hips and pelvis while walking (Akuthota et al., 2008). Poor endurance and delayed activation of the hip abductor/extensor muscle (m. gluteus medius) were first observed with people with lower back pain and other musculoskeletal conditions, such as, for example, ankle sprain (Leetun, Ireland, Willson, Ballantyne, & Davis, 2004). The iliopsoas muscle is the only blind flexor in the lumbar spine (Akuthota et al., 2008). However, it has the potential to exert strong pressure on the intervertebral discs. Maximum voluntary activation of the psoas muscle, such as in the exercise of full flexing of the trunk, can put a lot of pressure on the last disk, as much as 100 kg of weight (Akuthota et al., 2008). Shortening of the hip flexors (m. iliopsoas) can cause lower back pain by increasing pressure on the lumbar discs. Hold-relax stretching exercises of the iliopsoas muscle can be beneficial in reducing the intensity of pain with patients with lumbar hyperlordosis by improving the function of the transversus abdominis muscle (Bogdanović, Radenković, Kahrović, Murić, & Špirtović, 2020).

The diaphragm serves as a lid or a roof on the core muscle structure. The lower part consists of the pelvic floor muscles. Intra-abdominal pressure can also increase the activation of the diaphragm, contributing to spinal stability. The pelvic floor muscles co-activate together with transverse abdominal muscles (Hewett, Torg, & Boden, 2000). Patients with sacral and iliac pain show reduced activity of the pelvic muscles and the diaphragm (Akuthota et al, 2008). Based on this, it is possible that techniques that improve the work of the diaphragm and the muscles of the pelvic floor can become an integral part of the program for core stability.

Functional status

Core stability and the depending factors

In scientific and professional papers, there are many synonyms used for core stability (Akuthota & Nadler, 2004; Bliss & Teeple, 2005). Generally, core stability encompasses the lumbar-pelvic complex and its ability to maintain spinal vertebral balance within its physiological borders by reducing perturbations and maintaining the integrity of the spinal structure (Panjabi, 2003; Liemohn, Baumgartner, & Gagnon, 2005; Willson, Dougherty, Ireland, & Davis, 2005; Smith et al., 2008; Resende et al., 2019). Stability is the ability to maintain proper posture and/or control of segment movement and general movement. It is the ability to control force or a movement. In most cases, stability is a precursor to power (Cook, 2003). In order for stability to be optimal, it is necessary for any system to have the ability to maintain integrity (Willson et al., 2005). Clinically and practically, in these definitions there is a lack of practical applicability that would provide functional guidance in the development, application and assessment of current core stability (Bliven & Anderson, 2013). Several authors (Akuthota & Nadler, 2004; Kiesel, Plisky, & Butler, 2011; Colston, 2012; Bliven & Anderson, 2013) suggested a better definition in an attempt to write up the core. According to them, the core is the foundation of the kinetic chain in the transmission and distribution of kinetic energy between the cranial and caudal parts of the body, to solve various tasks in sports and everyday life.

The stability of the core can be static or dynamic (Bliss & Teeple, 2005; Cook, 2003). Static stability can be demonstrated during e.g. standing on one leg (Lee & Sun, 2018) or during the flexed arm hang test (Bubanj, Šekeljić, Marković, & Mazić, 2017), while dynamic activities are those that cause disturbances in the center of gravity in response to muscle activity (Bliss & Teeple, 2005). Maintaining the stability of the system through all three planes of motion during changes in the center of gravity means dynamic stability (Bliss & Teeple, 2005).

According to a group of authors (Akuthota et al., 2008), the system for maintaining spinal stability consists of passive, active and neural elements.

In order for stability to be optimal, all three elements must contribute and complement each other. The role of passive elements is very small. It includes the interrelationships of bone and ligament structures (Wilson et al., 2005). The contribution to the stability of the active muscle elements is significantly higher. For example, the in vivo lumbar part of the spinal column can withstand pressure >6000 N during daily work tasks with excellent stability (Wilson et al., 2005). But, if active support is lacking, the bone-ligamentous structure (spine) becomes unstable under a compressive load of only 90 N, a load much smaller than the weight of the upper body (Wilson et al., 2005; Kibler, Press, & Sciascia, 2006; Akuthota et al., 2008). There are three ways in which the active component contributes to core stability: pressure inside the abdomen, force compression, and tenseness of the core muscles (Wilson et al., 2005). The contraction of the abdominal muscles leads to an increase in intra-abdominal pressure. Also, the activity of the muscles of the diaphragm and pelvic floor contributes to an increase in general stiffness and intra-abdominal pressure (Wilson et al., 2005). Therefore, the significance of the active component for global rigidity is very important.

However, spine stability depends not only on muscle strength, but also on an adequate nerve impulse that gives feedback to the central nervous system (CNS) about the position (or relationship) of the trunk in space, thus enabling an adequate response (Akuthota et al., 2008; Pogetti, Nakagawa, Conteçote, & Camargo, 2018). Many causes that lead to reduced

efficiency of movement or performance, as well as increased chances of injury, can be directly related to inadequate coordination in the core muscles. (Akuthota & Nadler, 2004; Akuthota et al., 2008). Therefore, motor learning can be just as significant as strengthening the core muscles. The neutral spine is crucial for optimal stabilization of the core (Bliss & Teeple, 2005), but also the ability to control and maintain such an ability. This spine position is usually, but erroneously, synonymous with a straight back position. A neutral spine is not a single flat position. Instead, it is an intermediate position common to all movements and is usually located between flexion and extension. It is dictated by the musculoskeletal flexibility and structural anatomy of the individual (Bliss & Teeple, 2005). The immediate response of the CNS to a change in the position of the body or its extremities, or a change in the position of the center of gravity, is needed in order to adequately activate the muscular systems and maintain or establish adequate core stability. (Akuthota & Nadler, 2004; Willson et al., 2005; Kibler et al., 2006; Smith et al., 2008; Escamilla et al., 2010; Bliven & Anderson, 2013).

Core stability and sports performance

The relationship between core stability and sport performance is a controversial issue. The musculature positioning of the core enables the maintenance of a neutral position of the spine and pelvis, functioning in such a way as to protect against injuries to these parts of the body (Stanton, Reaburn, & Humphries, 2004). However, some researchers have found different relationships between core stability (Abt et al., 2007; Nesser, Huxel, Tincher, & Okada, 2008; Nesser & Lee, 2009) and programs related to the development of core stability (Stanton et al., 2004; Tse, McManus, & Masters, 2005; Myer et al., 2006; Thompson, Cobb, & Blackwell, 2007). The core muscles are thought to play a significant role in the transfer of kinetic energy across the trunk to the extremities (Abt et al., 2007; Tse et al., 2005). Sports performance can be significantly reduced if the extremity muscles are allowed to be much stronger than the core muscles (Tse et al, 2005; Nesser et al., 2008; Nesser & Lee, 2009). Some research has examined the link between core stability in different sports. The aim was to assess the role of the core in sports performance (Abt et al., 2007; Nesser et al., 2008; Nesser & Lee, 2009). Some other research has considered the economy/performance ratio (Stanton et al., 2004), the speed of movement of the rod head in golfers (Thompson et al., 2007), swimming (Nikolenko, Brown, Coburn, Spiering, & Tran, 2011), rowing (Tse et al., 2005) and balance (Myer et al., 2006). Despite this research, clear and precise information is still lacking. The focus of a large number of studies is on assessing the stability and endurance of core muscles and their influence on performance (Stanton, et al., 2004; Tse, et al., 2005; Meyer et al., 2006; Abt et al., 2007; Nesser et al., 2008; Nesser & Lee, 2009; Sato & Mokha, 2009; Nikolienko et al., 2011). Measures used to evaluate the core musculature may not evaluate its role in energy transfer during sports performance (Tse et al., 2005; Cowley & Swensen, 2008; Nesser et al., 2008; Cowley, Fitzgerald, Sottung, & Swensen, 2009; Nesser & Lee, 2009) due to the lack of test specificity.

At this point, there is limited research on the relationship between core muscle strength and athletic performance (Myer, et al., 2006; McGill, Karpowicz, & Fenwick, 2009) using tests specifically targeting the core. There is a possibility that the stability of the core does not play as big a role as it was thought in improving performance.

In one study, a group of researchers (Nikolenko et al., 2011) investigated the relationship between dynamic power tests and some performance parameters. The research involved 20 men with at least 6 months of training experience. Respondents were tested over three days.

On the first day they were provided with theoretical background pertaining to all the tests (where their height and body weight were also measured). On the second day the 40-yard sprint test was implemente (Nesser et al., 2008; Nesser & Lee, 2009), the shuttle run (Nesser et al., 2008; Nesser & Lee, 2009), the vertical jump and the back squat-1RM (Baechle & Earle, 2008). On the third day, a core test was performed with two standard medicine ball tests (Cowley & Swensen, 2008; Cowley et al., 2009).

Variables related to sports performance generally proved to be insignificant compared to the two core tests (Nikolienko et al., 2011), except the 1RM back squat test, that was found to have a moderate correlation with the test of throwing a medicine ball from a supine position. This may be because this test intentionally activates similar muscle groups as the back squat test (Nikolienko et al., 2011). So, in this case, the increased 1RM of the back squat and the test of throwing the medicine from a supine position can be attributed to the greater strength of the hip flexor muscles. The aim of this research was to verify the relationship between two dynamic core tests and sports performance tests. Apart from a moderate correlation between the back squat test and core tests, no other significance was found. So, according to this research, core power will not improve performance. One reason for this may be because it was measured by core-specific tests that are not adequate for the sports performance measures included in this study. It is possible that the mode of muscle work is not similar in the core tests and performance tests, but that does not mean that the trunk muscles were not active in the sports performance tests (Nikolienko et al., 2011).

Nesser and Lee (2009) conducted research concerning the relationship between core stability, endurance and different performance parameters. No significant correlation was found between core stability tests and performance parameters. The obtained results can be attributed to the specificity of training and testing procedures aimed to determine the role and the involvement of core muscles in sports performance. Also, research conducted by Nikolenko et al. (2011) shows a significant lack of core contribution to sports performance, and is similar to that conducted by Tse et al. (2005). The topic of the research was to explore the impact of the basic program on the endurance of some of the measures of sports performance. Both studies found no significant inter- or intra-group differences from the initial to the final status, after a core strengthening training program and any performance variable. This may be because the core training protocols were either not long enough or did not adequately engage the core muscles.

First of all, a very good evaluation of sports skills and adjustment of the tests to measure the strength and stability of the core is needed, and then an investigation of their conditional connection (Tse et al., 2005). Thompson et al. (2007) dealt with the impact of an eight-week training program on a specific task (stick head speed in golf). The findings showed a difference between the experimental and control groups. In the experimental group, the speed increased by 4.9%, while in the control, there was a slight decrease in the speed of the golf club head.

An adequate assessment of the core stability and the impact on improving sports performance depends mostly on the specifics of the sport and tests (Kubo, Ohta, Takahashi, Kukidome, & Funato, 2007). Magnetic Resonance Imaging taken from a wrestler's trunk muscles has shown that increasing the cross-section of the torso flexor muscles increases efficiency of the wrestling technique. The research of Kubo et al. (2007) suggests that there is a link among muscle cross-section and performance. However, it does not state how the core contributes to performance. Two basic field tests used in the research by Nikolenko et al. (2011) emphasized the core strength component. The main reason why there is no significant

correlation between core stability tests and different measures of sports performance seems to be the absence of a specific core test for a specific sport. In recent years, fitness experts and researchers have increasingly emphasized the significance of exercise and training programs to increase core stability. Also, a large number of researchers and clinicians suggest that increased lumbar stabilization is significant in the prevention of sports injury (Wang et al., 2012). Therapy that includes exercises to stabilize the body's core is an effective treatment in pain relief and in an improvement of the functional status in patients with chronic lumbar pain in most clinical practices (Hayden, Tulder, Malmivaara, & Koes, 2005). In addition to fitness, training for improving core stability is increasingly used in sports rehabilitation programs (Akuthota et al., 2008). Research has shown that lumbar stabilization exercises are a significant component of rehabilitation (Desai & Marshall, 2010; Sung et al., 2010). Usually, fitness exercisers and athletes generally follow core training programs the most (Willardson, 2007). The intertwining of different disciplines, therapy through personal trainers and fitness trainers, is becoming more pronounced. For example, the use of similar props, the performance of exercises, review of catalogs for sports equipment, etc. indicate a growing interest in the development of stability and core strength (Willardson, 2007). Seminars and workshops offered at national conferences have expanded the information on the proper use of such training programs and have suggested the benefits of such training. Some authors (Cook, 2003; Santana, 2001; Willardson, 2007) specifically highlight and promote special equipment for enhancing lumbar stabilization. Scientific papers from rehabilitation have shown the effectiveness of exercises and training programs to develop core stability in reducing the likelihood and prevention of sports injuries - mostly in the lower back and lower extremities (Fitzgerald et al., 2000; McGill et al., 2003; Myklebust et al., 2003; Myer et al., 2004). However, relatively few studies have directly examined the benefits for healthy athletes (Stanton et al., 2004; Willardson, 2007).

Experts interpret the concept of the core differently, and thus exercises and programs to increase core stability. Also, there is no consensus among them on whether and to what extent core stability affects performance improvement (Willardson, 2007). Also, there is no clear boundary that would separate core exercises from traditional exercises.

CONCLUSION

In this paper, the structure, functional and morphological status of the muscles that make up the body's core are presented, as well as how improving the core affects the advancement of sports technique and its efficiency. Most research shows that core stability improvement programs are very effective in an untrained population, as well as in athletes who are in the process of the rehabilitation. These studies suggest that it is necessary to incorporate a program to increase the lumbar stabilization at the beginning of basic sports programs. Also, as strength, endurance, coordination and skills are improved, it is necessary to continually improve lumbar stabilization programs. Recommended core stability exercises typically include isometric muscle activity, low exercise, and long periods of tension. This approach does not mean a certain improvement in core stability. Also, it is not certain that increased core stability will lead to a better sports performance.

Basically, clear consent is the first thing that needs to happen among sports experts; agreement on what the core is and which exercises are most effective for its development. Perhaps research should focus on traditional forms of exercise (e.g. the deadlift, different

types of squats, cleans, different types of thrusts and jerks) and examine how much they affect core stability and how much the development of stability affects their performance. To date, no battery of tests has been established that accurately assesses core stability in healthy athletes. The focus of future research should be on finding the appropriate core stability tests incorporating dynamic muscular activity while maintaining relatively high posture loads, consistent with the core stability requirements in sports performance.

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KINANTROPOLOŠKA ANALIZA TRUPA

Cilj ovog istraživanja je da se sprovede pretraga postojećih istraživanja koja se bave temom strukture, funkcionalnog i morfološkog statusa mišića trupa, kao i kako trup utiče na unapređenje sportske tehnike i efikasnosti. Termin "core" najčešće se odnosi na trup, tačnije na lumbalni region. Mišići trupa igraju značajnu ulogu u poravnanju i stabilnosti donjih ekstremiteta, povezanih sa povredama. Razvoj snage trupa u poboljšanju efikasnosti sportskih performansi je kontroverzno pitanje koje sa različitim rezultatima. Analizom članaka u naučnim časopisima utvrđeno je da je od posebne važnosti specifičnost programa za povećanje lumbalne stabilizacije odgovarajućim sportom ili veštinom. Zbog toga je neophodno sprovesti specijalizaciju trenažnih uslova na način da odgovaraju određenoj sportskoj grani ili disciplini.

Ključne reči: *stabilnost trupa, snaga, trening, sportske performanse*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 345 - 354
https://doi.org/10.22190/FUPES190402032B

Research article

EFFECTS OF GROUP FITNESS PROGRAMS ON THE BODY COMPOSITION OF WOMEN

UDC 796.012.1.32:615

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Abstract. *The aim of the research was to determine effects of group fitness programs of different intensity on changes in body composition. The sample comprised 90 women, aged 25 to 35. The sample consisted of two experimental groups, Zumba (n=30), Fitness (n=30), and one control group (n=30). The applied variables for assessment and changes in body composition were: total body fat (%), total muscle mass (kg), right arm fat (%), left arm fat (%), right leg fat (%), left leg fat (%), torso fat (%). Differences between the groups for each variable were determined through a univariate analysis of variance (ANOVA) and with the LSD Post Hoc test. Based on the results of the study, statistically significant differences were determined in all tests except in left and right arm fat (%). Muscle mass increase was most prominent in the experimental Fitness group (.000), whereas reduction in body fat was most prominent in the Zumba group (.035). It can be concluded that implemented experimental exercise programs, as well as the applied intensity of maximum heart frequency in the experimental groups (Zumba 65-85%; Fitness 55-75%) significantly impacted the changes in body composition at the final measuring, in comparison to the initial one.*

Key words: *Body Fat, Muscle, Zumba, Physical Activity*

INTRODUCTION

Physical activity significantly impacts the consumption of energy, leads to energy deficit which contributes to reduction in body weight (Van Baak, 1999; Hill, & Davies, 2001; DeLany, Kelley, Hames, Jakičić, & Goodpaster, 2014). A significant segment is dosing the load, for it is in close correlation with the exercise outcome, i.e., lost weight and changes in body composition (Jakičić, Marcus, & Gallegher, 2003; Slentz et al., 2004).

Received April 04, 2019 / Accepted September 10, 2020
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Body composition represents relative values of muscles, fat, bones and other anatomic components that contribute to the total body weight of a man (Solway, 2013). In practice, the most used are traditional methods of determining body composition based on a two-component model, according to which total body mass is comprised of two parts: fat and non-fat mass (Ellis, 2001). For example, percentage of body fat increases with age (Deurenberg, van der Kooy, Leenen, Weststrate, & Seidell, 1991) and it is more pronounced among the female than male population (Gallagher et al., 1996). Application of certain group fitness programs brings significant changes in body composition, because the application of certain movement structures is a significant anabolic stimulant for the body (Eliakim & Beyth, 2003). Due to the extent, intensity and character of the applied group fitness programs and constant muscle contractions, the biggest changes are reflected in the change of muscle mass and body fat percentage (Frost, 2000). Group fitness programs are a form of programmed physical exercise for women with the goal of improving health and esthetic appearance. Group fitness programs are an efficient tool for the control and reduction of body weight and positive changes in body composition (Donges, Duffield, & Drinkwater, 2010; Stasiulis, Mockiene, Vizbaraite, & Mockus, 2010; Elmahgoub et al. 2009). Zumba as a reflection of the fitness industry is a program with dance structures that, aside to physical, include social and emotional elements (Murciaa, Kreutzb, Cliftc, & Bongarda, 2010). Zumba fitness is a compound of aerobic exercise and Latin dance, performed along with entertaining Latino music (Ljubojević, Jakovljević, & Popržen, 2014). As a combination of aerobic training and strength exercise, Zumba is a good way to increase caloric consumption, improve the function of the cardio-vascular system and strengthen the entire body (Perez & Greenwood-Robinson, 2009). Research shows that Zumba dance encourages calorie consumption in the range between 378 and 817 kcal/h (Otto et al., 2011; Luettgen, Foster, Doberstein, Mikat, & Porcari, 2012; Sternlicht, Frisch, & Sumida, 2013) which is more than the recommended 300 kcal/h (ACSM, 2009). If we consider fitness programs that use additional load like weights along with certain movements, the effects on energy consumption and load intensity shall be completely different. After all, from these programs we can expect a certain level of muscular fiber hypertrophy, which is not the case with Zumba dance. Exercising with weights contributes to the preservation of muscle mass and strength thus improving the physical and functional abilities of female gymnasts (Kryger & Andersen, 2007).

The aim of the research was to determine the effects of group fitness programs of different intensity on changes in body composition.

METHOD

The research and measuring procedures were implemented on a sample of (N=90) females. The sample was divided into 3 sub-samples, two experimental groups: E1 – Zumba program (N=30); E2 – second Fitness program (N=30) and a control group K (N=30).

The sampled population is defined as the population of women aged between 25 and 35.

The following variables were extracted for body composition assessment: body weight (kg), total body fat (%), total muscle weight (kg), right arm fat (%), left arm fat (%), right leg fat (%), left leg fat (%), torso fat (%). All body composition parameters were measured with the segmental analyzer TANITA type BC-545n. The body weight variable (kg) was not subject to statistical data processing.

Before the commencement of the experimental program (first week), initial measuring of the experimental and control groups was carried out. After establishment of the initial state, the experimental group of participants took part in fitness programs. The control group participants were not involved in any type of systematic exercise (inactive women). Trainings were two times a week, one hour long.

The Zumba classes were led by a licensed fitness instructor. Exercise intensity was set by the music tempo, which changed during the training (65-85%) of maximum heart frequency. The warm-up lasted for 7 to 10 minutes (2-3 songs, tempo 120-135 u/m), and in the second part of the warm-up, the participants did strength exercises with moderate intensity through dance variations with lunges in semi-crouches (music tempo 125-140 u/m). The main part of the training was done with previously prepared Zumba music (6-7 genuine Zumba songs) which regulate the change of 30 tempos and dynamics of performing dance choreographies (tempo 140-160 u/m). Dances are 3-5 minutes long, and breaks between the dances are 15-30 seconds. All Latin dances differ in movement character and performance dynamics.

Fitness programs were realized with a slightly different load intensity (55-75%) of maximum heart frequency. In comparison to Zumba, the program structure is differently based. In the introductory part, lasting 8-10 minutes, the participants move in place and space and do complex shaping exercises (8-10 exercises, 10-12 repetitions). The main part of the training is done in line with previously prepared exercises which are divided per muscle partitions and each training puts emphasis on one big and one small muscle group. Exercise emphasis was distributed along the leg muscles, back muscles, arm muscles, abdominal muscles, shoulder muscles and chest muscles. Exercises are done either with own weight or with additional load by using existing props with the possibility of applying previously determined musical choreographies. The final part of the training, lasting 5-8 minutes, has the purpose of stretching and loosening all muscle regions, with emphasis on proper breathing and controlled muscle stretching.

The obtained results were processed in statistical software SPSS 20 for the purpose of this research. Basic statistical indicators were calculated with basic descriptive statistics. The following parameters were calculated: Mean; standard deviation (SD); minimum value (Min); maximum value (Max). Determining differences between groups for each variable was performed with a univariate analysis of variance (ANOVA) and by using the LSD Post Hoc test.

RESULTS

The values of result distribution symmetry indicators or skewness (Skew.) of body composition of the experimental Zumba group presented in Table 1 are in the allowed range of normal result distribution at initial measuring. Mild positive asymmetry towards lower values was recorded in all variables except for the variable - right leg fat (%) (-.02).

The values of elongation of result distribution or Kurtosis (Kurt.) of body composition of the participants, show mild platykurtic distribution in nine variables, while a slight variation in the leptokurtic distribution is indicated in the remaining variables except the variable - torso fat (%), where the distribution of the results is close to the arithmetic mean and the leptokurtic distribution is more pronounced, but still within the limits of normal distribution (Kurt.=2.15).

Table 1 Descriptive parameters of body composition of the experimental Zumba group at the initial and final measuring (n=30)

Initial measuring						
Variable	Mean	Min.	Max.	SD	Skew	Kurt.
Total body fat (%)	23.46	14.20	36.70	5.13	.35	-.03
Total muscle mass (kg)	48.33	40.40	59.80	4.93	.28	-.29
Right arm fat (%)	18.44	11.30	29.30	4.20	.77	.86
Left arm fat (%)	18.78	11.70	28.40	4.30	.44	-.02
Right leg fat (%)	26.36	17.90	35.20	4.18	-.02	-.13
Left leg fat (%)	25.62	18.00	35.20	4.29	.05	-.17
Torso fat (%)	20.21	10.90	35.10	4.84	.69	2.15
Final measuring						
Total body fat (%)	19.89	12.20	28.10	3.91	-.00	-.62
Total muscle mass (kg)	49.59	40.00	62.80	5.34	.29	-.04
Right arm fat (%)	18.11	11.10	27.20	3.92	.45	.20
Left arm fat (%)	18.19	11.40	27.90	4.10	.37	.06
Right leg fat (%)	23.73	15.00	30.60	3.60	-.57	.19
Left leg fat (%)	23.59	15.20	29.30	3.48	-.68	.09
Torso fat (%)	17.83	10.20	27.80	3.68	.36	1.13

The values of result distribution symmetry indicators (Skew.) of body composition of the experimental Zumba group at the final measuring are in the allowed range of normal result distribution. A mild positive asymmetry towards lower values was recorded in eight variables except for the variables - right leg fat (%) (-.57), left leg fat (%) (-.68).

Table 2 displays a mild positive asymmetry towards lower values for two variables, whereas for the remaining four it shows a mild negative asymmetry towards higher result values. The values of elongation of the result distribution (Kurt.) of body composition of the participants show mild leptokurtic distribution in some variables, right leg fat (%) (.05) and left leg fat (%) (.57).

Table 2 Descriptive parameters of body composition of the experimental Fitness group at the initial and final measuring (n=30)

Initial measuring						
Variable	Mean	Min.	Max.	SD	Skew	Kurt.
Total body fat (%)	25.31	18.50	33.20	3.90	.31	-.29
Total muscle mass (kg)	48.96	38.10	59.40	5.50	.16	-.83
Right arm fat (%)	18.43	13.60	22.50	2.40	-.06	-.88
Left arm fat (%)	18.62	13.80	22.70	2.32	-.22	-.58
Right leg fat (%)	28.14	19.90	34.60	3.89	-.62	.05
Left leg fat (%)	28.24	19.70	34.70	3.72	-.75	.57
Torso fat (%)	22.58	16.40	33.70	4.41	.87	-.00
Final measuring						
Total body fat (%)	22.21	16.00	27.50	3.10	-.08	-.87
Total muscle mass (kg)	51.91	40.30	64.10	6.19	.28	-.79
Right arm fat (%)	17.66	13.10	21.50	2.23	.01	-.64
Left arm fat (%)	17.78	13.20	21.60	2.19	-.13	-.60
Right leg fat (%)	25.40	18.00	30.20	3.07	-1.03	.61
Left leg fat (%)	25.44	18.70	30.10	2.98	-.93	.34
Torso fat (%)	21.02	16.20	30.10	3.35	.99	.40

At the final measuring, the variables – right leg fat (%) (.61), left leg fat (%) (.34) and torso fat (%) (.40), show a mild leptokurtic distribution.

Table 3 Descriptive parameters of body composition of the Control group at the initial and final measuring (n=30)

Initial measuring						
Variable	Mean	Min.	Max.	SD	Skew	Kurt.
Total body fat (%)	25.60	18.40	33.90	3.87	.17	-.18
Total muscle mass (kg)	47.86	39.50	59.40	5.22	.36	-.54
Right arm fat (%)	18.41	13.50	26.40	3.05	.43	.57
Left arm fat (%)	18.57	13.50	26.60	3.08	.39	.48
Right leg fat (%)	28.26	20.40	35.80	3.97	-.12	-.23
Left leg fat (%)	28.23	21.20	35.80	3.94	.06	-.57
Torso fat (%)	24.00	16.90	32.60	4.42	.31	-.95
Final measuring						
Total body fat (%)	26.41	18.70	33.40	3.36	-.34	.51
Total muscle mass (kg)	48.16	39.70	60.20	5.09	.38	-.21
Right arm fat (%)	18.58	13.40	25.20	2.97	.25	-.22
Left arm fat (%)	18.56	13.70	25.60	2.92	.39	-.03
Right leg fat (%)	28.66	20.90	35.70	3.66	-.40	.19
Left leg fat (%)	28.70	21.00	35.80	3.65	-.34	-.01
Torso fat (%)	24.36	17.50	32.90	4.07	.18	-.94

Table 3 shows a mild positive asymmetry towards lower result values for most of the variables, whereas for the variable - right leg fat (%) we recorded a mild negative asymmetry towards higher result values. At the final measuring, mild positive asymmetry towards lower result values was recorded for most of variables, whereas for the variables - total body fat (%) (-.34), right leg fat (%) (-.40) and left leg fat (%) (-.34), we recorded a mild negative asymmetry towards higher result values.

The values of elongation of result distribution (Kurt.) of the body composition of the participants show mild platykurtic distribution in all variables, except for the variables - total body fat (%) (.51) and right leg fat (%) (.19), whose values show mild leptokurtic distribution.

In Table 4, at the initial measuring, one can notice that differences were caused by the variables - torso fat (%) (f=5.301; sig.=.007) and left leg fat (%) (f=2.487; sig.=.017), where participants from the experimental Zumba group (E1) achieved significantly better results than the experimental Fitness group (E2) and Control group (K).

The significance of these differences can be seen in Table 5, which displays the results of Fisher's LSD test for the variables - left leg fat [%] (E1>E2, Sig.=.013; E1>K, Sig.=.013) and torso fat [%] (E1>E2, Sig.=.047; E1>K, Sig.=.007).

Table 4 Univariate differences in body composition between groups at the initial and final measuring

Initial measuring						
Variable	Mean E1	Mean E2	Mean K	F	Sig.	Fisher's LSD
Total body fat (%)	23.46	25.31	25.60	2.152	.122	
Total muscle mass (kg)	48.33	48.96	47.86	.333	.718	
Right arm fat (%)	18.44	18.43	18.41	.001	.999	
Left arm fat (%)	18.78	18.62	18.57	.034	.967	
Right leg fat (%)	26.36	28.14	28.26	2.104	.128	
Left leg fat (%)	25.62	28.24	28.23	4.287	**.017**	E1>E2; E1>K
Torso fat (%)	20.21	22.58	24.00	5.301	**.007**	E1>E2; E1>K
Final measuring						
	Mean E1	Mean E2	Mean K	F	Sig.	Fisher's LSD
Total body fat (%)	19.89	22.21	26.41	27.121	**.000**	E1>E2; E1>K; E2>K
Total muscle mass (kg)	49.59	51.91	48.16	3.471	**.035**	E2>K
Right arm fat (%)	18.11	17.66	18.58	.646	.527	
Left arm fat (%)	18.19	17.78	18.56	.455	.636	
Right leg fat (%)	23.73	25.40	28.66	15.838	**.000**	E1>K; E2>K
Left leg fat (%)	23.59	25.44	28.70	17.581	**.000**	E1>E2; E1>K; E2>K
Torso fat (%)	17.83	21.02	24.36	23.267	**.000**	E1>K; E2>K

Table 5 Fisher's LSD test results

Variable	I	J	Mean Diff. (I-J)	Sig.
Left leg fat (%)	E1	E2	-2.62	**.013**
		K	-2.61	**.013**
	E2	K	.01	.995
Torso fat (%)	E1	E2	-2.37	**.047**
		K	-3.79	**.002**
	E2	K	-1.42	.230

At the final measuring, one can notice that differences were caused by the variables- total body fat (%) (F=27.121; Sig.=.000), total muscle mass (kg) (F=3.471; Sig.=.035), right leg fat (%) (F=15.838; Sig.=0.000), left leg fat (%) (F=17.581; Sig.=.000), where the participants from the experimental Zumba group (E1) and experimental Fitness group (E2) achieved significantly better results than the Control group (K) in all the given variables except for the variable - total muscle mass (kg), where only the E2 group achieved better results than the C group. For the variables - total body fat (%) and Left leg fat (%), the participants of the E1 group achieved more superior results than the E2 group. The significance of the given differences can be seen in Table 6, which displays Fisher´s LSD test for the variable - total body fat (%) (E1>E2, Sig.=.011; E1>K, Sig.=.000; E2>K, Sig.=.000), total muscle mass (kg) (E2>K, Sig.=.011), right leg fat (%) (E1>K, Sig.=.000; E2>K, Sig.=.000), left leg fat (%) (E1>E2, Sig.=.037; E1>K, Sig.=.000; E2>K, Sig.=.000) and torso fat (%) (E1>E2, Sig.=.001; E1>K, Sig.=.000; E2>K, Sig.=.001).

Table 6 Fisher's LSD test results

Variable	I	J	Mean Diff. (I-J)	Sig.
Total body fat (%)	E1	E2	-2.32	**.011**
		K	-6.51	**.000**
	E2	K	-4.20	**.000**
Total body muscle mass (kg)	E1	E2	-2.32	.110
		K	1.43	.323
	E2	K	3.75	**.011**
Right leg fat (%)	E1	E2	-1.67	.065
		K	-4.93	**.000**
	E2	K	-3.27	**.000**
Left leg fat (%)	E1	E2	-1.85	**.037**
		K	-5.11	**.000**
	E2	K	-3.26	**.000**
Torso fat (%)	E1	E2	-3.20	**.001**
		K	-6.54	**.000**
	E2	K	-3.34	**.001**

DISCUSSION

On the basis of the descriptive parameters for body composition assessment, as one of the fitness components, it can be concluded that the participants of both the experimental and control groups have similar values of given parameters at the initial measuring and they are in the allowed range of normal values anticipated for the given age (Ugarković, 1986; Mišigoj-Duraković, Hajmer, & Matković, 1998; Mladenović, Joksimović, & Krstić, 2001). At the initial measuring, total body fat (%) is slightly lower for the experimental Zumba group (23.46%) than for the experimental Fitness group (25.31%) and control group (25.60%). The percentage value is in normal distribution for the given population (Wilmore, Buskirk, DiGirolamo, & Lohman, 1994; Deurenberg et al., 1998; Tharp & Woodman, 2002; Heyward, 2006; Egger, Champion, Egger, Champion, & Bolton, 1999). The obtained descriptive parameters at the final measuring show that the participants from the experimental groups had numerical reduction in measures for body composition assessment. High intensity load programs lead to a faster reduction of body fat (Bryner, Toffle, Ullrich, & Yeater, 1997). The application of group fitness programs may initiate the function of energy consumption, which results in the reduction of fat and body weight. Load intensity during the program has a great significance (Grediagin, Cody, Rupp, Benardot, & Shern, 1995). A group of authors highlighted that exercising at full intensity has a more favorable effect on fat loss in all body regions (Lee, Park, Kim, Choi, & Kim, 2012; Amiri, Mirzaie, & Elmieh, 2013). The highest determined values are for the reduction of total body fat (%) (Zumba, initial 23.46, final 19.89; Fitness, initial 25.31, final 22.21). The achieved results were most prominent for the experimental Zumba group for all variables, except for total muscle mass (kg) (initial 48.33, final 49.59) which was better for the second experimental Fitness group (initial 48.96, final 51.91) in comparison to the experimental Zumba group and control group (initial 47.86, final 48.16). The noted changes in body composition might be attributed to the implementation of the experimental program, which was proved in other studies as well (Mitić, 1995; Ross et al., 2000;

Ljubojević et al., 2002; Pantelić & Mladenović, 2004; Bjelica et al., 2016). In both the final and initial measuring, there were numerical differences between the experimental and control groups in body composition, which is in line with other studies (Milburn & Butts, 1983; Wilmore & Costill, 1999). Significant changes were also reflected in the reduction of total body mass (Zumba, initial 65.33-final 60.77; Fitness, initial 66.93-final 63.20) displayed in (kg). Similar results are in line with other studies (Kostić, Đurašković, Miletić, & Mikalački, 2006; Petrofsky, Batt, & Morris, 2006).

Taking all of the above into consideration, it can be concluded that the implemented experimental exercise programs significantly influenced changes in body composition as one of the fitness components for the participants of both experimental groups in the final measuring in comparison to the initial one, which is reinforced by the results of other studies (Preeti, & Nigudkar, 2016; Šebić, Ljubojević, Nožinović, Omerhodžić, & Kajević, 2016; Maisarah et al., 2018).

CONCLUSION

It can be concluded that the implemented experimental exercise programs, as well as the applied intensity of maximum heart frequency for experimental groups (Zumba 65-85% and Fitness 55-75%) significantly influenced the changes in body composition of the participants. Changes are evident in the reduction of fat and increase of muscle mass among the participants. There were no statistically significant changes in the Control group. Reduction of body fat is one of the important factors for health and risk reduction for many diseases, so a group program approach is recommended as an efficient tool.

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EFEKTI GRUPNIH FITNES PROGRAMA NA SASTAV TELA ŽENA

Cilj istraživanja bio je da se utvrde efekti grupnih fitnes programa različitog intenziteta na promene u telesnom sastavu. Uzorak je sačinjavalo 90 žena, starosti od 25 do 35 godina. Uzorak su sačinjavale dve eksperimentalne grupe, Zumba (n=30), Fitness (n=30), i jedna kontrolna grupa (n=30). Primenjene promenljive za procenu i promene u telesnom sastavu bile su: ukupna masnoća u telu (%), ukupna težina mišića u telu (kg), masti desne ruke (%), masti leve ruke (%), masti desne noge (%), masti leve noge (%), masti trupa (%). Razlike između grupa za svaku promenljivu utvrđene su univarijantnom analizom varijanse (ANOVA metodom) i LSD Post Hoc testom. Na osnovu rezultata istraživanja, statistički značajne razlike su utvrđene u svim testovima, osim u masti leve i desne ruke (%). Povećanje mišićne mase bilo je najizraženije u eksperimentalnoj fitnes grupi (.000), dok je smanjenje telesne masti bilo najizraženije u grupi Zumba (.035). Može se zaključiti da su primenjeni eksperimentalni programi vežbanja, kao i primenjeni intenzitet maksimalne frekvencije srca u eksperimentalnim grupama (Zumba 65-85%; fitnes 55-75%), značajno uticale na promene u telesnom sastavu na završnom merenju, u poređenju sa početnim.

Ključne reči*: telesna masnoća, mišići, zumba, fizička aktivnost*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 355 - 369
https://doi.org/10.22190/FUPES200826033S

Research article

FEEDBACK USE AND PERCEPTIONS OF PHYSICAL EDUCATION PRE-SERVICE TEACHERS

UDC 796.01.015
796.356.361

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Abstract. *The purpose of this study was to explore the use of feedback and perceptions of the use of feedback by pre-service teachers in peer-teaching (instructing their peers in university classes) and practical placement settings (teaching in schools). Pre-service teachers specializing in primary physical education (PE) and one other teaching method (n=59) were observed while teaching a 15-minute lesson in a peer-teaching setting, with six participants also observed while teaching on practical placement. Participants retrospectively recalled the feedback they perceived providing during the lesson. Average feedback frequency rate was once every 56 seconds in peer-teaching and once every 86 seconds in practical placement. The most common type of feedback provided was verbal, non-skill related, positive feedback. Pre-service teachers perceived that they provided feedback significantly more often than they actually did (every 41 seconds versus every 56 seconds in peer-teaching). In peer-teaching, pre-service teachers perceived that they provided significantly more non-verbal, negative, knowledge of results, descriptive, and corrective types of feedback than they actually provided, whereas they perceived that they had provided significantly less verbal, non-skill related, positive, knowledge of performance, prescriptive, and terminal types of feedback than they actually provided (p<01). Pre-service teachers provided feedback frequently in peer-teaching and practical placement settings, but less often in practical placement than peer-teaching. Actual and perceived feedback frequencies differed significantly and suggest that pre-service teachers may not always be aware of how often and the type of feedback they are providing, highlighting that PE teacher education programs may need to work with pre-service teachers to develop self-awareness.*

Key words: *Knowledge of Performance, Knowledge of Results, Teacher Effectiveness, Physical Education, Motor Learning*

Received August 26, 2020 / Accepted September 10, 2020
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INTRODUCTION

Providing feedback to students during physical education (PE) is considered to be an essential teacher behavior influencing time on task, participation, and student motivation as well as skill acquisition. The provision of feedback to learners has been studied extensively in motor learning and skill acquisition as well as discussed widely in pedagogy literature (Maksimović, & Osmanović, 2018; Rink, 2020). Although feedback is perceived as important to learning in PE, studies have rarely described teachers who actually provide feedback, so we have limited practical understanding of the use of feedback in PE. In PE, the provision of feedback is often prescribed as part of education and evaluation of pre-service teachers (Rink, 2020). It is also commonly listed as a key component of professional standards for PE teachers (Australia Institute for Teaching and School Leadership, 2011). Thus, researchers, theorists, and practitioners have identified providing feedback as important in teacher effectiveness.

Teacher effectiveness in PE can be conceptualized narrowly in terms of student and teacher behaviors related to producing student outcomes (Rink, 2014), with teacher evaluation often focused on teacher process variables including the provision of feedback (Ward, 2014). Much of the teacher effectiveness research in PE has been based on teacher processes, with outcomes aligned to the direct instructional approach, which emphasizes the provision of feedback (Metzler, 2014).

Feedback

Feedback is information that the learner receives about their performance. In PE, this is often called teacher feedback (Lee, Keh, & Magill, 1993), while in motor learning, feedback provided by a teacher or coach is termed augmented (or extrinsic) feedback (Magill & Anderson, 2020). Motor learning researchers have been interested principally in the use of feedback to improve skill performance (Rink, 2003); however, PE researchers have distinguished between feedback about the skill and more general feedback (van der Mars, Vogler, Darst, & Cusimano, 1998; Fredenburg, Lee, & Solmon, 2001). Thus, feedback could be skill-related (feedback that has information about the performance of the skill or knowledge required to perform the task) or non-skill related (feedback that does not give information specifically about performance of the skill, including positive forms of encouragement or motivation or negative forms of punishment or behavior correction) (Spittle, 2013; Magill & Anderson, 2020).

Skill-related feedback in motor learning is often classified and described in terms of whether it provides information about the outcome of performance (Knowledge of Results-KR) or the process of performing the skill (Knowledge of Performance-KP) (Magill & Anderson, 2020). Irrespective of the importance placed upon KR and KP in the motor learning literature, researchers in PE have rarely investigated the use of KR and KP in practice. Skill-related feedback can also be descriptive, prescriptive, or corrective. Descriptive feedback refers to feedback that describes an error in performance without evaluation (Spittle, 2013). Prescriptive feedback provides information that prescribes how to make a performance better (Spittle, 2013). Corrective feedback refers to a combination of both descriptive and prescriptive feedback, that is, an error is outlined and a correction is provided (Silverman, Tyson, & Krampitz, 1992).

Feedback frequencies

Just as the type of feedback provided can vary, when feedback is provided (timing) and how often feedback is provided (frequency) can vary. Concurrent feedback is provided during the performance of a skill, whereas terminal feedback is provided after the performance of a skill (Magill & Anderson, 2020). The feedback frequency that generates the most effective learning of movement skills varies (Magill & Anderson, 2020) and studies in PE on relationships between the amount of feedback provided by teachers and student performance have been equivocal (see Lee et al., 1993; Silverman, 1994; Rink, 2020). Early theorists and researchers believed that higher frequencies improved motor learning, and in PE the notion that providing more feedback was better also emerged (Silverman, 1994). Providing feedback less frequently, however, encourages the learner to engage in more active learning processes and, potentially, try alternative and potentially more effective learning strategies (Salmoni, Schmidt, & Walter, 1984; Winstein & Schmidt, 1990). In addition, in PE, what was once deemed to be most effective, that is higher feedback frequencies, was aligned most often with more with direct instructional models, rather than other instructional models (Metzler, 2011; 2014).

Much of the research on feedback frequency has examined the influence that feedback has on the learner (e.g., Kernodle & Carlton, 1992; Koka & Hein, 2005), not on the type and frequency of feedback actually provided by a teacher. Motor learning studies have predominantly been conducted in controlled, laboratory settings with feedback frequency of each individual learner regulated. Few studies have been conducted in PE settings, and the studies that have been reported in the literature have generally utilized classes that have been structured and designed by the experimenters. Researchers have rarely investigated how teachers provide feedback in PE when not provided with explicit instructions on feedback provision. Thus, our understanding of how often and what types of feedback are provided in PE is limited. In addition, researchers have not concentrated on how pre-service teachers, as opposed to in-service teachers, use feedback in their teaching.

The limited and often dated available research on feedback frequencies in PE, suggests that teachers do provide feedback frequently, that is, it is provided at a frequency of more than once per minute. An early review of research suggested that in general, teachers provided feedback as often as 30-60 times throughout a 30-minute lesson (Siedentop, 1991), with more recent data largely confirming this review (Behets, 1997; Spittle, Kennedy, & Spittle, 2012). For example, Fishman and Tobey (1978) found that PE teachers provided feedback at rates above once per minute, with KP provided 94% of the time. Silverman and associates (1992) and Silverman, Woods, and Subramaniam (1998) reported that teachers (n=8 and n=7, respectively) were providing feedback at an average rate of once every 30 to 60 seconds. Although on average feedback rates were high, there was much variability between teachers, with one teacher providing nearly seven times as much feedback as another. Behets (1997) found that teachers (n=9) provided feedback on average once every 19.48 seconds. van der Mars and associates (1998) reported that elementary school teachers (n=18) provided mostly skill related or positive feedback at a rate of once every 16.09 seconds. Tan (1996) revealed that experienced teachers (n=5) provided feedback on average once every 27.6 seconds and inexperienced teachers (n=5) provided feedback once every 35.9 seconds. A more recent study by Spittle and associates (2012) observed that feedback was provided by PE teachers (n=23) on average every 42.39 seconds.

In the studies reported here, there is some consistency in the type and frequency of feedback provided. Commonly, feedback was provided at rates of between once every 30-

60 seconds of lesson time. In general, it is thought that teachers provide feedback during skill practice rather than game play, direct feedback to individuals rather than groups, and provide verbal feedback more often than non-verbal feedback (Siedentop, 1991). Feedback provided most often takes the form of non-skill related, positive evaluative statements and is used as a form of encouragement or motivation for students (Silverman, 1991). When skill related feedback is provided, KP is used at a much greater rate than KR (Fishman & Tobey, 1978; Silverman et al., 1992; Silverman et al., 1998; Spittle et al., 2012).

In the studies reported, feedback frequencies between individual teachers varied substantially, with high standard deviations observed. In many of the studies, feedback events were not reported in relation to time spent in activity, rather in relation to overall lesson duration. In PE, teachers spend time on transitions between activities, explanations, demonstrations and skill presentations, meaning that students are not physically active for an entire lesson. These periods not only lessen the amount of time students spend in activity, but also the amount of time available to give feedback. To determine true rates of feedback frequency, only the times spent in activity should be used. Further information on actual frequencies of feedback in PE settings, including research on the amount of feedback received by individual students, is required to further understand effective teaching behavior.

Experience and knowledge

Provision of feedback is potentially associated with stronger pedagogical and content knowledge in PE, so that more effective teachers provide feedback more effectively (Ward, 2009), with the use of corrective, quantitative feedback indicative of pedagogical content knowledge of primary school teachers (Creasy, Whipp, & Jackson, 2012) and more use of specific congruent feedback with improved content knowledge (Ward, Kim, Ko, & Weidong, 2014). Pre-service teachers, because they are currently engaged in physical education teacher education (PETE) programs may be influenced in their use of feedback by their current pedagogical and content knowledge, which may mean that their use of feedback differs from more experienced teachers. Earlier studies on pre-service teachers have measured feedback use in simulated or peer learning situations. For example, Landin, Hawkins, Hebert, and Cutton (2001) reported that pre-service PE teachers (n=14) provided descriptive feedback at an average rate of once every 87 seconds and prescriptive feedback every 25 seconds in the initial lesson in a peer-teaching exercise as part of their course. This rate of feedback provision appears to be similar to other studies with teachers. As feedback is considered an important teacher behavior, understanding how pre-service teachers use feedback and their perceptions surrounding their use of feedback may assist in developing more effective teacher behaviors in pre-service teachers.

Perceptions of feedback use

It is possible that teachers, and pre-service teachers, are not aware of how often and what types of feedback they provide. Part of being an effective teacher and creating effective learning environments is understanding and reflecting on your practice. Teacher perceptions of feedback behavior refer to the amount of feedback an instructor thinks that they are giving to their students or a class. Most research on perceptions of feedback behavior in PE has focused on students' perceptions rather than teachers' perceptions (Hastie & Saunders, 1991; Nicaise, Cogerino, Fairclough, Bois, & Davis, 2007). In the field of coaching, however, a few studies have observed coaches and subsequently asked

coaches to recall their behaviors. These studies have found that most coaches are unaware of how frequently they performed certain behaviors (Smoll & Smith, 2006; Millar, Oldham, & Donovan, 2011). For example, Millar and associates (2011) examined the recall ability of rowing coaches on the timing, nature and content of feedback provided and found that coaches were largely inaccurate at recalling their feedback to athletes. Coaches gave more concurrent and prescriptive feedback and less terminal and descriptive feedback than they thought.

Whilst these studies have focused on the recall ability of coaches and not teachers, the results suggest that instructors in movement domains may not keep track of the frequency and type of feedback they are providing. We know little about how aware pre-service teachers are of how often and the types of feedback they provide in teaching. Exploring how well teachers recognize their teaching behaviors has implications for how they can become more effective in their teaching.

Studies on teacher feedback have not compared how pre-service teachers use feedback in peer-teaching and in actual teaching situations. Peer-teaching appears to be used frequently in PETE programs to provide experience of teaching to pre-service teachers, as well as to simulate the teaching experience. Typically in peer-teaching, pre-service teachers will be teaching their peers, that is, other pre-service teachers. One question that arises from this practice is how well this simulates or recreates the real authentic experience of teaching. For example, pre-service teachers may be more comfortable with their peers or teaching their peers may be confronting and may lead to less frequent feedback provision because of concerns related to their pedagogical content knowledge (Ward, 2009). Exploring how feedback varies between peer-teaching and actual teaching situations with pre-service teachers would help understanding the effectiveness of peer-teaching in PETE programs for influencing important teacher behaviors.

Aims

The purpose of this study was to explore the use of feedback and perceptions of the use of feedback by pre-service teachers in peer-teaching (instructing their peers in university classes) and practical placement settings (teaching in schools). The specific aims were to explore the frequency and type of feedback provided in peer-teaching settings; explore the frequency and type of feedback provided in practical placement settings; explore the perceived frequency and type of feedback used in peer-teaching; explore the perceived frequency and type of feedback used in practical placement; and compare actual and perceived feedback frequencies in peer-teaching and practical placement settings.

METHODS

Participants

Participants were 59 pre-service teachers (32 male aged 21.50±2.08 years, Mean±SD and 27 female aged 21.30±2.48 years, Mean±SD). Pre-service teachers were all completing a 4-year Bachelor of Education (Prep to Year 12 [K-12]), specializing in primary PE and one other teaching method (e.g., health, math, science, English). Participants were recruited from a core primary PE unit, normally studied in the second year. The majority of participants

(n=44) reported being in their second year, with a further 14 participants in their third year and one student in their fourth year of study.

Materials

Participant demographic form

Participants completed a demographics form to provide information on their gender, age, year of their degree, and the number of PE units they had completed as part of their course.

Feedback Observation System

The Feedback Observation System was used to record feedback provided by the participants. The system was based on the measure used initially by Fishman and Tobey (1978) and adapted in various subsequent studies (Faucette & Patterson, 1990; Silverman et al., 1992; Landin et al., 2001). Feedback observed during activity time in the lesson was recorded in the system. The type of feedback was initially classified as either skill-related feedback or non-skill-related feedback. The researcher also recorded whether the feedback was verbal on non-verbal and whether it was concurrent with or terminal to skill performance. Skill-related feedback was further classified as KP or KR, and as descriptive, prescriptive or corrective. Non skill-related feedback was classified as either positive or negative. A copy of the Feedback Observation System is available from the authors.

Teacher Feedback Perception Response Sheet

The Teacher Feedback Perception Response Sheet was developed by the researchers and was used by the pre-service teachers to record their perceptions of their own feedback behavior during the delivery of the lesson. The response sheet provided a definition along with an example of each type of feedback. The response sheet asked the participant to retrospectively recall the frequency of each type of feedback they felt they provided. A copy of the Teacher Feedback Perception Response Sheet is available from the authors.

Procedure

Ethics approval was granted by a University Human Research Ethics Committee as well as the State Department of Education and Training to conduct research in schools. Permission was granted by the lecturer in charge of the core primary PE unit studied by the pre-service teachers to recruit participants from that class. The unit was selected as it is a core unit and pre-service teachers complete a practical peer-teaching assessment in class. In addition to this, the pre-service teacher cohort completing the unit also participated in practical placement where they may have the opportunity to teach a PE lesson in schools. Participants were approached during class and asked to participate in the study. They were informed that participation was entirely voluntary and would not affect their performance or success in any unit. All sessions were observed and recorded by the same researcher.

Peer-teaching setting

Peer-teaching data was collected during tutorials. All participants delivered a 15-minute PE lesson to their peers, focused on teaching a particular primary school dance, such as the

'Honky Tonk Stomp', 'Men in Black' and the 'Cowboy Hustle'. Each dance taught by the participants differed, and was determined by the unit tutor earlier in the semester. The data collection procedure for the peer-teaching setting followed the following steps: participants were asked to complete a Participant Demographic Form prior to lesson delivery; participants delivered the lesson and feedback frequency data was collected using the Feedback Observation System; and after delivery of the lesson, participants completed the Teacher Feedback Perception Response Sheet. Participants were filmed in these sessions, with all class members having signed a statement to consent for filming. Filming allowed for time spent in activity to be calculated, as well as observer reliability to be measured on the Feedback Observation System, by comparing live and video coding for all participants. Video coding was completed 4 weeks after live coding.

Practical placement setting.

Practical placement setting. A cohort of six participants were further observed while teaching a PE lesson as a part of their practical placement period in schools. Permission was sought to collect data in the school, and a time was organized to observe the participant teach a PE lesson. Year levels of the primary school students being taught ranged from Prep to Grade 4 (age 5-10 years), and a number of sports and activities were taught including football, basketball, and general game play.

A similar protocol was used while collecting data during practical placement with feedback frequency data collected during the delivery of each lesson using the Feedback Observation System. In practical placement settings, however, filming during the lesson was not conducted. Following delivery of the lesson, participants were again asked to complete the Teacher Feedback Perception Response Sheet.

Data Analysis

Descriptive statistics and frequencies were used to analyze the demographic data collected. Descriptive statistics were also used to determine mean frequencies of the different types of feedback in both the peer-teaching and placement settings. To aid in comparison of feedback frequencies, frequency is reported as the frequency of feedback provided per minute of activity. Paired sample t-tests were used to compare differences between actual and perceived feedback frequencies for each type of feedback in both settings. Cohen's d was calculated to determine effect size of the differences between actual and perceived feedback behaviors of pre-service teachers. Pearson correlations were calculated to determine reliability between live observation coding and coding of sessions observed on video.

RESULTS

Peer-teaching Setting

Actual feedback frequency

The mean feedback frequencies in peer-teaching settings for each type of feedback are presented in Table 1. The average total feedback for all participants in the peer-teaching setting was 1.08 feedback times per minute, equating to providing feedback every 56 seconds during activity. Verbal feedback was provided at a greater rate than non-verbal feedback, with non-verbal feedback provided on average every six minutes and 40 seconds, whereas

verbal feedback was provided on average every 65 seconds. The most common type of feedback was positive, non-skill related feedback, and was provided by participants once every 87 seconds. The least frequent type of feedback provided by participants was negative, skill related feedback, provided at a rate once every 100 minutes of activity. When participants did provide skill-related feedback, it was most often prescriptive KP. Terminal feedback was provided more often than concurrent feedback.

Perceived feedback frequency

Descriptive statistics in Table 1 reveal that participants perceived that they gave feedback 1.46 times per minute of activity. This equates to providing feedback every 41 seconds. Participants perceived that they gave more non-verbal than verbal feedback, reporting non-verbal feedback on average every 76 seconds and verbal feedback every 91 seconds. The feedback type that participants perceived they gave the most was again positive, non-skill related feedback, perceived at a rate of once every 2 minutes and 38 seconds. The least common type of feedback was, as reported in the actual frequencies, negative, non-skill related feedback, at an average rate of once every 16 minutes and 40 seconds. Pre-service teachers also perceived they provided feedback during the performance of skill (concurrent) as often as they provided feedback after performance (terminal).

Table 1 Actual and Perceived Feedback Frequency in Peer-teaching Setting

	Actual		Perceived				
Feedback type	*M*	*SD*	*M*	*SD*	*p*	*t*	Cohen's *d*
Verbal	0.92	0.37	0.66	0.44	0.00	4.84	0.67
Non-Verbal	0.15	0.27	0.79	0.65	0.00	-7.83	-1.29
Non-Skill	0.70	0.36	0.41	0.43	0.00	4.06	0.73
Positive	0.69	0.36	0.38	0.41	0.00	4.45	0.80
Negative	0.01	0.05	0.06	0.15	0.01	-2.77	-0.45
Skill	0.35	0.23	0.32	0.28	0.57	0.57	0.12
KR	0.01	0.10	0.21	0.30	0.00	-4.54	-0.89
KP	0.35	0.23	0.15	0.26	0.00	4.53	0.81
Descriptive	0.05	0.10	0.16	0.28	0.01	-2.56	-0.52
Prescriptive	0.27	0.18	0.16	0.19	0.00	3.91	0.59
Corrective	0.03	0.06	0.16	0.23	0.00	-4.12	-0.77
Concurrent	0.31	0.30	0.44	0.52	0.09	-1.72	-0.30
Terminal	0.74	0.39	0.38	0.38	0.00	5.07	0.93
Total	1.08	0.49	1.46	0.83	0.00	5.01	-0.56

Note: Feedback is reported as frequency per minute of activity during the lesson

Comparison of actual and perceived feedback frequencies

There were significant differences between actual and perceived feedback frequencies for 11 of the 13 feedback types. Cohen's d values indicated moderate to large effect sizes. Participants perceived that they provided significantly more feedback than they were observed providing for non-verbal, negative, KR, descriptive, and corrective types of feedback. Participants actually provided more feedback than they perceived that they had provided for verbal, non-skill related, positive, KP, prescriptive, and terminal feedback. There were no significant differences between actual and perceived frequencies for skill-related and concurrent feedback.

Practical Placement Setting

Actual feedback frequency

The feedback frequencies in practical placement settings are presented in Table 2. Average total feedback provision for participants in the practical placement setting was 0.70 times per minute, equating to providing feedback on average every 86 seconds. Pre-service teachers provided verbal feedback more often than non-verbal feedback, with verbal feedback being provided at a rate of once every 50 seconds, whereas non-verbal feedback was provided at a rate of once every 14 minutes and 17 seconds. The most common type of feedback provided was positive non-skill related feedback at an average rate of once every 80 seconds. Corrective skill-related feedback was the least frequent form of feedback, provided at an average rate of once every 33 minutes and 20 seconds.

Perceived feedback frequency.

Perceived feedback frequencies in practical placement settings in schools are displayed in Table 2. Pre-service teachers perceived that on average they provided feedback 0.90 times per minute, equating to providing feedback on average every 66 seconds during activity. They perceived that they provided verbal feedback often, at a rate of once per one minute and 45 seconds of activity. This was often non-skill related feedback, at a rate of once per 88 seconds, perceived most often as positive feedback. Pre-service teachers also perceived that they most often provided concurrent feedback.

Comparison of actual and perceived feedback frequencies.

Paired sample t-tests indicated that there were no differences between actual and perceived feedback frequencies for most forms of feedback (Table 2). There was a significant difference for non-verbal feedback, with participants perceiving that they provided more non-verbal feedback than what was observed. Cohen's *d* value indicated a large effect size.

Table 2 Actual and Perceived Feedback Frequency in Practical Placement Setting

	Actual		Perceived				
Feedback type	*M*	*SD*	*M*	*SD*	*p*	*t*	Cohen's *d*
Verbal	1.20	1.23	0.57	0.83	0.12	-1.86	0.60
Non-Verbal	0.07	0.04	0.32	0.31	0.01	3.78	-1.13
Non-Skill	0.80	0.81	0.62	0.84	0.23	-1.36	0.22
Positive	0.75	0.79	0.68	0.80	0.53	-0.68	0.09
Negative	0.05	0.04	0.27	0.43	0.33	1.08	-0.72
Skill	0.48	0.47	0.44	0.54	0.51	-0.72	0.08
KR	0.08	0.08	0.15	0.30	0.77	0.31	-0.32
KP	0.39	0.44	0.23	0.27	0.64	-0.49	0.44
Descriptive	0.12	0.14	0.32	0.45	0.97	0.04	-0.60
Prescriptive	0.32	0.42	0.30	0.43	0.76	-0.33	0.05
Corrective	0.03	0.07	0.24	0.44	0.42	-0.88	-0.67
Concurrent	0.24	0.25	0.65	0.88	0.41	0.90	-0.63
Terminal	1.04	1.02	0.30	0.40	0.20	-1.47	0.96
Total	0.70	0.64	0.90	1.13	0.76	0.33	-0.22

Note: Feedback is reported as frequency per minute of activity during the lesson

Observation reliability

Pearson correlations revealed strong relationships between feedback frequencies of live codings and subsequent coding of video footage, supporting the reliability of the feedback frequency measure used. The weakest correlation was for negative feedback at .68, with non-verbal feedback at .83 and all other correlations above .90, including verbal (.95), non-skill (.96), positive (.97), skill (.99), KR (1.00), KP (.97), descriptive (1.00), prescriptive (.98), corrective (1.00), concurrent (.91), and terminal (.97).

Discussion

This study describes the use of feedback and perceptions of the use of feedback by pre-service teachers in peer-teaching (instructing their peers in university classes) and practical placement settings (teaching in schools). Pre-service teachers provided feedback at an average rate of 1.08 times per minute (or every 56 seconds) in peer-teaching, while in practical placement pre-service teachers provided feedback at an average rate of .70 times per minute (or every 86 seconds).

While research on feedback frequencies has received some attention in recent times (Kim & Housner, 2010; Spittle et al., 2012) the feedback behaviors of pre-service teachers is an area that is yet to be extensively investigated. The rate of feedback provision in peer-teaching is similar to previous studies with more experienced PE teachers in actual teaching settings, which has generally reported average rates of feedback provision of every 30 to 60 seconds (Siedentop, 1991; Spittle et al., 2012). The rate of feedback provision by the pre-service teachers on practical placement, however, was somewhat less frequent. Rates may be lower in the practical setting because the pre-service teachers feel less confident than in the peer-teaching environment or in comparison to more experienced teachers. This could be due to experience and content knowledge. Provision of feedback is potentially associated with stronger pedagogical and content knowledge in PE (Ward, 2009; Ward et al., 2014). This suggests that although peer-teaching provides a simulation of teaching, it may not always recreate the real authentic experience of teaching. For example, pre-service teachers may be more comfortable with their peers than when working with a supervising teacher or when teaching a group of students.

The standard deviations for the mean feedback frequencies indicate that there was much variability in frequency of feedback among participants. Previous studies that have measured feedback frequencies in PE have found similar high standard deviations among participants (Tan, 1996; Silverman et al., 1998; Spittle et al., 2012). So although the average rates of provision were every 56 seconds in peer-teaching and 86 seconds in practical placement, some pre-service PE teachers were providing feedback a lot more than this, and others a lot less. Future research could potentially explore why these differences occurred and how pre-service teachers (e.g., those with more or less pedagogical content knowledge) use feedback.

Pre-service teachers provided more non-skill related feedback than skill related feedback in both peer-teaching and practical placement settings. Non-skill related feedback was provided on average every 86 seconds in peer-teaching and every 171 seconds in practical placement, whereas skill related feedback was provided every 75 seconds in peer-teaching and 125 seconds in practical placement. This result is consistent with previous findings where the most common type of feedback provided is non-skill related positive feedback (see review Silverman et al., 1998). A possible explanation for a greater frequency of

non-skill related feedback in the current study may be experience and content knowledge of the pre-service teachers. Researchers have suggested that provision of feedback is potentially associated with stronger pedagogical and content knowledge in PE (Ward, 2009; Ward et al., 2014). Further, pedagogical content knowledge has been linked to the use of corrective, quantitative feedback (Creasy et al., 2012). Having less experience and potentially lower pedagogical and content knowledge could mean that pre-service teachers provided less skill related feedback pertaining to technical instruction and correcting errors as they were unsure of errors in movement or did not know what to look for. The non-skill related feedback was predominantly positive feedback and may have been used to keep learners on task and motivated (Koka & Hein, 2005). As the learning situations, especially peer-teaching, may be perceived to be a controlled environment, a focus on behavior management may have been reduced. Pedagogical and content knowledge was not a factor measured in the current study and, therefore, may be an area for future research.

Nearly all of the skill related feedback provided by the pre-service teachers was KP rather than KR, suggesting a focus on the process of movement or technique rather than the outcome of the movement. The pre-service teachers provided KP on average every 171 seconds in peer-teaching and every 154 seconds in practical placement, whereas they only provided KR every 100 minutes in peer-teaching or 12 minutes and 30 seconds in practical placement. Studies of PE teachers also suggest that teachers provide significantly more KP than KR (Fishman & Tobey, 1978; Spittle et al., 2012), although the differences between the rates of provision appear to be more pronounced in the current study. Motor learning textbooks generally suggest that KP is more often useful for the learner than KR and so should be provided more often (Spittle, 2013; Magill & Anderson, 2020). This is because KR is easier for learners to determine for themselves without the assistance of the instructor or teacher than KP. The outcome of movement is often obvious and inherent in the skill because learners immediately know the result of the skill attempt, whereas movement technique or form can be more difficult for the learner to perceive for themselves (Spittle, 2013). It appears that pre-service teachers understood this concept. Although KR was rarely provided, it was anecdotally noted that the most common situation it was observed occurring in practical placement was when pre-service teachers took on an umpiring or scoring role during game play in a game or sport.

Participants perceived that they provided feedback on average every 41 seconds in peer-teaching and every 66 seconds in practical placement. They perceived that they provided significantly more feedback in peer-teaching than they actually did (every 41 seconds versus every 56 seconds). This suggests that the pre-service teachers were overestimating how often they were providing feedback. Although previous research has not compared perceptions and actual feedback use of PE pre-service teachers, research with coaches has suggested that they overestimated the amount of feedback they provided (Millar et al., 2011). Millar et al. suggested that this could be because coaches know what to do, but may have difficulty performing the behavior. They explained that the differences between perceived and actual feedback were unlikely to be due to social desirability bias, as participants were aware that their behavior was being reported, but was more likely to be due to confirmation bias, where participants recalled behaviors in a way that was consistent with their personal beliefs about themselves.

By overestimating the amount of feedback provided, it suggests that the pre-service PE teachers may not be completely aware of their use of feedback. Developing awareness of feedback use may help pre-service PE teachers use feedback more effectively. De Marco

and Mario (1997) found that making coaches aware of their behavior improved their perceptions, even though they still overestimated. Increasing reflective behavior of pre-service teachers may increase self-awareness and help the pre-service PE teachers become more reflective practitioners. Examples of activities that may be relevant in PE include reviewing peer-teaching at the end of sessions and using video sessions to provide feedback to the pre-service teachers.

There were also differences between perceptions and actual use of specific types of feedback in the peer-teaching setting. Participants perceived that they provided significantly more feedback than they were observed actually providing for non-verbal, negative, KR, descriptive, and corrective types of feedback. Participants actually provided more feedback than they perceived that they had for verbal, non-skill related, positive, KP, prescriptive, and terminal types of feedback. Thus, pre-service teachers both under and over-estimated their use of the different types of feedback. Again, although there is limited evidence in PE, Millar and associates' study (2011) on recall ability of rowing coaches found that coaches were largely inaccurate at recalling their instructions and feedback to athletes. Coaches perceived that they provided more evaluative and affective feedback; however, they were observed providing very high levels of prescriptive feedback. The results of this study, together with those of sport coaching research, however, suggest pre-service physical educators in general can be inaccurate in their recall of feedback behavior.

The current study provides useful information about use and perceptions of use of feedback provided by PE pre-service teachers while peer-teaching and also while teaching on practical placement. The research settings in which the study was conducted are authentic to PETE and occurred as they would if the research was not being conducted. Research in the peer-teaching setting was conducted during actual classes at the university and no aspect of the practical placement setting was altered. Participants were able to structure their lessons as they saw fit and select sports and activities of their choice. This allowed the current study to examine feedback frequencies in a general sense, rather than limiting the study to one sport or lesson topic. The research in the peer-teaching setting used a larger sample (n=59) than previous research on feedback use on PE, which has generally studied fewer than 20 participants (Spittle et al., 2012). Despite this, there are some potential limitations of the current study that should be acknowledged. For example, although the sample size for the peer-teaching setting was large in comparison to previous research, the sample size for the practical placement setting was very small, with only six participants. The measure used to record feedback frequencies was developed by the researchers for the study as there was no established measure of the feedback use of pre-service PE teachers and the specific types of feedback of interest. The measure was developed based on approaches used in previous research (e.g., Faucette & Patterson, 1990; Silverman et al., 1992; Landin et al., 2001). There was also no available measure of perceptions of feedback use, so this measure was also developed for the current study. Consequently, there is no previous reliability and validity information on these measures. We did, however, test for reliability of the feedback use measure by comparing live coding of feedback frequency and video footage viewed later, which revealed strong relationships between scores, supporting its reliability.

The limitations of the study provide some directions for future research. Increasing the sample size, especially in the practical setting would allow for more comparisons to be made between settings. The use of authentic settings provided for more naturalistic observations and should be used in future research. To expand research of pre-service teacher behaviors such as feedback use, valid and reliable instruments to record the behaviors of interest are

needed and future research could work to create psychometrically validated measures to support research. This study explored pre-service teachers; however, the use of feedback by experienced teachers is also not well understood and could be targeted in future research given the perceived importance of feedback provision as a teaching behavior. Results in the current study found that more non-skill related feedback was provided than skill-related feedback by pre-service teachers. An investigation into the reason(s) for this difference may give more insight into the lesson goals of PE pre-service teachers and whether there is more emphasis on student motivation or skill acquisition. The findings of the current study suggest that pre-service teachers were providing less feedback than more experienced PE teachers. It is currently unknown as to why this occurs.

CONCLUSIONS

In conclusion, this study demonstrates that pre-service teachers provided feedback frequently in peer-teaching and practical placement settings, but differed in their use of feedback in peer-teaching versus practical placement settings, with feedback provided more often in peer-teaching. Actual and perceived feedback frequencies did not always match and suggest that pre-service teachers may not always be aware of how often and the type of feedback they are providing, highlighting that PETE programs may need to work with pre-service teachers to develop self-awareness and provide opportunities for authentic leaning experiences to ensure that pre-service teachers have opportunities to learn about and practice this teaching skill.

Acknowledgement: *The authors sincerely thank the Department of Education and Training (Victoria, Australia) for providing permission to conduct research in schools. We also thank the schools involved in the research as well as the supervising teachers, lecturers of units, students, and participants who made this study possible. The authors received no financial support for research, authorship, and/or publication of this article.*

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UPOTREBA POVRATNIH INFORMACIJA I PERCEPCIJE NASTAVNIKA FIZIČKOG VASPITANJA U PRE-SLUŽBI

Cilj ovog istraživanja bio je da istraži upotrebu povratnih informacija i percepciju upotrebe povratnih informacija od strane nastavnika u pre-službi vršnjačke nastave tj., podučavanje svojih vršnjaka tokom univerzitetske nastave i nastave u školama. Nastavnici pre-službe specijalizovani za osnovno fizičko vaspitanje (FV) i još jednu nastavnu metodu (n=59) posmatrani su tokom 15-minutnog predavanja u vršnjačkom okruženju, dok je šestoro nastavnika takođe, posmatrano tokom držanja praktične nastave. Nastavnici su se retrospektivno prisetili povratnih informacija koje su pružali tokom lekcije. Prosečna stopa učestalosti povratnih informacija bila je jednom u 56 sekundi u vršnjačkoj nastavi i jednom u 86 sekundi u praktičnoj nastavi. Najčešća vrsta povratnih informacija bila je verbalna, pozitivna povratna informacija koja se ne odnosi na veštine. Nastavnici u pre-službi uočili su da povratne informacije pružaju znatno češće nego što su to zapravo učinili (svake 41 sekunde naspram svakih 56 sekundi u vršnjačkoj nastavi). U vršnjačkoj nastavi, nastavnici u pre- službi zapazili su da pružaju znatno više neverbalnih, negativnih, znanja o rezultatima, opisnih i korektivnih vrsta povratnih informacija nego što su zapravo pružali, dok su smatrali da su pružili znatno manje verbalnih, neverbalnih pozitivnih, povezanih sa veštinama, o poznavanju učinka, preskriptivnih i terminalnih vrsta povratnih informacija, nego što su stvarno pružali ($p<.01$). Nastavnici su često pružali povratne informacije u vršnjačkom podučavanju i praktičnoj nastavi, ali ređe tokom praktične nastave u odnosu na podučavanje u vršnjačkom okruženju. Stvarne i uočene frekvencije povratnih informacija znatno su se razlikovale i sugerišu da nastavnici u pre-službi možda nisu uvek svesni koliko često i koju vrstu povratnih informacija pružaju, ističući da će u okviru obrazovnih programa nastavnika fizičkog vaspitanja biti neophodno da se radi na razvoju samosvesnosti.

Ključne reči: *znanje o performansama, znanje o rezultatima, efikasnost nastavnika, fizičko vaspitanje, motorno učenje*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 371 - 380
https://doi.org/10.22190/FUPES200116034J

Research article

CHANGES IN BODY COMPOSITION AND MUSCLE FITNESS DURING THE OFF-SEASON PERIOD IN YOUNG SOCCER PLAYERS

UDC 796.332.012

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Abstract. *The aim of this research was to examine the effects of a 6-week off-season period on body composition and muscle fitness in young soccer players. A total of 48 young soccer players, randomly selected for the experimental group-EG (n=24; Age: 16.83±1.14 years; Height: 175.35±6.68 cm) and control group-CG (n=24; Age: 16.80±1.19 years; Height: 178.18±6.97 cm) took part in this research. The variables of body composition (body mass, body fat mass and BMI) and muscle fitness (CMJ, CMJAS, 20m sprint, slalom test and slalom test with ball) were measured. The first testing session (TS1) took place immediately after the end of the competition period. The second testing session (TS2) was after 2 weeks and the third testing session (TS3) was after 6 weeks from the beginning of the preparation period. Statistically significant differences were found after TS2 and TS3 in all the variables ($p<0.05$) except in the variables of agility (slalom test and slalom test with a ball) in CG. A significant difference in the experimental group after TS2 was found in the 20m sprint ($p<0.05$) and after TS3 in body mass ($p<0.05$), body fat mass ($p<0.05$), BMI ($p<0.05$) and the 20m sprint ($p<0.05$). An effect size analysis showed significant increases after TS2 between EG and CG in the variable body fat mass (ES=-0.73, moderate) and significant decreases in the variable CMJAS (ES=0.60, moderate). Significant increases after TS3 between EG and CG were found in the variable body fat mass (ES=-0.93, moderate) and significant decreases in both the variable of jumping performance CMJ (ES=0.81, moderate) and CMJAS (ES=0.91, moderate).*

Key words: *Body Composition, Muscle Fitness, Off-Season Period, Detraining*

Received January 16, 2020/ Accepted May 21, 2020
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INTRODUCTION

Soccer is one of the most complex sports in the world, being played in every country without exception, which depends on many variables such as body composition muscle fitness and others (Tumilty, 1993). Depending on sport to sport, body composition is different due to performance expectations and specific training (Carbuhn, Fernandez, Bragg, Green, & Crouse, 2010). The technical skills and physical fitness of each player in soccer significantly affect match performance (Kutlu, Yapıcı, Yoncalık, & Çelik, 2012) and the use of both of these skills in training would produce an extremely effective performance in a game such as soccer (Little & Williams, 2007).

Each soccer season is generally based on three periods: the preparation period, competition period and off-season or transition period. In most important soccer leagues, a standard season lasts approximately 10-11 months, and they have only one cycle of these periods, but in some European countries, national championships are played on the principle of autumn-spring. For this reason, these leagues contain two cycles of the preparation, competition and off-season (transition) period. The off-season period can last for about 4-7 weeks for teams that do not participate in the top-class soccer league, and coaching during this period comes down to the individual training of the players themselves (Slettaløkken & Rønnestad, 2014). In a game such as soccer, players during the off-season period most often participate in a periodized strength and conditioning program to maintain their performance (Minett, Binkley, Weidauer, & Specker, 2017).

The transition or off-season period is a period of reduced stress and a very important time to start the recovery of mental and physical performance after an exhausting competition season (García-Pallarés, García-Fernández, Sánchez-Medina, & Izquierdo, 2010). This phase of reduction or complete training cessation after the end of the competitive season has been defined as detraining (Mujika & Padilla, 2000a) and can be divided into short term - less than 4 weeks, and long term - more than 4 weeks (Mujika, & Padilla, 2000b). At the start of the preparation period, the effects of non-training can affect how players prepare during this phase and it can be determined how much detraining affects the performance of soccer players (Kraemer et al., 2004).

In soccer, there are only a few papers that focused on the off-season period. The research shows that recreational players and untrained individuals in a period of three to six weeks of non-training during the transitional period do not show any changes in the variables of aerobic capacity and muscle strength (Mujika & Padilla, 2000b; Izquierdo et al., 2007). On the contrary, a decrease in physical fitness is logical after such a period in professional athletes who have a relatively higher level of physical fitness than recreational athletes (Mujika & Padilla, 2000a; Koundourakis et al., 2014). The significance of this research is to see how long players can be passive, whether the optimal break of two weeks is enough to not affect their form and what the differences are in body composition and muscle fitness between the players who spend their transition period passively and those who practice at least three times a week, including high intensive interval training, strength exercise training and training of small sides games. The aim of this research was to examine the effects of 6-week detraining on body composition and muscle fitness during the off-season period in young soccer players.

METHODS

The sample of participants

Forty-eight male young soccer players participated in this study and were divided into two groups: the experimental group (EG) consisted of 24 participants (Age: 16.83±1.14 years; Height: 175.35±6.68 cm) and the control group (CG) which also consisted of 24 participants (Age: 16.80±1.19 years; Height: 178.18±6.97 cm). Healthy, non-injury participants were included in this research over a period of six months. The participants voluntarily took part in this research which was carried out in accordance with the Declaration of Helsinki. Approval from the parents/guardians and from the club was obtained for all the participants, as during the course of this research they were under 18 (age rank: 15-18 years). All the participants, parents and clubs were informed of the purpose of the investigation.

Testing protocol

The first testing session (TS1) or initial measurement took place immediately after the end of the competition period. The second testing session (TS2) or transit measurement was after 2 weeks, and the third testing season (TS3) or final measurement was at the beginning of the preparation period for the forthcoming season 6 weeks after the program. For all the test sessions, the participants were instructed to avoid any activities for a 24-hour period before their lab visit. Before testing, the participants performed a basic 20-minute warm-up protocol consisted of 10 min of light running and 10 min of dynamic stretching. All tests were performed on an artificial grass sports field and each testing session had an identical execution protocol.

The experimental group of soccer players followed the special training program (active period) while the control group did not participate in any training program (passive period) during the six weeks in the off-season period. The experimental group performed a total of 18 trainings (3×6) in the off-season period. Each week training order was the same, with a standard warm-up procedure following high-intensity interval training specially designed for each participant (HIIT), strength exercises or small-sided games (SG) with proper intensity. The intensity of training was monitored using polar heart rate monitors (Polar Team Pro; Polar Electro, Kempele, Finland) and supervised by team coaches.

The sample of variables

Body composition

During all the testing sessions, measurements of body mass (kg), body fat mass (kg) and Body Mass Index-BMI (kg/m^2) were taken for each participant - using a multi-frequency bioelectrical impedance analyzer (InBody 770, Biospace Co. Ltd, Seoul, Korea). Measurements of body height were carried out with an anthropometer to within a 0.1 cm (anthropometer according to Martin).

Evaluation of explosive power

Jumps are usually applied for the purpose of testing explosive power, due to the short duration and intensity of movement (Cormie, Mcguigan, & Newton, 2011; Jezdimirović, Joksimović, Stanković, & Bubanj (2013). The sample of the measuring instruments used to evaluate explosive power included a set of two tests (Bosco, Luhtanen, & Komi, 1983): the

countermovement jump (CMJ) and the countermovement jump with arm swing (CMJAS). All participants were asked to perform three maximal jumps of each test with 30 s pauses between each repetition and 5 min breaks between the performances of each individual test. The evaluation of vertical jumping was carried out on a flat surface using a system of electric photocells (Optojump, Microgate, Bolzano, Italy) which displayed excellent validity and reliability when testing these types of jumps (Glatthorn et al., 2011) and the highest jump of the three was taken as data for the statistical analysis of each jump.

Evaluation of speed

The participants were required to perform three maximum effort sprints of 20 meters (Mendez-Villanueva et al., 2011). The participants performed three sprints separated by 3 minutes of rest and the fastest performance was included as data for the statistical analysis. A system of photocells was set at the starting line and at a distance of 20m (Witty, System, Microgate, Bolzano, Italy). The system of photocells was set at hip height for all the participants so as to ensure that only one part of the participant's body passed through the gate (Yeadon, Kato, & Kerwin, 1999).

The evaluation of agility

The evaluation of agility was carried out using the slalom test, with and without the ball (Sporiš, Jukić, Milanović, & Vučetić, 2010). The test was described previously by a group of authors (Milanović, Sporiš, Trajković, James, & Šamija, 2013). Six cones were set up 2m apart, the first cone 1m away from the starting line. The player started to run as fast as possible constantly changing direction from right to left, and after he reached the last cone the player made an 180° turn and went on running the slalom back to the starting line. Measurements of the results were carried out using a system of photocells (Witty, System, Microgate, Bolzano, Italy), while all of the equipment was set up according to the guidelines and recommendations of authors who worked with these systems of tracking results (Yeadon et al., 1999).

Statistical analysis

The statistical analysis included descriptive statistics, a univariate analysis of variance with repeated measures (ANOVA) and the Bonferroni post-hoc test in order to determine whether there was a statistically significant difference between the groups on the tests. Main±standard deviation was calculated for all the variables of the experimental and control groups. The magnitude of differences between the experimental and control groups in the initial, transit and final measurement was measured with effect size (ES) analyses and interpreted as: trivial ≤ 0.20; small = 0.2–0.59; moderate = 0.60–1.19; large = 1.20–1.99; very large ≥ 2.0 (Hopkins, Marshall, Batterham, & Hanin, 2009). An effect was deemed unclear if the confidence intervals overlapped the threshold for substantial positive and negative values (±0.20 standardized units) (Hopkins et al., 2009). The level of statistical significance was set at $p<0.05$, an all of the data were processed using the statistical package IBM SPSS (version 22.0; Inc., Chicago, IL, USA).

RESULTS

Table 1 presents the values of body composition and muscle fitness of all the participants in the experimental group and shows the results of the ANOVA which indicates the differences between the testing sessions. No significant differences were observed in the experimental group between TS1 and TS2 except in the variable 20m sprint (3.05±0.12 vs 3.10±0.14). However, significant differences were found between TS1 and TS3 in body mass (66.03±8.18 vs 66.69±7.83), body fat mass (8.26±2.45 vs 8.95±2.57), BMI (21.42±1.81 vs 21.64±1.69) and the 20m sprint (3.05±0.12 vs 3.14±0.13). Between TS2 and TS3 significant differences were found in body mass (66.11±7.99 vs 66.69±7.83) and BMI (21.44±1.73 vs 21.64±1.69). There were no significant differences in the jumping performance or agility test in any testing sessions in the experimental group

Table 1 The differences between the testing sessions – the experimental group

Variables	TS1	TS2	TS3	ANOVA p
Body mass (kg)	66.03 ± 8.18	66.11 ± 7.99	66.69 ± 7.83[ab]	**0.003**
Body fat mass (kg)	8.26 ± 2.45	8.54 ± 2.51	8.95 ± 2.57[a]	**0.002**
BMI (kg/m^2)	21.42 ± 1.81	21.44 ± 1.73	21.64 ± 1.69[ab]	**0.004**
CMJ (cm)	33.76 ± 2.75	33.79 ± 2.97	33.48 ± 2.69	0.555
CMJ AS (cm)	40.50 ± 3.46	40.09 ± 3.20	40.24 ± 2.93	0.383
20m sprint (s)	3.05 ± 0.12	3.10 ± 0.14[a]	3.14 ± 0.13[a]	**0.000**
Slalom test (s)	5.88 ± 0.11	5.81 ± 0.30	5.82 ± 0.18	0.225
Slalom test with a ball (s)	9.88 ± 0.81	9.84 ± 0.67	9.83 ± 0.68	0.935

Legend: [a] - significant change from TS1; [b] - significant change from TS2;
CMJ - countermovement jump; CMJAS - countermovement jump with arm swing;
TS1 - initial measurement; TS2 - transit measurement; TS3 - final measurement

CMJAS (39.64±4.60 vs 36.95±4.20) and the 20m sprint (3.07±0.10 vs 3.16±0.14). Between TS2 and TS3, significant differences were found in body mass (69.91±7.84 vs 70.73±7.92), body fat mass (10.37±2.50 vs 11.27±2.39), BMI (21.97±1.58 vs 22.23±1.55) and CMJ (31.89±3.65 vs 30.96±3.48). There were no significant differences for the agility test in any testing sessions.

Table 2 The differences between the testing sessions – the control group

Variables	TS1	TS2	TS3	ANOVA p
Body mass (kg)	69.15 ± 7.72	69.91 ± 7.84[a]	70.73 ± 7.92[ab]	**0.000**
Body fat mass (kg)	9.19 ± 2.13	10.37 ± 2.50[a]	11.27 ± 2.39[ab]	**0.000**
BMI (kg/m^2)	21.73 ± 1.57	21.97 ± 1.58[a]	22.23 ± 1.55[ab]	**0.000**
CMJ (cm)	33.15 ± 3.61	31.89 ± 3.65[a]	30.96 ± 3.48[ab]	**0.000**
CMJ AS (cm)	39.64 ± 4.60	37.69 ± 4.67[a]	36.95 ± 4.20[a]	**0.000**
20m sprint (s)	3.07 ± 0.10	3.12 ± 0.10[a]	3.16 ± 0.14[a]	**0.000**
Slalom test (s)	5.90 ± 0.15	5.93 ± 0.24	5.90 ± 0.26	0.845
Slalom test with a ball (s)	9.99 ± 0.34	9.98 ± 0.67	9.89 ± 0.57	0.762

Legend: [a] - significant change from TS1; [b] - significant change from TS2;
CMJ - countermovement jump; CMJAS - countermovement jump with arm swing;
TS1 - initial measurement; TS2 - transit measurement; TS3 - final measurement

Based on the result in Table 2 which contains the values for all the participants in the control group, significant differences were found between TS1 and TS2 in body mass (69.15±7.72 vs 69.91±7.84), body fat mass (9.19±2.13 vs 10.37±2.50), BMI (21.73±1.57 vs 21.97±1.58), CMJ (33.15±3.61 vs 31.89±3.65), CMJAS (39.64±4.60 vs 37.69±4.67) and the 20m sprint (3.07±0.10 vs 3.12±0.10). Significant differences were found between TS1 and TS3 in body mass (69.15±7.72 vs70.73±7.92), body fat mass (9.19±2.13 vs 11.27±2.39), BMI (21.73±1.57 vs 22.23±1.55), CMJ (33.15±3.61 vs 30.96±3.48),

Table 3 presents the differences between the experimental and control group in all the testing sessions. There were no significant differences between the EG and CG at the initial measurement. Significant differences between EG and CG at the transit measurement were found in body fat mass p = 0.015 (ES=-0.73, *moderate*) and CMJAS p=0.043 (ES=0.60, *moderate*). The effect size shows *small* significant decreases in body mass (ES=-0.48, *small*), CMJ (ES=0.55, *small*) and the slalom test (ES=-0.44, *small*). Significant differences between the EG and CG at the final measurement were found in body fat mass p=0.002 (ES=-0.93, *moderate*), CMJ p=0.007 (ES=0.81, *moderate*) and CMJAS p=0.003 (ES=0.91, *moderate*). The effect size shows *small* significant decreases in the body mass (ES=-0.51, *small*) and slalom test (ES=0.40, *small*).

Table 3 The differences between the experimental and control group in all the testing sessions

Initial measurement					
Variables	EG	CG	MD	p	*ES (95% CI)*
Body mass (kg)	66.03 ± 8.18	69.15 ± 7.72	-3.12	0.181	-0.39 (-0.96 to 0.19)†
Body fat mass (kg)	8.26 ± 2.45	9.19 ± 2.13	-0.93	0.130	-0.41 (-0.97 to 0.17)†
BMI (kg/m^2)	21.42 ± 1.81	21.73 ± 1.57	-0.32	0.514	-0.18 (-0.75 to 0.39)
CMJ (cm)	33.76 ± 2.75	33.15 ± 3.61	0.61	0.515	0.19 (-0.38 to 0.75)
CMJ AS (cm)	40.50 ± 3.46	39.64 ± 4.60	0.86	0.472	0.21 (-0.36 to 0.78)
20m sprint (s)	3.05 ± 0.12	3.07 ± 0.10	-0.02	0.566	-0.18 (-0.75 to 0.39)
Slalom test (s)	5.88 ± 0.11	5.90 ± 0.15	-0.02	0.508	-0.15 (-0.72 to 0.42)
Slalom test with a ball (s)	9.88 ± 0.81	9.99 ± 0.34	-0.11	0.538	-0.19 (-0.75 to 0.38)
Transit measurement					
Variables	EG	CG	MD	p	*ES (95% CI)*
Body mass (kg)	66.11 ± 7.99	69.91 ± 7.84	-3.80	0.103	-0.48 (-1.05 to 0.10)†
Body fat mass (kg)	8.54 ± 2.51	10.37 ± 2.50	-1.83	**0.015**	-0.73 (-1.30 to -0.14)*‡
BMI (kg/m^2)	21.44 ± 1.73	21.97 ± 1.58	-0.53	0.266	-0.32 (-0.88 to 0.25)
CMJ (cm)	33.79 ± 2.97	31.89 ± 3.65	1.90	0.063	0.55 (-0.04 to 1.12)†
CMJ AS (cm)	40.09 ± 3.20	37.69 ± 4.67	2.40	**0.043**	0.60 (0.01 to 1.17)*‡
20m sprint (s)	3.10 ± 0.14	3.12 ± 0.10	-0.02	0.572	-0.16 (-0.73 to 0.41)
Slalom test (s)	5.81 ± 0.30	5.93 ± 0.24	-0.12	0.112	-0.44 (-1.01 to 0.14)†
Slalom test with a ball (s)	9.84 ± 0.67	9.98 ± 0.67	-0.14	0.490	-0.21 (-0.77 to 0.36)
Final measurement					
Variables	EG	CG	MD	p	*ES (95% CI)*
Body mass (kg)	66.69 ± 7.83	70.73 ± 7.92	-4.04	0.082	-0.51 (-1.08 to 0.07)†
Body fat mass (kg)	8.95 ± 2.57	11.27 ± 2.39	-2.32	**0.002**	-0.93 (-1.51 to -0.32)*‡
BMI (kg/m^2)	21.64 ± 1.69	22.23 ± 1.55	-0.58	0.192	-0.36 (-0.93 to 0.21)
CMJ (cm)	33.48 ± 2.69	30.96 ± 3.48	2.52	**0.007**	0.81 (0.21 to 1.39)*‡
CMJ AS (cm)	40.24 ± 2.93	36.95 ± 4.20	3.29	**0.003**	0.91 (0.30 to 1.49)*‡
20m sprint (s)	3.14 ± 0.13	3.16 ± 0.14	-0.02	0.683	-0.02 (-0.59 to 0.55)
Slalom test (s)	5.82 ± 0.18	5.90 ± 0.26	-0.08	0.204	-0.40 (-0.97 to 0.18)†
Slalom test with a ball (s)	9.83 ± 0.68	9.89 ± 0.57	-0.06	0.742	-0.10 (-0.66 to 0.47)

Legend: EG - experimental group; CG - control group; MD - main difference; ES - effect size; CI – confidence interval; † - small; ‡ - moderate

DISCUSSION

The aim of this research was to examine the effects of a 6-week detraining on body composition and muscle fitness during the off-season period between the young soccer players who spent their transition period passively and those who practiced at least three times a week, including high-intensity interval training, strength exercise training and training of small side games. The off-season period is very useful for players and coaches to recover and to "prepare" for the following season (Silva, Brito, Akenhead, & Nassis, 2016).

Based on the present findings, during the off-season period soccer players add extra kilograms of body fat mass and decrease their physical parameters. The soccer players that followed the special training program achieved lower results of body measurements compared to the players that did not follow any organized training program. At the end of the 2-week and 6-week detraining period, significant increases in body mass, body fat mass and BMI were evident in the control group. These results were similar to those mentioned by other researchers (Ostojić, 2003; Hoshikawa et al., 2005; Reinke et al., 2009). No significant differences in body composition were observed after 2 weeks in the experimental group, but after 6 weeks of detraining significant increases in all variables of body composition were evident. An increase in body mass and body fat mass which has been observed after the off-season period is consistent with the other literature (Sotiropoulos, Travlos, Gissis, Souglis, & Grezios, 2009; Koundourakis et al., 2014; Requena et al., 2017). Significant differences between two groups ware found in body fat mass p=0.015 (ES=-0.73, *moderate*) after a 2-week program and after a 6-week in the same variable p=0.002 (ES=-0.93, *moderate*). The increased body mass in our study could be attributed to reduced training stress during the detraining period. All of the above studies were performed including adult soccer players in contrast with our study where the participants were young soccer players. Unlike in our study, other authors reported that after 4 weeks of detraining there were no significant differences in body mass between the measurements of youth soccer players (Vassilis et al., 2019). In addition, one study reported non-significant differences in body mass and the BMI between the initial and final measurement of young soccer players after 6 weeks of detraining (Melchiorri et al., 2015).

Vertical jumping and sprinting performance show significant differences in CMJ, CMJAS and the 20m sprint in the control group after 2 weeks and 6 weeks of detraining. These findings are in agreement with the previous study (Caldwell & Peters, 2009). In the experimental group, vertical jumping performance did not change between the three testing sessions performed, but sprinting performance has a significant increase. These findings are in agreement with the other studies in young soccer players (Amigo, Cadefau, Ferrer, Tarrados, & Cusso, 1998) and semi-professional players (Caldwell & Peters, 2009). Significant differences between two groups ware found in CMJAS p=0.043 (ES=0.60, *moderate*) after a 2-week training program and after a a6-week p=0.003 (ES=-0.91, *moderate*) and CMJ p=0.007 (ES=0.81, *moderate*) after 6-week. These results are similar to those of previous studies (Ostojić, 2003; Caldwell & Peters, 2009; Koundourakis et al., 2014). Nevertheless, some studies (Requena et al., 2017) did not find significant changes in vertical jumping between the groups. There were no significant differences in sprinting performance between the groups in any testing sessions and these findings are in agreement with some studies (Requena et al., 2017). Unlike our results, the research found a significant decrease in the 20m sprint after the off-season period (Koundourakis et al., 2014). The results of this study demonstrated that the players in the experimental and the control groups did not show a significant increase or decrease on the agility test (the slalom test and slalom test with a ball) within a 6-week time period.

CONCLUSION

The results of this study showed that the amount of body fat increased as vertical jumping decreased after a specified training program lasting 6 weeks during the off-season period. Obviously, the players from the experimental group demonstrated better values of maintaining their sports form. A 6-week training program period including high intensity interval training, strength exercises and training involving small sides games, as used in this study, seems sufficient to maintain physical parameters and parameters of body composition (not after 6 weeks) of players and to let them start the preseason period with a good level of physical fitness. This study also provides useful information for coaches to design a special training program to maintain physical performance and stop changes in body composition in the off-season period and avoid very long periods of complete rest (no more than 2 weeks) at the end of the season.

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PROMENE U TELESNOJ KOMPOZICIJI I MIŠIĆNOM FITNESU TOKOM PRELAZNOG PERIODA MLADIH FUDBALERA

Cilj ovog istraživanja je da se ispitaju efekti 6-nedeljnog prelaznog perioda na telesnu kompoziciju i mišićnom fitnesu mladih fudbalera. Ukupno 48 mladih fudbalera, nasumično podeljenih u eksperimentalnu grupu-EG (n=24; uzrast: 16.83±1.14 godina; visina: 175.35±6.68cm) i kontrolnu grupu-CG (n=24; uzrast: 16.80±1.19 godina; visina: 178.18±6.97cm) učestvovalo je u ovom istraživanju. Varijable za procenu telesne kompozicije (telesna težina, telesne masti i BMI) i mišićnog fitnesa (CMJ, CMJAS, 20m sprint, slalom test i slalom test sa loptom) su mereni. Prvo testiranje (TS1) obavljeno je neposredno nakon završetka takmičarskog perioda. Drugo testiranje (TS2) je bilo nakon 2-nedelje i treće testiranje (TS3) je bilo nakon 6-nedelja na početku pripremnog perioda. Na osnovu statističke analize (ANOVA sa ponovljenim merenjima) statistička značajnost je pronađena posle TS2 i TS3 u svim varijablama ($p<0.05$) osim u varijablama agilnosti (slalom test and slalom

test sa loptom) kontrolne grupe. Statistička značajnost eksperimentalne grupe posle TS2 pronađena je samo u varijabli 20m sprint (p<0.05), a posle TS3 u telesnoj težini (p<0.05), telesnim mastima (p<0.05), BMI (p<0.05) i 20m sprint (p<0.05). Analiza veličine efekta pokazala nam je značajna smanjenja posle TS2 između EG i CG u varijabli telesnih masti (ES=-0.73, umerena) i značajna uvećanja u varijabli CMJAS (ES=0.60, umerena). Značajna smanjenja posle TS3 između EG i CG je pronađeno u varijabli telesne masti (ES=-0.93, umerena) i značajna uvećanja u oba parametra skakčkih sposobnosti CMJ (ES=0.81, umerena) i CMJAS (ES=0.91, umerena).

Ključne reči: *telesna kompozicija, mišićni fitness, prelazni period, prestanak treniranja*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 381 - 390
https://doi.org/10.22190/FUPES200614035D

Research article

THE INCIDENCE OF SPINAL POSTURAL DISORDERS IN FIRST-GRADE ELEMENTARY-SCHOOL STUDENTS

UDC 615.851.1

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Abstract. *The aim of this study is to determine the state of postural disorders in the sagittal and frontal planes of the spinal column, as well as any gender differences in first-year elementary school students. The participant sample comprised 138 school children, 73 male and 56 female participants, all from the territory of the municipality of Knjaževac, Serbia. The measuring instrument, the Formetric 4D System, Diers, Germany was used for the assessment of postural disorders of the spinal column. The testing results were presented in terms of frequencies and percentages, while the chi-square independence test was used to determine differences in spinal deformity incidence between male and female participants. The results obtained indicate that, in the sagittal plane, deformity was present in a total of 73.9% of the sample (72.6% among the male and 75.4% among the female participants), whereas in the frontal plane this percentage amounted to 84.1% (84.9% among the male, and 83.1% among the female ones). Moreover, the results indicate that no statistically significant differences were found in terms of the incidence of postural disorders between male and female participants in the sagittal plane (sig=0.859) and in the frontal plane of the spinal column (sig=0.949). In view of the results obtained, it can be concluded that a high incidence of spinal postural disorders in both the frontal and sagittal planes was equally present in participants of both genders.*

Key words: *Kyphosis, Lordosis, Scoliosis, Kypho-Lordosis, Flat Back, Gender Differences*

Received June 14, 2020 / Accepted September 1, 2020
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INTRODUCTION

Postural status refers to the specific alignment of various segments of the human body which, under normal conditions, enables the most economical and rational movement, from the viewpoint of biomechanics and energy expenditure. In terms of deviations from normal postural status, there are irregularities located in parts of the locomotor apparatus (muscles, tendons, joints and bones) (Beganović & Bošković, 2012), and, depending on their location in different regions of the locomotor apparatus, these can be functional or structural in character (Milenković, 2007). Irregularities, that is, deviations from normal postural status, present a growing problem in children (Jorgić & Đorđević, 2016; Đorđević et al., 2016; Novaković, Đorđević, Aleksandrović, Pivač, & Bjelica, 2016). Most frequently, postural disorders in children can be discerned on the frontal and sagittal planes of the spine (Živković, 2009).

Research results into the incidence of postural disorders on the sagittal plane indicate that, in children of a pre-school age, this percentage can go up to 40%, while there are no statistically significant gender differences during this developmental stage (Romanov, Stupar, Međedović, & Brkin, 2014). Furthermore, the incidence of spinal deformities on the sagittal plane in elementary-school children tends to be up to 40%, with a significant difference between the thoracic and lumbar portions in terms of deformity incidence (Đorđević et al., 2016; Novaković et al., 2016), between 15 and 20% for the thoracic segment, and up to 20% for the lumbar segment. Studies to date have also demonstrated the existence of gender differences in terms of the incidence of postural disorders on the sagittal plane (Đokić, Međedović, & Smiljanić, 2011). In elementary-school children, deviations in the thoracic part of the sagittal plane are more frequently found among male subjects compared to female subjects, while the latter tend to exhibit a higher percentage of deviations in the lumbar portion of the spinal sagittal plane (Nikšić, Mahmutović, & Rašidagić, 2015; Vukićević, Čokorilo, Lukić, Miličković, & Bjelica, 2018).

The presence of postural disorders on the frontal plane of the spinal column has been found to be greater than 50% (Protić-Gava, Šćepanović, & Rakić, 2011; Stanojković, Vukmanović, Draganac, & Petronić-Marković, 2012; Stančev, 2012). The results of studies conducted using elementary-school age participants indicate a significantly higher percentage of postural disorders on the frontal plane compared to the sagittal plane of the spine (Vukićević et al., 2018). Moreover, further analyses have discovered gender differences, in favor of female subjects, in the incidence of deviation from normal posture on the frontal plane of the spine (Đokić et al., 2011).

The diagnostic methods used in studies to date include: the Napoleon Wolanski method (Protić-Gava et al., 2011; Protić-Gava, Šćepović, & Batez, 2013), the clinical method (Stanojković et al., 2012), inspection method (Petrović et al., 2012), somatometric and somatoscopic method (Đokić & Stojanović, 2010; Đokić et al., 2011), the bending test and Cobb method (Đonović, Milić, Kocić, & Radovanović, 2009), Spinal mouse (Jorgić et al., 2015a; Jorgić, Milenković, Milenković, Stanković, & Bubanj, 2015b). The diagnostic methods employed to date were all non-invasive and allowed a high degree of subjectivity during assessment.

Based on the studies conducted so far into the incidence of spinal postural disorders on the frontal and sagittal planes in pre-school and elementary-school children, it is not possible to discern with clarity the incidence of deviation from normal posture on the frontal and sagittal planes of the spine, nor any attendant gender differences, particularly

for first-year students. The seventh year of life, which coincides with elementary-school enrolment, is a crucial point during the juvenile period when development of postural disorders is concerned (Korovljev, Marinković, Roška, & Madić, 2015).

In accordance with the above mentioned, the aim of this study is to determine the state of postural disorders in the sagittal and frontal planes of the spinal column, as well as any gender differences in first-year elementary school students.

METHODS

The sample of participants

The sample of participants comprised first-year students of the elementary schools "Dimitrije Todorović Kaplar," "Vuk Karadžić" and "Mladost," all in the municipality of Knjaževac, Serbia. The total number of participants included in the study was 138 (height 127.93±6.06; mass 27.09±6.42 and Body Mass Index-BMI 16.64±3.21), where 73 participants were male (height 127.96±5.83; mass 27.49±6.48 and BMI 16.49±2.95) and 65 participants were female (height 127.91±6.34; mass 27.94±6.56 and BMI 16.80±3.49).

The participants were tested during the months of April and May during the 2018/2019 academic school year. Consent for participation in the study was obtained from school principals and first-grade teachers at the above mentioned elementary schools, in the form of a confirmation of participation in the Interreg IPA project: "Development of diagnostic centers for postural and muscular-skeletal disorders in schoolchildren in Serbia and Bulgaria".

Measures

The standardized anthropometric instrument (SECA model 284; SECA, Hamburg, Germany) was used in order to determine the descriptive parameters of the tested sample: body height, mass, BMI. This instrument is a cutting-edge anthropometric station, compliant with the most stringent criteria as determined by the International Society for the Advancement of Kinanthropometry-ISAK (Stewart, Marfell-Jones, & Olds, 2011). The measuring device (Formetric 4D System, Diers, Germany) was used for determining the postural status of the sagittal and frontal planes of the spine. Methodology in the diagnostics of postural status in children and adults is non-invasive (Betsch et al., 2011; Mangone, Raimondi & Paoloni, 2013; Đorđević, Vidojević, Đokić, Milenković, & Stanković, 2018). Diagnostics is performed using photometry, which in turn is based on the principle of triangulation. The reliability and validity of the instrument was established in earlier studies (Somoskeöy, Tunyogi-Csapó, Bogyó, & Illés, 2012; Lason, Peeters, Vandenberghe, Byttebier, & Comhaire, 2015). The device relies on the Cobb method to calculate the angle of the physiological curves of the spinal column in the frontal and sagittal planes.

In accordance with the reference values for normal posture, as well as for deviation from normal posture for the sagittal plane (Schröder, Stiller, & Mattes, 2011), the following variables were used: normal posture on the sagittal plane, kyphotic bad posture, flat back in the thoracic portion of the sagittal plane of the spine, lordotic bad posture, flat back in the lumbar portion of the sagittal plane of the spine, kypho-lordotic bad posture, flat back in the thoracic and lumbar segments of the sagittal plane, flat back in the

thoracic portion and lordotic bad posture in the lumbar portion of the spine, kyphotic bad posture and flat back in the lumbar portion.

The variables used for assessing the status of the spinal column on the frontal plane included: Normal spinal posture on the frontal plane, left thoracic scoliotic bad posture I degree, left thoracic scoliotic bad posture II degree, right thoracic scoliotic bad posture I degree, right thoracic scoliotic bad posture II degree, left lumbar scoliotic bad posture I degree, left lumbar scoliotic bad posture II degree, right lumbar scoliotic bad posture I degree, right lumbar scoliotic bad posture II degree, total left scoliotic bad posture I degree, total left scoliotic bad posture II degree, total right scoliotic bad posture I degree, total right scoliotic bad posture II degree, duplex scoliotic left thoracic and right lumbar posture I degree, duplex scoliotic left thoracic and right lumbar posture II degree, scoliosis duplex right thoracic and left lumbar posture I degree, scoliosis duplex right thoracic and left lumbar posture II degree. The rankings for determining variables were adopted from the study by Devedžić and associates (2016).

Statistical data analysis

Testing results were presented as means and standard deviation, as well as in the form of frequencies and percentages. The Chi-Squared Independence Test was used to determine any differences in the incidence of spinal deformity on the sagittal and frontal planes between male and female participants. Statistical analysis of the obtained results was conducted using the software SPSS version 20.

RESULTS

Table 1 Postural status in the sagittal plane

	Participants		
	Male and female (№/%)	Male (№/%)	Female (№/%)
Normal posture	36 / 26.1	20 / 27.4	16 / 24.6
Kyphotic bad posture	8 / 5.8	4 / 5.5	4 / 6.2
Flat back in the thoracic segment of the sagittal plane	31 / 22.5	18 / 24.7	13 / 20.0
Lordotic bad posture	16 / 11.6	4 / 5.5	12 / 18.5
Flat back in the lumbar segment of the sagittal plane	13 / 9.4	8 / 11.0	5 / 7.7
Kypho-lordotic bad posture	6 / 4.3	2 / 2.7	4 / 6.2
Flat back in thoracic and lumbar segments of the sagittal plane	25 / 18.1	16 / 21.9	9 / 13.8
Thoracic flat back and lordotic bad posture	3 / 2.2	1 / 1.4	2 / 3.1
Number of participants	138	73	65

Table 1 provides the basic descriptive statistics parameters on the incidence, presented in the form of numbers and percentages, of the spinal deformity on the sagittal plane in first-year elementary-school children from the municipality of Knjaževac. The data obtained regarding normal posture on the sagittal plane, for the total sample, are given as follows: normal posture was found in 36 participants, i.e., 26.1%, whereas deviations were found in 102 participants (73.9%). The data indicate a rather small deviation in terms of the percentages of normal posture for boys (27.4%) and girls (24.6%). In addition, a much greater incidence of abnormality of the physiological curve in the lumbar segment was found compared to the

thoracic segment: kyphotic bad posture accounted for 5.8% of the total sample, with 5.5% among the boys and 6.2% among the girls, whereas lordotic bad posture was present in 11.6% of the total sample, namely 5.5% among the male participants and 18.5% among the female participants. The disorder with the greatest incidence was an insufficiently developed physiological curve, found in 52.2% of the total sample, 59% among the male and 44.6% among the female participants.

Table 2 Postural status in the sagittal plane

	Participants		
	Male and female (№/%)	Male and female (№/%)	Male and female (№/%)
Normal spinal posture	22 / 15.9	11 / 15.1	11 / 16.9
Left thoracic scoliotic bad posture of the I degree	24 / 17.4	15 / 20.5	9 / 13.8
Left thoracic scoliotic bad posture of the II degree	2 / 1.4	2 / 2.7	
Right thoracic scoliotic bad posture I degree	24 / 17.4	15 / 20.5	9 / 13.8
Right thoracic scoliotic bad posture of the II degree	2 / 1.4	1 / 1.4	1 / 1.5
Left lumbar scoliotic bad posture I degree	5 / 3.6	3 / 4.1	2 / 3.1
Right lumbar scoliotic bad posture I degree	4 / 2.9	1 / 1.4	3 / 4.6
Total left scoliotic bad posture I degree	15 / 10.9	8 / 11.0	7 / 10.8
Total left scoliotic bad posture II degree	3 / 2.2	2 / 2.7	1 / 1.5
Total right scoliotic bad posture I degree	7 / 5.1	1 / 1.4	6 / 9.2
Total right scoliotic bad posture II degree	4 / 2.9	1 / 1.4	3 / 4.6
Duplex scoliotic left thoracic and right lumbar posture I degree	8 / 5.8	4 / 5.5	4 / 6.2
Duplex scoliotic left thoracic and right lumbar posture II degree	2 / 1.4	1 / 1.4	1 / 1.5
Duplex scoliotic right thoracic and left lumbar posture of the I degree	14 / 10.1	8 / 11.0	6 / 9.2
Duplex scoliotic right thoracic and left lumbar posture of the II degree	2 / 1.4		2 / 3.1
Number of participants	138	73	65

Table 2 presents results which refer to the frontal plane, with results presented in the form of numbers and percentages, as well. The data obtained regarding normal posture in the frontal plane, for the total sample, are given as follows: normal posture was found in 22 participants, or 15.9% of the total sample, while some form of deviation was found in 116 participants, or 84.1% of the total sample. The data indicate very small deviations between boys and girls regarding the percentage for normal posture, 15.1% and 16.9%, respectively. In addition, there is significantly greater incidence of abnormality of the physiological curve in the left and right thoracic portion, compared to: the right and left sides of the lumbar portion: scoliotic left thoracic bad posture (18.8%) and right thoracic bad posture (18.8%); left lumbar deviation (3.6%) and right lumbar deviation (2.9%), in the thoracic portion of the spinal column in male participants: left (23.2%), right (21.9%), and in the lumbar portion: left (4.1%) and right (1.4%); among the female participants: thoracic left (13.8%) and right (15.3%), and lumbar left (3.1%) and right (4.6%). The results also indicate a significantly greater number of deviations on the frontal plane which are of a functional first degree (73.2%), compared to the second degree (10.7%); in the boys, this percentage for the first degree of deformity was (75.4%), and (9.6%) for the second degree of deformity, whereas for the girls the percentage for the first degree of deformity was (70.7%) and (12.2%) for the second degree of deformity.

Table 3 Difference between the male and female participants in terms of the postural status

Difference between male and female participants in terms of postural status on the sagittal plane				
	Value	df	P	phi coefficient / degree of effect
Continuity Correction[b]	.031	1	.859	.032 (medium)
N of Valid Cases	138			
Difference between male and female participants in terms of postural status on the frontal plane				
Continuity Correction[b]	.004	1	.949	-.025 (low)
N of Valid Cases	138			

Table 3 presents the results obtained based on Yates' Correction for Continuity, which compensates for the overestimation of the value of the chi-squared test which is a consequence of the low number of dimensions. The tables indicate that there is no statistically significant difference (sig=0.859) between male and female participants in the study in terms of the incidence of postural disorders on the sagittal plane, expressed as a percentage. Additionally, no statistically significant difference (sig=0.949) was found between the genders regarding disorders on the frontal plane of the spine.

DISCUSSION

The results of this study indicate a deviation from normal posture on the sagittal and frontal planes in a high percentage. Deviation from normal posture on the sagittal plane, that is, postural disorders, were found in the thoracic and lumbar portion in a total of 73.9%, namely in 72.6% of the male participants and in 75.4% of the female participants. Earlier studies looking into a similarly aged, also juvenile, sample of participants, have reported high percentages of postural disorders of a functional type (Milenković, 2007; Dragić, Midić, & Midić, 2012; Protić-Gava et al., 2013; Jorgić et al., 2015b; Vukićević et al., 2018). More detailed analysis yields that, from the total percentage of postural disorders on the sagittal plane, the greatest percentage is accounted for by a lack of a physiological curve (50%) in the thoracic (22.5%), lumbar segments (9.4%) and thoracolumbar segments of the spine (18.1%), with very little difference between the genders (among the male participants in the thoracic (24.7%), lumbar (11%) and thoracolumbar segments (21.9%); among the female participants, it is in the thoracic (20%), lumbar (7.7%) and thoracolumbar portion of the spine (13.8%)). Furthermore, Table 1 indicates the percentage of postural disorders on the sagittal plane which accounts for an over-pronounced physiological curve in the thoracic portion and lumbar portion of the spine (23.9%). While the percentage of an over-pronounced physiological curve on the sagittal plane in relation to the gender of the participants is the following: for the male participants it is (5.5%) in the thoracic segment, (6.9%) in the lumbar and thoracolumbar segments (2.7%); and for the females it is (6.2%) in the thoracic segment and (21.6%) in the lumbar segment and thoracolumbar segments of the spine (6.2%). The results obtained in the present study are very similar to those obtained in earlier studies (Dragić et al., 2012; Protić-Gava et al., 2013; Vukićević et al., 2018).

Postural disorders located on the frontal plane indicate a high incidence percentage, with 84.9% among the male participants and 83.1% among the female participants, which is in accordance with the findings of earlier studies looking into the same age group (Vukićević et al., 2018). A more detailed analysis of the results obtained clearly indicates that a functional first degree constitutes the highest percentage, among the male participants

75.4% and among the female participants 70.7%, where changes have occurred strictly due to muscular imbalance (Živković, 2009; Jovović & Čanjak, 2011), whereas a functional second degree is found at a percentage of (10.9%), with (9.5%) among the male participants and (12.4%) among the female participants. Furthermore, an analysis of the results clearly indicates a higher concentration of partial disorders on the frontal plane (44.1%), primarily in the thoracic region (37.6%), compared to the lumbar region (6,5%), while total and duplex scoliotic bad posture is found in the percentage (39.8%). Earlier studies also indicate an approximately equal incidence, in terms of percentages, of postural disorders on the frontal plane in the same age group (Vukićević et al., 2018). Some of the causes of the emergence of such functional disorders on the frontal plane of the spine might lie in muscle imbalance due to long periods spent in an incorrect seated posture, carrying heavy schoolbags, a sedentary lifestyle, and ever-increasing hypokinesia encountered in this age group (Stanojčić et al., 2019).

An analysis of results regarding the incidence of postural disorders of the spinal column did not yield statistically significant differences between the male and female participants on the sagittal plane (sig=0.859), or on the frontal plane (sig=0.949); similarly, earlier studies (Protić-Gava, Krsmanović, Jevtić, Kadović, & Romanov, 2009; Protić-Gava, Krneta, Bošković, & Romanov, 2010; Protić-Gava et al., 2013; Vukićević et al., 2018) also found no differences in this developmental period, whereas at the start of adolescence there is a statistically significant difference. Results thus obtained may indicate that there are no gender differences in this respect, for this particular developmental period, as a result of similar habits and behaviors, as well as due to effects of the omnipresence of a contemporary sedentary lifestyle (Stanojčić et al., 2019). Also, this developmental period tends to be characterized by biological maturity following chronological age, which is not the case during the onset of adolescence, where we find statistically significant gender differences in terms of the incidence of postural disorders of the spine.

CONCLUSION

Based on the results obtained in the present study, there is an exceptionally high incidence of postural disorders of the spinal column. Also, in terms of the presence of deformities at this particular age of development, no difference between the genders was found, on the sagittal or on the frontal plane of the spine. It can be concluded that the first grade of elementary school is an important period for preventive action to be taken by professionals in the field of kinesitherapy and corrective gymnastics, both in the form of educating the parents, teachers and children, and in the form of specific measures, i.e., specific exercises aimed at prevention and correction, within the framework of physical education classes that are a part of the first-grade elementary school curriculum. Finally, preventive and corrective gymnastics programs can also form part of activities which can be provided by physical education teachers and physical therapists within the framework of fitness centers.

Acknowledgment: *The authors wish to thank the Sports Association of Knjaževac for their collaboration and for allowing us to use their diagnostic center for the assessment of spinal postural status in first-grade elementary school children from the municipality of Knjaževac, using the device Formetric 4D System, Diers, Germany, as part of the Interreg IPA project "Development of diagnostic centres for postural and musculo-skeletal disorders in school children in Serbia and Bulgaria," no. CB007.1.21.129. We also owe a special debt of gratitude to the Ministry of Education, Science and Technological Development of the Republic of Serbia, for their support and for making this study possible, as part of the project no. OI179024.*

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UČESTALOST POSTURALNIH POREMEĆAJA KIČMENOG STUBA UČENIKA PRVOG RAZREDA OSNOVNE ŠKOLE

Cilj istraživanja bio je da se utvrdi zastupljenost i razlika prema polu u posturalnim poremećajima kičmenog stuba u sagitalnoj i frontalnoj ravni učenika prvog razreda osnovne škole. Uzorak ispitanika sačinjavalo je 138 učenika, tj., 73 ispitanika muškog pola i 65ispitanika ženskog poila sa teritorije gradske opštine Knjaževac, Srbija. U proceni posturalnih poremećaja kičmenog stuba korišćen je merni instrument Formetric 4D System, Diers, Germany. Rezultati merenja predstavljeni frekvenciono i procentualno, dok je za utvrđivanje razlika u zastupljenosti deformiteta kičmenog stuba između ispitanika muškog i ženskog pola korišćen je Hi kvadrat test za testiranje nezavisnosti. Rezultati su ukazali da je u sagitalnoj ravni prisutnost deformiteta na ukumnom uzorku 73.9% (kod ispitanika muškog pola 72.6% i kod ispitanika ženskog pola 75.4%), dok je u frontalnoj ravni taj procenat generalno iznosio 84.1% (kod ispitanika muškog pola 84.9% i kod ispitanika ženskog pola 83.1%). Takođe, rezultati su ukazali da nisu uočene statistički značajne razlike u zastupljhenosti posturalnih poremećaja između ispitanika muškog i ženskog pola u sagitalnoj (sig=0.859) i frontalnoj ravni kičmenog stuba (sig=0.949). U skladu sa dobijenim rezultatima može se zaključiti da je visok nivo zastupljenosti postualnih poremećaja kičmenog stuba u frontalnoj i sagitalnoj ravni podjednako prisutan kod ispitanika oba pola.

Ključne reči: *kifoza, lordoza, skolioza, kifolordoza, ravna leđa, polne razlike*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 391 - 397
https://doi.org/10.22190/FUPES200414036K

Research article

THE IMPACT OF THE SPECIAL PHYSICAL EDUCATION ON CHANGING AEROBIC ENDURANCE IN STUDENTS

UDC 796.012-057-87

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Abstract. *The aim of this research is to determine the changes in aerobic endurance of students achieved after taking part in Special Physical Education 1, general part - SPE 1 program activities realization. The initial and final measurements of aerobic endurance (Cooper's test of running for 12 minutes) in 119 of students (39 female and 80 male students, aged 19 to 21) of the University of Criminal Investigation and Police Studies in Belgrade-CPU students were carried out during the freshmen year of undergraduate studies at the beginning and the end of the summer semester, i.e., at the entrance exam and after SPE 1 realization. The Student's t-test for dependent samples was used to determine the significance of the differences between the variables monitored at the initial and the final measurement. The results for the sample of female students (N=39) showed that after teaching SPE 1, a statistically significant change (p<0.018) in the aerobic endurance occurred (M=2288.2±218.27m, Mean±SD; t=-2.473 at the final measurement vs M=2226.8±277.07m, Mean±SD at the initial measurement). The results obtained for the sample of male students (N=80) showed also that after realized teaching SPE 1, a statistically significant change (p<0.021) in the above mentioned variable occurred, also (M=2847.7±185.77m, Mean±SD; t=-2.512 at the final measurement vs M=2747.8 ±237.03m, Mean±SD at the initial measurement). It can be concluded that after the SPE 1 course taught during the freshmen year of undergraduate studies aerobic endurance significantly improved in students of both genders.*

Key words: *Aerobic Capabilities, Cooper's* Test, *Special Physical Education, Students*

Received April 14, 2020 / Accepted September 8, 2020
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INTRODUCTION

Students attend lessons for the subject Special Physical Education 1 - general part (SPE 1) from the University of Criminal Investigation and Police Studies in Belgrade (CPU) as part of their undergraduate academic studies program during their second semester as a mandatory subject. The SPE 1 with its content and goals is directly related to developing, maintaining, and elevating to a higher level the health, professional and special capabilities and knowledge of special significance for efficient and successful performing of professional tasks of the servicemen of the Ministry of Internal Affairs of the Republic of Serbia (Milošević, Mudrić, Jovanović, Amanović, & Dopsaj 2005; Milošević, & Milošević, 2013; Milošević, & Milošević, 2014; Amanović, Baić, Nikać, & Ljubisavljević, 2015). Admission of candidates to the CPU includes: health status, psychological capabilities, skills verification tests, affinities and capabilities, and success achieved in previous education. Affinity test verification and skills test verification consists of a test of general knowledge, a test of Serbian language knowledge and literature and a basic motor skills test. Verification of the basic motor skills (BMS) of the candidates who apply for the CPU in Belgrade includes motor educability assessment, aerobic endurance, muscle force estimation, maximum back muscles force, maximum muscle force of dominant palm, and repetitive strength of arms' extensors (Dopsaj, Milošević, Blagojević, & Vučković, 2002; Amanović, Milošević, & Mudrić, 2004; Milošević et al., 2005). One of the tasks of the SPE 1 is also development of basic motor skills in students of the CPU (Amanović, Jovanović, & Mudrić, 1999; Milošević et al., 2005; Milošević, Nemec, Nemec, & Milošević, 2017; Milošević, Nemec, Nemec, & Milošević, 2018). The term of endurance implies a capability to exercise over a longer period of time without reduction of its efficiency, hence it can be considered a capability of opposing fatigue (Zatsiorsky, 1975). Endurance is the capability of an individual to maintain the given intensity of an activity (Farfelj, 1972), or to extend the duration of an action already initiated (Gajić, 1985). Endurance implies the quite complex capability of opposing fatigue (Nićin, 2000), i.e., it is an action performed without reduction in efficiency (Kukolj et al., 1996).

The aim of this research is to determine the differences in aerobic endurance of students achieved after taking part in SPE 1 program activities.

METHODS

Sample of participants

The sample of participants included 119 of students of both genders of the CPU aged 19 to 21 who had undergone a selection process - passed the entrance exam and enrolled in the freshmen year of undergraduate studies. It was made up of 39 female students (body height, BH=169.34±6.17cm, body mass, BM=65.89±10.18kg, body mass index, BMI=22.98±4.78kg/m²) and 80 male students (BH=181.81±7.31cm, BM=79.19±8.09kg, BMI=23.96±1.79kg/m²). All of the participants have previously passed psychological tests and medical examination and confirmed their eligibility for jobs and working tasks within the Ministry of Internal Affairs of the Republic of Serbia.

Measurement

The aerobic endurance of the students is tested on the athletic running track by teachers and next to the SPE at the CPU. For estimation of aerobic endurance, Cooper's running test over a 12-minute period (in meters) was carried out according to standard protocol (Milošević, 1985; Milošević et al., 2005). The distance covered during that time indirectly points to the degree of development of the aerobic system of students of both genders. The initial and final measurements of the aerobic endurance in CPU students was realized during the freshmen year of undergraduate studies at the beginning and the end of the summer semester, i.e., at the entrance exam and after the SPE 1 realization. Aerobic endurance is an integral part of the battery of tests used to estimate the basic motor skills of students of the CPU:

- COOPERm - aerobic endurance - Cooper's 12-minute running test for male students (in meters);
- COOPERf - aerobic endurance - Cooper's 12-minute running test for female students (in meters).

Data Processing

The results reached were analyzed by descriptive statistics including: calculating the basic parameters of central tendency, arithmetic mean (Mean), coefficient of variation (cV%), standard deviation (SD), minimum and maximum value of each observed variables (Min, Max), the indicator of degree of inclination - the coefficient of asymmetry (Skew), and the indicator of the degree of curvature - the coefficient of flattery (Kurt). Significance of differences of the studied variables, created under the influence of teaching from the subject of the SPE 1, was determined by performing the Student's t-test for dependent samples. Statistical significance was defined at 95% of probability, hence at the level $p>0.05$. Due to the determination of the degree of influence (effect size) of educational treatment (the impact of teaching of the SPE 1 to change of aerobic endurance of an body of students) eta-square was calculated. All analyses were determined by using the statistical package for data processing SPSS 20.0.

RESULTS

Table 1 presents the values of basic descriptive indicators of aerobic endurance of the female (COOPERf) and male students (COOPERm).

Table 1 The initial and the final measurement basic descriptive indicators

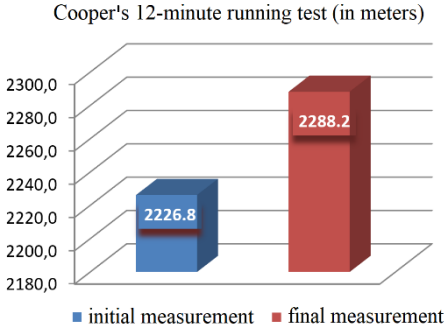
	COOPERf (in m)		COOPERm (in m)	
	Initial measurement	Final measurement	Initial measurement	Final measurement
Mean	2226.8	2288.2	2747.8	2847.7
SD	227.07	218.27	237.03	185.77
cV%	12.44	9.54	8.63	6.52
Min	1675.0	1970.0	2235.0	2610.0
Max	3075.0	3080.0	3440.0	3250.0
Skew	0.537	1.384	0.490	-0.153
Kurt	1.218	3.244	0.295	-0.408

The coefficient of variation for the studied variable at the initial measurement marks a moderate degree of homogeneity of the participants around average values (cV%=12.44 for the sample of female students, hence cV%=8.63 for the sample of male students), while at the final measurement a higher degree of homogeneity is recorded (cV%=9.54 for the sample of female students and cV%=6.52 for the sample of male students). The value of standard deviation (*SD*) of the variable monitored is satisfactory, hence it is less than 10% of the average value which points out that the sample which is monitored in this research solidly represents the population of students of the CPU.

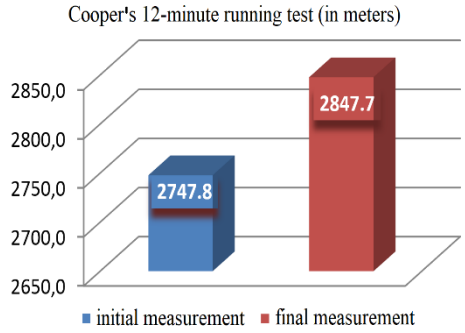
Table 2 The t-test results for dependent samples at the initial and the final measurement

Variable	Mean initial measurement	Mean final measurement	df	t-value	Sig.	Eta square
COOPERf (in m)	2226.8	2288.2	38	-2.473	0.018	0.14
COOPERm (in m)	2747.8	2847.7	79	-2.512	0.021	0.07

Table 2 presents the significance of differences determined between the initial and the final measurement. Results of the Student's t-test for dependent samples in female students showed that a statistically significant impact of teaching SPE 1 on aerobic endurance (t=2.473; p<0.018). Values of eta-square (0.14) in female students show that the impact of educational treatment on the result of the repeated test is great. The results of the Student's t-test for dependent samples in male students also showed the statistically significant impact of teaching SPE 1 on aerobic endurance (t=-2.512; p<0.021). The eta-square value (0.07) for the male students points out of the moderate impact of educational treatment on the result of the repeated test.



Graph 1 The mean values at the initial and the final measurement for the female students (N=39)



Graph 2 The mean values at the initial and the final measurement for the male students (N=80)

DISCUSSION

The foundation of work capabilities of humans represents the level of development of the aerobic energetic mechanism, hence the foundation of professional general basic physical training as a civilian, member of a military group, as well as a police officer (Milošević, 1985;

Lord, 1998; Vučković, 2002). The development of basic motor skills is one of the tasks of the SPE 1 which is a precondition for the qualitative performance of police tasks, and represents a foundation for other specific physical capabilities which are dominant for the successful training and competence of employees of the Ministry of Internal Affairs of the Republic of Serbia (Milošević et al., 2005; Milošević, & Milošević, 2013; Milošević, & Milošević, 2014). The results of Cooper's 12-minute running test obtained in this research on the sample female students (N=39) showed a statistically significant improvement ($p<0.018$) in aerobic endurance under the influence of teaching SPE 1 (M=2288.2±218.27m, Mean±SD; t=-2.473) compared to the initial measurement (M=2226.8±277.07m, Mean±SD). The change of absolute value amounts to 61.4m, while the change/improvement of relative values amounts to 2.8%. Concerning the sample of male students (N=80), the results at the initial measurement (M=2847.7m±185.77, Mean±SD) compared to the final measurement (M=2747.8±SD= 237.03, Mean±SD, t=-2.512) also showed a statistically significant improvement ($p<0.021$). The change of the absolute value amounts to 99.9m, while the change/improvement of the relative values amounts to 3.5%.

With an aim to provide actual, descriptive, classification and normative criteria for the estimation of basic morphologic features and basic motor skills in healthy students aged of 18 to 26, Dopsaj et al. (2010) yielded satisfactory values of aerobic endurance in 356 female students (CPU and the Faculty of Sport and Physical Education, University of Belgrade students). The results of aerobic endurance tested by Cooper's 12-minute running test were M=2225.1±214.00m (Mean±SD).

Blagojević (2003) studied the aerobic endurance of a student population of the first three years of study (students of the Police Academy, generation 1995/1996). Average values of Copper's 12-minute running test were: 2820.8±200.6m for the freshmen year, 2748.4±193.6m for the sophomore year, 2721.9±184.3m for the junior year of studies.

The study of Janković (2009) on a population of students of the CPU (generation 2006/2007) yielded the following results: the average value of Cooper's 12-minute running test for the freshmen year students amounts to 2791.03±237.64m with a coefficient of variation of 8.51%; for the students of the sophomore year of studies it amounts to 2595.84±326.34m, with a coefficient of variation of 12.57%; for students of the junior year of studies it amounts to 2500.46±271.20m, with a coefficient of variation of 10.85%.

CONCLUSION

Based on results of the research it can be concluded that teaching the SPE 1 subject at the end of the freshmen year of undergraduate studies, as a one-semester subject at the CPU, significantly impacts the improvement of aerobic endurance in students of both genders.

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UTICAJ SPECIJALNOG FIZIČKOG OBRAZOVANJA NA PROMENE AEROBNE IZDRŽLJIVOSTI STUDENATA

Cilj ovog istraživanja bio je da se utvrde promene u aerobnoj izdržljivosti nakon realizovane nastave iz predmeta Specijalno fizičko obrazovanje 1, opšti deo-SPE 1. Inicijalno i finalno merenje aerobne izdržljivosti (Cooper-ov test trčanja u trajanju od 12 minuta) 119 studenata (39 devojaka i 80 muškaraca, starosti od 19 do 21 godine), studenata Kriminalističko-Policijskog Univerziteta (CPU) u Beogradu realizovana su u okviru prve godine osnovnih akademskih studija, na prijemnom ispitu i na kraju letnjeg semestra, odnosno pre i posle realizacije SPE 1. Za utvrđivanje značajnosti razlika između posmatranih varijabli na inicijalnom i finalnom merenju korišćen je Studentov t-test za zavisne uzorke. Rezultati u ovom istraživanju na uzorku studentkinja (N=39) pokazali su da je nakon realizovane nastave iz predmeta SPE 1, došlo do statistički značajne promene apsolutne vrednosti pomenute varijable na finalnom merenju ($p<0.018$) aerobne izdržljivosti ($M=2288.2\pm218.27$m, srednja vrednost±SD; $t=-2.473$ na finalnom merenju vs $M=2226.8\pm277.07$m, srednja vrednost±SD na inicijalnom merenju). Rezultati dobijeni na uzorku muškaraca (N=80) takođe su pokazali da je nakon realizovane nastave iz predmeta SPE 1, došlo do statistički značajne promene apsolutne vrednosti pomenute varijable na finalnom merenju ($M=2847.7\pm185,77$m, srednja vrednost±SD; $t=-2,512$ na završnom merenju nasuprot $M=2747,8\pm237.03$ m, srednja vrednost±SD na početnom merenju). Može se zaključiti da se nakon realizovane nastave SPE 1 na prvoj godini osnovnih studija aerobna izdržljivost značajno poboljšala kod učenika oba pola.

Ključne reči: *aerobna sposobnost, Kuperov test, specijalno fizičko obrazovanje, studenti*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 399 - 408
https://doi.org/10.22190/FUPES200628037C

Research article

COMPARISON OF THREE TYPES OF KNOWLEDGE OF PERFORMANCE ON THE LEARNING OF ROUNDHOUSE TAEKWONDO KICK OF INEXPERIENCED ADULT LEARNERS

UDC 796.85

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Abstract. *The Roundhouse kick (RHK) is one of the most employed techniques in taekwondo competitions to score on the opponent, since it provides a fast and a powerful attack. However, its effectiveness depends on high technical accuracy. To polish an athlete's technique, trainers generally provide movement-related information via augmented feedback. Feedback is provided in two different ways, knowledge of result (KR) and knowledge of performance (KP). KR is about the accuracy score of a trial, whereas KP concerns the movement pattern that produces the result. Few studies have focused on understanding which moment of providing feedback on martial arts movement patterns is the most efficient. The purpose of this study was to analyze whether KP would be more effective for taekwondo RHK learning if provided after relatively good trials, after relatively poor trials or when requested by the learner. Eighteen undergraduate students with no prior experience with martial arts were assigned to different groups: a group that received feedback after performing good trials (GOOD), a group that received feedback after poor attempts (POOR) and a group that decided when to receive feedback (SELF). Four blocks of tests were performed, including a pre-test, post-test, retention and transfer. The subjects had to hit a higher amount of RHK on a kick pad according the movement pattern. The ANOVA revealed that the SELF group showed a higher score than the GOOD and POOR groups, while no differences were found between the GOOD and POOR groups.*

Key words: *Motor Skill; Learning; Knowledge of Performance; Taekwondo; Roundhouse Kick*

Received June 28, 2020 / Accepted September 16, 2020
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INTRODUCTION

Taekwondo competition is a free-fighting combat sport that implicates the usage of high and fast kicks to repel an opponent (Zar, Gilani, Ebrahim, & Gorban, 2008). Although the rules allow the use of hands and feet in a taekwondo competition to strike an opponent, generally, athletes prefer to use kicking rather than hands techniques. One of the most employed kick during a taekwondo match is the roundhouse kick (RHK), since it provides a fast and a powerful attack (Luk, Hong, & Chu, 2001; Li, Yan, Zeng, & Wang, 2005; Matsushigue, Hartmann, & Franchini, 2009; Falco, Estevan, & Vieten, 2011). Furthermore, RHK is a highly adaptable technique that allows taekwondo athletes to perform minimal changes in technique to hit the target, such as the head and torso across different distances (Falco et al., 2011). Basically, to perform the taekwondo RHK, the kicking leg is elevated in an arc in the direction of the front of the body and the knee is extended up until the instep hits the target (Park, Park, & Gerrard, 2009). Although taekwondo RHK is considered a very efficient technique during a taekwondo match, it is crucial that athletes improve and have their technique execution polished in order to fit the kick and score successfully. To improve athlete techniques performance, trainers usually provide movement-related information to their learners via verbal feedback (Fishman & Tobey, 1978; Landin, Hebert, & Cutton, 1989).

The term feedback is classified into two subcategories, intrinsic feedback and augmented feedback (Schmidt & Lee, 1999). Intrinsic feedback is the sensory-perceptual information that is perceived by the performer while executing a movement, while augmented feedback is performance-related information from an external source. Augmented feedback has been long recognized as an important influential variable in the acquisition of a motor skill. Moreover, feedback plays two fundamental roles on motor skill acquisition, including, motivating and providing proper information about technique execution (instruction and corrections) (Magill, 1993). The positive effects of augmented feedback have been studied in several situations such as rehabilitation afterward a stroke (Langhorne, Coupar, & Pollock, 2009), learning of medical skills (Porte, Xeroulis, Reznick, & Dubrowski, 2007), in physiotherapy (Winstein, 1991), and physical education and sports (Lauber & Keller, 2012).

For sport motor skills, the development of appropriate technique is essential for individual performance and the prevention of movement-related injuries. For example, it is well known that the inappropriate jumping landing technique is associated with a high risk of lower limbs lesions (Arendt, Agel, & Dick, 1999). Thus, a study showed that augmented feedback reduced jump landing forces, suggesting a reduced risk of lower limb lesions. Also, in some sports, such as gymnastics, a successful performance is based on the athlete's movement pattern. However, in others sports, such as ball games and combat sports, success is based on outcomes that can be dependent on technique. Thus, trainers commonly focus on movement patterns when training their athletes. Therefore, depending on the situation, augmented feedback can be provided in two different ways, knowledge of result (KR) and knowledge of performance (KP). The first consists of information provided to a performer about the accuracy score of a trial, whereas KP concerns the movement pattern that produces the result (Schmidt & Lee, 2005). Lauber and Keller (2012) exemplify KR as feedback given when a trainer tells a high jump athlete, whereas KP is concerned with the movement pattern that the learner made, for example, when the coach tells the learner that his hip is not extended enough when crossing the bar. In addition, divergences concerning the ideal moment of providing feedback are found in the literature. Three basic types of feedback, considering the moment of providing feedback, can be found in the literature,

including feedback given after good trials, feedback given after poor trials and self-controled feedback. Feedback after good trials is provided by the trainer when the learner performs the technique properly; however, feedback after poor trials is given when the learner performs a technique in an unsuccessful way. Finally, self-controlled feedback is provided when the learner requires it (Chiviacowsky & Wulf, 2007; Chiviacowsky, Wulf, Wally, & Borges, 2009).

Prior studies reported that feedback after poor trials is more important than after good trials, since the information provided after a poor performance is able to guide the learner to the correct movement (Salmoni, Schmidt, & Walter, 1984; Schmidt & Young, 1991). These results differ from more recent studies that observed that feedback after good attempts is more efficient than after poor attempts (Chiviacowsky & Wulf, 2007; Chiviacowsky et al., 2009). However, Chiviacowsky, Medeiros, and Kaefer (2007) found no differences in the motor skill learning of children when comparing the moment of providing feedback. Another method of feedback has been found in the literature, self-controlled feedback. Unlike the mentioned types of feedback, self-controlled feedback is given when requested by the learner (Chiviacowsky & Wulf, 2005).

The contradiction found in the literature is the reason for further studies in the field of motor skills learning. Furthermore, studies designed to investigate the effects of augmented feedback on combat sports motor skills are still scarce. So, in an attempt to establish the most appropriate moment to provide KP, we conducted this study by assessing the universal characteristics that occur during motor skill learning, including improvement, consistency, persistence and adaptability (Magill, 2000). The improvement of a motor skill occurs when a subject improves the learned skill after a period of training. Consistence is observed when the learner presents little variability in his movement patterns. Persistence occurs when an individual remains presenting good performance in the learned skill over a long period in the absence of practicing the task. And, finally, adaptability describes the capacity of an individual transferring the learned movement to a new task or other context (Magill, 2000).

The purpose of this study was to investigate whether KP would be more effective for taekwondo RHK learning if provided after relatively good trials, after relatively poor trials, or when requested by the learner.

METHODS

Sample

Graduate students of both sexes were recruited from the student population enrolled in physical education courses. The subjects were interviewed regarding their prior sport experience. The major inclusion criteria for participation in this study was absence of prior experience in any martial art. Eighteen subjects aged 19-39 years were selected and gave informed consent before beginning the study. The subjects were randomly assigned to 3 groups. A group that received KP after good trials (GOOD, n=6), a group that had KP provided after poor trials (POOR, n=6) and a self-controlled group (SELF, n=6) that received KP only when the individual requested.

Task

The subjects had to perform the taekwondo roundhouse kick with their dominant leg. The purpose of the task was to hit the highest number of RHKs using the dominant leg on a kick pad following the proper movement pattern (table 1).

Table 1 Criteria for movement pattern analysis of RHK

Performance Criteria	Chance 1	Chance 2	Chance 3	Score (Sum)
1. The dominant leg (strike leg) should be positioned back with the feet apart at a distance equivalent to the width of the hip and the feet should point to the right side.				
2. To keep the guard high, right arm protects the thoracic-lumbar region and the left arm protects the face.				
3. To bend the hip and knee of the strike leg at approximately 90 degrees.				
4. To perform pelvic axial rotation and hip abduction.				
5. To extend the knee (strike leg) simultaneously deferring the kick with the back of the foot in plantar flexion.				
6. To bend the knee of the attack leg, also performing a rotation of the hip with the supporting leg and ending with a hip extension leg attack.				
			Skill Score (Sum)	

Note: The subjects had 3 attempts to perform the tasks. Successes were marked with number "1", while un-successes were marked with "0". The score of each movement was the sum of all 3 attempts, and the Skill Score was calculated

The RHK is characterized by a horizontal and vertical shift of the center of mass towards the target, and is coupled with a fast forward pelvic axial rotation, abduction in the hip joint, flexion in the hip joint, and extension in the knee joint (Gavagan & Sayers, 2017).

Procedure

Before intervention, the subjects were submitted to a pretest, and after the intervention, they were submitted to a posttest, retention test and transfer test. Our tests and assay methods were adapted from the Test of Gross Motor Development (TGMD) proposed by Ulrich (2000). However, we provided the subjects with 3 attempts to perform the task, unlike TGMD that suggests only two chances for each participant. Furthermore, six performance criteria were stipulated to assay the movement pattern. During the tests all the subjects were videotaped. And, following the same assay methodology of TGMD, the number of successes of each participant were registered and summed up. Each performance criteria executed correctly resulted in one point (see table 1). The intervention/classes consisted of 3 sessions of 60 minutes each. The content of the lessons was the same for all groups and it consisted of drills for the correct learning and execution of the task. Each group was designated to receive KP at a specific moment. Thus, the GOOD group received KP after relatively good attempts, while the POOR group received KP when they performed relatively poor attempts. Finally, the SELF group received KP when the participants requested. After the end of the intervention, a posttest was performed in order to assess the subject's improvement on the learned skill. The posttest followed the same procedures as the pretest. Six days later, when the subjects did not practice at all, a retention test (the same as the pretest and posttest) was performed to verify whether they were able to retain the learning.

To assess bilateral adaptability, the subjects were submitted to a bilateral transfer test. To do that, the subjects were asked to perform the task using the untrained leg. The criteria of score adopted for movement pattern assessment is described in table 1. The score obtained from each set was summed up. All the tests were videotaped (Camera JVC Everio GZMGOOD30 30GB Hard Disk Drive Camcorder with 34x Optical Zoom) for data collection.

Statistical analysis

GraphPad Prism 7 was used to analyze the results. The Shapiro-Wilk test was performed for normality verification. Intra-groups differences were verified with a One-Way repeated measures ANOVA. An alpha level of $p<.05$ was considered significant. Effect size is expressed through partial ETA-squared ($\eta p2$).

RESULTS

Knowledge of performance

The ANOVA revealed a significant effect of the test for the groups ($F(2, 15)=5.353$, $p=.018$, $\eta p2=.41$), block of tests ($F(3, 45)=205.2$, $p<.0001$, $\eta p2=.93$) and Group x Block interaction ($F(6, 45)=2.479$, $p=.04$, $\eta p2=.25$). Post hoc analyses using the Tukey test showed significant differences between the pretest and the posttest for all groups, indicating that all of them improved the RHK skill. The consistence was assessed comparing the results from the pretest and the retention test and from the posttest and the retention test. Significant differences between the pretest and the retention test were found, while no significant differences between the posttest and the retention test were observed. These results show that the skill persisted in all groups. To assess adaptability, we compared the transfer test results with the pretest and posttest outcomes. So, since the performance in the transfer test was significantly higher than in the pretest, and no significant differences were found for the posttest, we found that all groups bilaterally transferred their learning of the taekwondo RHK (table 2).

Table 2 Mean±standard deviation intra-groups outcome scores on trials of KP feedback

	GOOD	SELF	POOR
Pre	5.83 ± 1.47	4.66 ± 1.50	4.5 ± 0.83
Post	14.14 ± 1.67 *	17 ± 1.09 *	11 ± 5.54 *
Retention	14.42 ± 1.71 *	17 ± 1.54 *	14.83 ± 1.32 *
Transfer	13.85 ± 2.03 *	16.83 ± 1.60 *	13 ± 3.22 *

Note: (*) Significant difference *($p<0.05$)* when comparing pre-test with post-test, retention and transfer test

Post hoc comparisons also indicated that all groups presented no significant differences on the kicks in the pretest. However, in the posttest, we found that the SELF group presented a significantly higher performance than the GOOD and POOR groups concerning the movement pattern of kicks. No significant differences were found between the GOOD and POOR groups in task performance. Retention test results also showed that the SELF group presented better performance than the GOOD and POOR groups; however, no significant differences were observed between the GOOD and POOR groups. The transfer

test revealed that the SELF group was significantly better than the GOOD and POOR groups, but no significant differences were detected between the GOOD and POOR groups.

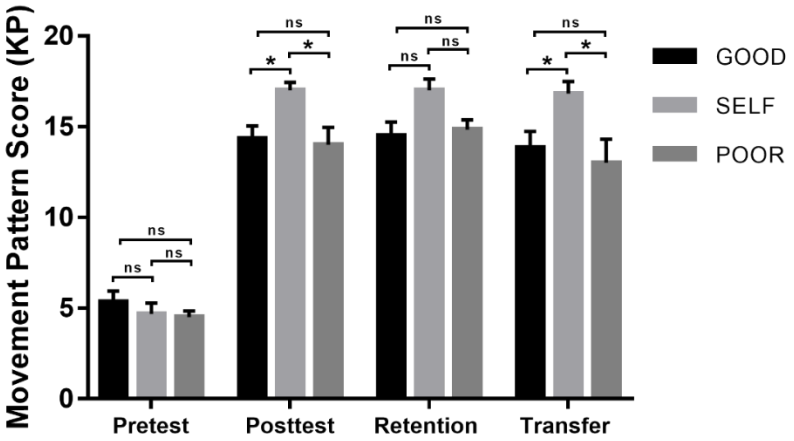

Fig. 1 Comparison between groups pertaining to the movement pattern score of knowledge of performance (KP)
Note: (*) Significant difference ($p<0.05$); (ns) No significant difference

DISCUSSION

The purpose of this study was to investigate whether KP would be more effective for taekwondo RHK learning if provided after relatively good trials, after relatively poor trials or when requested by the learner. Before comparing the most effective moment of providing feedback, we checked whether all three experimental groups were able to learn the skill. An intra-group comparison revealed that all groups were able to improve, retain, and transfer the taekwondo RHK skill, independently of the moment (after good trials, after poor trials or when requested by the learner) they received the feedback. We also observed that all groups achieved consistence upon learning the skill. Indeed, other studies have found that subjects who receive either self-controlled and externally controlled feedback improve and retain the learning of different types of skills, such as strength enhancing (Chiviacowsky, Medeiros, & Kaefer, 2007), golf shooting (Chiviacowsky, Pinho, Alves, Schild, 2008), disc flying (Siqueira, Henrique, Beltrão, Cattuzzo, 2010), ball throwing in rhythmic gymnastics (Lemos, Chiviacowsky, Ávila, Drews, 2013), and crawl swimming. (Katzer, Schild, Meira, Corazza, & Chiviacowsky, 2015). However, we would like to emphasize that the main goal of our study was not to investigate the impact of feedback on the learning of RHK, but the most ideal moment of offering KP feedback.

Our main results showed that the group that received self-controlled KP achieved higher scores on the movement pattern than feedback after relatively good and relatively poor trials in post, retention and transfer tests. In line with our results, Chiviacowsky and Wulf (2005) found that feedback is more effective when the learner is allowed to make a decision about receiving it after the trial. In addition, the same group verified, through a questionnaire, that most learners prefer receiving feedback after a good performance

(Chiviacowsky, Wulf, & Ávila, 2013). This preference may be associated with psychological and motivational factors. In fact, Saemi, Wulf, Varzaneh, & Zarghami (2011) reported that motivational factors are associated with feelings of aptness, that is, a positive feedback improves the intrinsic motivations of an individual. For instance, Badami, Vaezmousavi, Wulf, & Namazizadeh (2011) reported that positive feedback plays an important role in stimulating the learning of a motor skill. Corroborating with Badami's study, West, Bagwell, & Dark-Freudeman (2005) observed increased performance in subjects that received positive feedback when compared to control conditions. Thus, positive feedback has been effective in motivating subjects to raise their goals, while negative feedback seems to adjust their goals in a downward manner (Ilies & Judge, 2005). Moreover, Nieuwenhuis, Slagter, Alting von Geusau, Heslenfeld, & Holroyd (2005) showed that subjects who received positive feedback after performing a time estimation task showed more activation in certain brain areas, including the posterior cingulate cortex, the right superior frontal gyrus, the rostral anterior cingulate cortex, and the striatum.

Although the literature has showed a similarity between feedback after good attempts and when requested by the learners (self-controlled) (Chiviacowsky & Wulf, 2005), curiously, here we observed that KP feedback after relatively good attempts did not differ from KP feedback after relatively poor trials. Indeed, investigation describing the effects of feedback about KP on movement performance is sparce, especially in the combat sport field, since most of the studies have been focusing on feedback on KR. Moreover, martial arts movements, such as the kick, may be a compound of several complex movement patterns; consequently, the performance of the learner will possibly depend on the integration of some individual basic physical capabilities, such as balance, flexibility, speed and strength. So, individuals of the same sample can present dissimilar physical capability levels as mentioned before. This factor might be considered a limitation of our study. In fact, no differences were detected in the pretest between the groups, indicating that all participants presented a similar score in the pattern of movement. However, we can speculate that this similar result may have occurred due to a lack of knowledge of and experience with the task; however, along the training, individual physical capabilities, such as flexibility and motor coordination, may have been a key factor that influenced the performance, and consequently the results. So, we suggest that further investigations about KP should assess the mentioned capabilities in order to normalize this important variable in baseline tests and select participants with similar physical capabilities when assessing complex movements. An interesting way to do this is to use advanced learners, as athletes, for example, since they may present similarities in physical capabilities. Yet, in future studies, it might be interesting to assess whether there is interaction between the type of feedback and the complexity of the task. For example, learning a skill of low complexity, as the frontal taekwondo kick, can require less frequency of feedback, or the moment of providing feedback about KR or KP may be more irrelevant than when learning a task of high complexity. Furthermore, it should be noted that this study recruited a relatively small sample that may be considered as a limitation of our study. So, more studies with an larger sample size should be carried out in order to explore the efficiency of providing different types of KP in Olympic combat sports such as taekwondo.

Despite the indicated limitations, our study brings interesting practical implications to the motor skill learning and sport psychology field, since motivational aspects can be considered and improved by providing feedback properly (Saemi et al., 2011). So, we believe that our results can influence coaches and draw their attention to the importance of

the proper coach-athlete relationship on the learning of a martial art motor skill like in other sports. Furthermore, considering the efficiency of KP on the learning, we expect to arouse the interest of physical education professionals and researches for the development of studies that aim to investigate several other methods of feedback, such as verbal and visual feedback. In fact, beyond conventional methods, other types of feedback found in the literature, such as a virtual reality simulation system, and their effectiveness on improving a taekwondo athlete's performance should be investigated, since this might contribute to the growth of the sport.

In summary, our findings suggest that providing KP feedback when requested by the learners may influence the learning of taekwondo RHK more positively than it is provided by the trainer.

CONCLUSION

Although all groups improved, retained and bilaterally transferred the taekwondo RHK, it was found that self-controlled KP is the most efficient type of feedback on the learning of the kick. Based on this, it is our belief that the results obtained have a great potential in contributing to the optimization of the training process, especially in martial arts learning.

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KOMPARACIJA TRI VRSTE ZNANJA O PERFORMANSAMA UČENJA TEKVONDO NOŽNOG UDARCA NEISKUSNIH BORACA

Kružni udarac zamahom nogom (RHK) jedna je od najkorišćenijih tehnika na tekvondo takmičenjima, obzirom da omogućuje brz i moćan napad. Međutim, njegova efikasnost zavisi od tehnike, tj., tačnosti udarca. Da bi poboljšali tehniku sportista, treneri uglavnom pružaju sportistima znatan broj povratnih informacija vezanih za kretanje. Povratne informacije se pružaju na dva različita načina, znanjem o rezultatu (KR) i znanjem o učinku (KP). KR se odnosi na ocenu tačnosti tehnike, dok se KP odnosi na obrazac kretanja koji daje rezultat. Nekoliko studija se fokusiralo na razumevanje najefikasnijeg trenutka pružanja povratnih informacija o obrascima pokreta u borilačkim veštinama. Cilj ove studije bio je da se istraži da li bi KP bio efikasniji za učenje taekvondo RHK ukoliko se pruža nakon relativno dobrih izvođenja, nakon relativno loših izvođenja ili na zahtev učenika. Osamnaest studenata osnovnih studija, bez prethodnog iskustva u borilačkim veštinama, raspoređeni su u različite grupe: grupu koja je dobijala povratne informacije nakon dobrih izvođenja (GOOD), grupu koja je dobijala povratne informacije nakon loših izvođenja (POOR) i grupu koja je odlučivala kada će dobiti povratne informacije (SELF). Izvršena su četiri bloka ispitivanja, uključujući pre-test, post-test, retention i transfer ispitivanje. Bilo je neophodno da ispitanici izvedu veći broj RHK u jastuk, prema odgovarajućem obrascu kretanja. Metodom ANOVA je utvrđeno da je SELF grupa ostvarila bolji rezultat od GOOD i POOR grupa ispitanika, dok između GOOD i POOR grupe ispitanika nisu utvrđene statistički značajne razlike.

Ključne reči: *motorička veština, učenje, znanje o učinku, tekvondo, kružni udarac zamahom nogom*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 409 - 416
https://doi.org/10.22190/FUPES200909038M

Research article

THE RELATIONSHIP BETWEEN PLAYING SPORTS AND SELF-EFFICACY IN PEOPLE WITH DISABILITIES

UDC 615.01-056.24

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Abstract. *Self-efficacy is an assessment of an individual's own ability to organize and perform certain actions necessary to achieve the desired outcomes, and its development is very important. The research aimed to determine whether participation in sports and success in playing sports are associated with more pronounced self-efficacy in people with disabilities, and included two studies. The aim of the first study was to examine the differences in self-efficacy between those who play sports (goalball) and those who do not play sports on a sample of people with visual impairment, as well as whether this difference exists between goalball players of different levels of performance. The aim of the second study was to examine the existence of differences in self-efficacy between wheelchair basketball players and non-wheelchair basketball players. The Generalized Self-Efficacy Scale consisting of ten statements was used as the measuring instrument and the respondents stated how much each item refers to them on a five-point Likert-type scale (from 0 to 4). In data processing the statistical method of the t-test, univariate analysis of variance (One way ANOVA), as well as the Post-Hoc test, were used. The results show that people with disabilities who play sports have more pronounced self-efficacy compared to those who do not play sports, as well as compared to athletes without disabilities. Statistical differences in self-efficacy between athletes with disabilities of different levels of performance have not been identified.*

Key words: *Self-Efficacy, Goalball, Wheelchair Basketball*

Received September 09, 2020 / September 16, 2020
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INTRODUCTION

Self-efficacy represents a self-evaluative construct and it is one of the basic terms of the Social Cognitive Theory (SCT) of Albert Bandura. Bandura (1995) defines self-efficacy as an assessment of an individual's own ability to organize and perform certain actions necessary to achieve the desired outcomes. It reflects how confident a person is that he or she possesses the personal capacities that allow him or her to fully control the outcomes of set goals, despite disruptive events, difficulties, and obstacles (Bandura, 1986). If a person has manifested a higher estimation of their self-efficacy, she or he will be encouraged to act in accordance with their goals. Individuals with a strong belief in their self-efficacy are likely to set high goals for themselves, effectively control their work and commitment, will be persistent in their attempts to achieve satisfactory success, i.e. to achieve the set goal (Genc, Pekić, & Matanov, 2013). Self-efficacy is, according to Bandura (1995), mostly situation-specific, but research shows the existence of general self-efficacy (Lindley & Borgen, 2002).

Self-efficacy is not a genetically determined trait, but is an evolving characteristic (Maddux & Gosselin, 2012). Smederevac and Mitrović (2009) summarize four main sources of self-efficacy: 1) the "power of experience" as the most influential source, emphasizing that if a person has only easy successes or failures, he will not gain resilient self-efficacy, for which it is necessary to have experience in the form of overcoming problems through effort; 2) model learning is another source of self-efficacy; 3) the third source of self-efficacy is "social pressure", i.e. reassurance by others that a person can succeed in a particular activity; 4) interpretation of physical and emotional states (anxiety, tension, depression, fatigue) can contribute to the expression of self-efficacy.

Higher levels of self-efficacy have a positive effect on many psychological aspects (Maddux & Gosselin, 2012). Generalized self-efficacy facilitates coping with stress, but also affects the cognitive assessment of a stressful situation (Jerusalem & Schwarzer, 1992), i.e. it is an important factor that can moderate the impact and interpretation of the relationship between personality traits and perceived stress (Ebstrup, Eplov, Pisinger, & Jørgensen, 2011).

Research done on the sports population in the broadest sense shows a positive relationship between perceived self-efficacy and performance in many sports (through effort and perseverance in sports activities as a moderator of the variable) (Mueller, 1992; Weigand & Stockham, 2000). In addition to being motivating, a high assessment of one's effectiveness helps reduce the fear of injury and thus affects the success in acquiring new motor skills (Perkos, Theodorakis, & Chroni, 2002). People who have a higher self-assessment of their abilities (self-efficacy) achieve better results in mastering the more complex elements of skiing technique (Cigrovski, Matković, & Ivanec, 2008). A high level of perceived self-efficacy reduces the chances of the athlete applying self-handicapping strategies, i.e., looking in advance for reasons for poor performance, and coaches are encouraged to work on improving self-efficacy (Kuczka & Treasure, 2005).

Practicing sports can, in addition to physical and health benefits, also contribute to mental well-being (Moss, Landon, & Fleming, 2017). People with visual impairments who do sports are better socialized than those who do not do sports (Movahedi, Mojtahedi, & Farazyani, 2011) and they have a more adequate self-concept (Koolaee, 2017). Self-efficacy is a very important factor for the decision of persons with disabilities to engage in sports (Dixon-Ibarra & Driver, 2013), and on the other hand, it is assumed that participation

in sports will increase the self-efficacy of persons with disabilities (Moss et al., 2017). Also, the self-efficacy of teachers in working with students with disabilities is extremely important (Block, Taliaferro, Harris & Krause, 2010) and increases with participation in specialized programs (Tindall, Culhane, & Foley, 2016; Reina, Santana, Montesdeoca, & Roldan, 2019; Foley, Santarossa, Tindall, & Lieberman, 2020).

Many sports are primarily intended for people with disabilities. Goalball, designed in 1946 by Hanz Lorenzen and Sepp Reindletog (Jorgić, Grbović, Đorđević, Stanković, & Stanković, 2019) is considered the "identity card" of blind and partially sighted people. It is designed to be a part of the rehabilitation of veterans with a visual impairment from the Second World War (Aleksandrović, Jorgić, & Mirić 2016). Currently, the most successful countries in goalball are Lithuania, USA, Brazil, Turkey, Denmark, Sweden, Finland, Canada, Spain, China, Iran, etc. (Milenković, Milenković, & Cvetković, 2014). One team includes three players, and the goal is to throw the ball, which contains bells, into the opponent's net.

Players throw the ball on the ground from one end of the field to the other, and the players remain in the selected area during both the attack and defense. Players must use the ringing tone to estimate the position and movement of the ball. The game itself consists of two halves of twelve minutes each. Blindfolded and visually impaired competitors wear blindfolds so that the conditions of the game itself are equal for all the players and visually impaired competitors would not have an advantage (Madić, Stanojević, Aleksandrović, & Jorgić, 2015). Wheelchair basketball is very popular and the most developed team competitive sport for people with disabilities (Molik et al., 2009). In wheelchair basketball male players, self-efficacy is associated with adequate goal scoring (Katartzi, Theodorakis, Tzetzis, & Vlachopoulos, 2007), while the development of self-efficacy in wheelchair basketball female players is associated with the severity of disability (Schliermann & Stoll, 2007).

In this paper, we deal with the issue of general self-efficacy in athletes with disabilities in order to determine whether participation in sports and success in sports are associated with more pronounced self-efficacy. With this intention, we conducted two studies. The first study aims is to examine the differences in self-efficacy between those who play sports (goalball) and those who do not play sports, on a sample of people with visual impairment. An additional goal is to examine whether this difference exists between goalball players of different levels of success. The second study aims to examine differences in self-efficacy between wheelchair basketball players and non-wheelchair basketball players.

METHODS

Sample

The sample in Study 1 consisted of 52 males with visual impairment. The participants were from Serbia, Montenegro, Bosnia and Herzegovina, Hungary, Romania, and Macedonia. Based on the level of competition, the participants were divided into three groups: an international level-c group (19 participants), national level-European group (17 participants), and a subsample of non-athletes (16 participants). The criterion for inclusion in the first subgroup was participation in international competitions and more than three training sessions per week. Based on sports status, the participants were divided into two groups: athletes (36) and non-athletes (16). The sample in Study 2 consisted of 22 wheelchair basketball players and 14 non-disabled basketball players.

Instrument

The Generalized Self-Efficacy Scale was used as the measuring instrument (Jerusalem & Schwarzer, 1992). It consists of ten statements, and the participants state how much each item refers to them on a five-point Likert-type scale (from 0 to 4). The score is one-dimensional and is obtained by simply adding marked answers to all questions. A higher score indicates a higher level of self-efficacy. One of the main reasons for using this scale (among many others that examine self-efficacy) is the existence and availability of verified versions in the Romanian, Hungarian and Macedonian language, in addition to Serbian. This is very important because the participants come from different language areas. Also, in previous research, this scale has shown solid results when it comes to reliability (Schwarzer, Basler, Kwiatek, Schroder, & Zhang, 1997; Ivanov, 2002).

Statistical Analysis

In data processing, the statistical methods of the t-test, univariate analysis of variance (One way ANOVA), as well as the Post-Hoc test were used.

RESULTS

The results presented in Table 1 show that the differences in the level of self-efficacy between visually impaired people who practice goalball and those who do not practice sports are statistically significant at the level of 0.00.

Table 1 Differences in self-efficacy between athletes and non-athletes with visual impairment

Variable		T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Self-efficacy	Equal variances assumed	6.038	50	0.000	4.205	0.696
	Equal variances not assumed	5.718	27.766	0.000	4.205	0.735

It was assumed that there were statistically significant differences between goalball players at the international and national level, between goalball players playing at an international level and non-athletes, and between goalball players at a national level, and non-athletes in terms of self-efficacy. Internationally ranked goalball players were expected to have the most pronounced self-efficacy, followed by those nationally ranked, and the least pronounced self-efficacy was expected for non-athletes. To test these hypotheses, an ANOVA was calculated, and the results are shown in Table 2. The presented parameters indicate the existence of differences between the selected subgroups of the examined sample.

Table 2 Differences between athletes with visual impairment of different ranks and non-athletes with visual impairment – the ANOVA method

Self-efficacy	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	229.835	2	114.917	22.530	0.000
Within Groups	249.934	49	5.101		
Total	479.769	51			

In order to see exactly which subgroups these statistically significant differences exist between, a Post-hoc test was calculated. The results are shown in Table 3 and they indicate that there is a statistically significant difference between international level goalball players and non-athletes, as well as between national level goalball players and non-athletes at a significance level of 0.00, while the difference between national and international level goalball players is not statistically significant.

Table 3 Results of the Post-hoc test to determine the differences between athletes with visual impairment of different ranks and non-athletes with visual impairment

(I) Level of competition		Mean Difference (I-J)	Std. Error	Sig.
International	National	1.780	0.766	0.073
	Non-athletes	5.019*	0.754	0.000
National	International	-1.780	0.766	0.073
	Non-athletes	3.239*	0.787	0.000
Non-athletes	International	-5.019*	0.754	0.000
	Non-athletes	-3.239*	0.787	0.000

Study 2 aimed to compare the expression of self-efficacy in basketball players with and without disabilities. Even from the parameters of descriptive statistics (Table 4), a clear difference in the expression of self-efficacy can be seen between basketball players with and without disabilities, with wheelchair basketball players achieving higher scores on the self-efficacy scale. Using the t-test, these differences were also shown to be statistically significant (Table 5).

Table 4 The expression of self-efficacy in basketball players with and without disabilities

Variable	Sport	N	Mean	Std. Deviation	Std. Error Mean
Self-efficacy	Wheelchair basketball players	22	32.7727	5.73155	1.22197
	Basketball players	14	26.1429	4.95917	1.32539

Table 5 Differences in self-efficacy between basketball players with and without disabilities

Variable	F	Sig.	T	df	Sig. (2-tailed)
Self-efficacy	0.231	0.634	3.559	34	0.001

DISCUSSION

The results obtained in this research clearly show that participation in sports is associated with more pronounced self-efficacy in people with disabilities. The results indicate that differences in the level of self-efficacy between visually impaired people who engage in goalball and those who do not engage in sports are statistically significant. Practically, this data tells us that those with visual impairments who practice goalball believe more in their own resources compared to people with visual impairments who do

not play sports. This is proof that playing sports is extremely important for visually impaired people, for the mental, and not only physical (which is somewhat taken for granted) aspects of health and life satisfaction. The results in this segment, which indicate the existence of statistically significant differences between internationally ranked athletes and non-athletes, as well as between nationally ranked athletes and non-athletes, with no statistically significant differences between internationally and nationally ranked athletes, indicate another important fact regarding the development of self-efficacy and playing sports among the blind and visually impaired - it does not matter how successful you are in goalball, it is important that you play it. Particularly interesting is the data obtained in the second part of the research, which refers to the fact that the self-efficacy of wheelchair basketball players is drastically higher compared to basketball players who are without disabilities. It should be taken into account that the more pronounced self-efficacy of persons with disabilities is a significant factor in opting for sports (Dixon-Ibarra & Driver, 2013), and it can be considered that persons with disabilities who are active have already had more pronounced self-efficacy than those who did not engage in organized sports activities. However, the results obtained are in agreement with the claims that participation in sports leads to increased self-efficacy (Moss et al., 2017).

Such a high level of self-efficacy in people with disabilities, especially those who play sports, can be explained if we keep in mind the main sources of self-efficacy. These sources are experience, model learning, persuasion and interpretation of physical and emotional states (Smederevac & Mitrović, 2009). "The power of experience" as the most influential source says that if a person has only easy successes or failures, he will not gain resilient self-efficacy, for which it is necessary to have experience in the form of overcoming problems through effort. It is common sense to assume that people with disabilities have achieved their success by making greater efforts than people without physical disabilities. The reduction of mental and physical tension that only physical activity brings can also affect the more favorable perception of one's own abilities.

Whatever the mechanisms underlying increasing the self-efficacy of people with disabilities through organized sports activities are, the most important thing is the outcome. People who have more pronounced faith in their own abilities will set high goals, effectively control their work and commitment, and will be persistent in their attempts to achieve satisfactory success (Genc et al., 2013). This belief in the possession of personal capacities and work on achieving high and realistic goals, despite the difficulties and obstacles, is necessary for every individual, especially for people with disabilities. The participants in this study are people with physical disabilities, and sport is an activity that is primarily based on physical activity. Therefore, playing sports for these people is perhaps the most effective way of full integration and a way to overcome life's obstacles. People with physical disabilities overcome the barrier that determines their disability by playing sports.

CONCLUSION

The development of self-efficacy is extremely important because people who have more pronounced self-efficacy will set higher goals and work on achieving them despite the obstacles. It is very important for people with physical disabilities to build resilient self-efficacy. The results of the research strongly suggest that participation in organized sports activities is an excellent way to strengthen self-efficacy for people with disabilities,

although it is not related to success in the sport itself. The limitation of this study lies, above all, in the relatively small sample, but it provides a basis for further research into the psychological benefits that can result from engaging in sports for people with disabilities.

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ODNOS BAVLJENJA SPORTOM I SAMOEFIKASNOSTI OSOBA SA INVALIDITETOM

Samoefikasnost, čiji je razvoj izuzetno značajan, predstavlja procenu sopstvenih sposobnosti organizovanja i preduzimanja određenih radnji koje su neophodne za postizanje željenih ishoda. Da bi se utvrdilo da li su bavljenje sportom i uspeh u sportu povezani sa izraženijom samoefikasnošću kod osoba sa invaliditetom, sprovedene su dve studije. Cilj prve studije, koja je izvedena na uzorku osoba sa oštećenjem vida, bio je da ispita razlike u izraženosti samoefikasnosti između onih koji se bave sportom (golbalom) i onih koji se ne bave sportom, kao i da utvrdi da li postoji razlika između golbalista različitih nivoa uspešnosti. Cilj druge studije bio je da ispita postojanje razlika u samoefikasnosti između košarkaša u kolicima i košarkaša bez invaliditeta. Kao merni instrument korišćena je Generalizovana Skala Samoefikasnosti koja sačinjena od deset tvrdnji. Ispitanici su putem petostepene skale Likertovog tipa (od 0 do 4), odgovarali na svaku od stavki. U obradi podataka korišćena su statističke metode t-test, univarijantna analiza varijanse (One way ANOVA), kao i Post-Hoc test. Rezultati pokazuju da osobe sa invaliditetom koje se bave sportom imaju izraženiju samoefikasnost u odnosu ne samo na osobe sa invaliditetom koje se ne bave sportom, već i u odnosu na sportiste bez invaliditeta. Statističke razlike u samoefikasnosti među sportistima sa invaliditetom različitih nivoa uspešnosti nisu identifikovane.

Ključne reči: *samoefikasnost, golbal, košarka u kolicima*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 417 - 429
https://doi.org/10.22190/FUPES200721039P

Research article

ANTHROPOLOGICAL, HEMATOLOGICAL AND CARDIO-PHYSIOLOGICAL VARIABLES IN PHYSICALLY ACTIVE BOYS AND GIRLS

UDC 615.796_005

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Abstract. *Physical activity (PA) is stimulatory physiologic stress for the human body and regular PA induces significant changes in many physiological, biochemical and anthropological parameters. The aim of this study is to determine the values and the differences among the cardio-physiological, hematological and anthropological parameters for different age and gender subgroups in healthy physically active children and an adolescent population. An anthropometric evaluation (Matiegka protocol), hematological analysis i.e., red blood cells count (RBC), hemoglobin level, hematocrit, and ergometrical testing (Brus protocol) were made. Regarding mass and height until the age of 12 (U12), girls were heavier and taller than boys. The mean values for relative muscle mass in all the groups of boys and girls of different ages are in the optimal range (>50%) and indicate well developed muscle mass. There are no differences between the same age subgroups for this anthropometric parameter between the boys and girls. All the subgroups of girls of different ages showed higher body fat percent than their male siblings. Among the girls, RBC variables did not show a difference in the age subgroups. Regarding gender, all RBC variables were significantly higher among the male groups, except the U12. Cardio-physiological parameters of heart frequency at rest, exercise time duration and maximal oxygen consumption ($VO2_{max}$), were significantly higher among the boys. In all age-based male subgroups VO_{2max} was higher among the older boys. Conclusion: This study has shown age related changes in anthropological, hematological and ergometrical parameters in a male and female young active population. The girls showed significantly lower levels of cardio-physiological fitness which can be contributed either to gender and lower volume of PA.*

Key words: *Body Composition, Red Blood Cell, Hemoglobin, Hematocrit, Adolescents*

Received July 21, 2020 / Accepted August 20, 2020
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INTRODUCTION

The significance of regular physical activity (PA) for the physical, mental and social health of youth is acknowledged in the scientific public, and therefore it is important to promote and support regular PA as a foundation of good health for young generations. Sports medicine aims to achieve the optimum benefit and to avoid health risk from exercise. One of the roles of pre-participation examinations, besides providing optimal health safety and decreasing the risk for health accidents for a person during physical activities is to monitor and follow the changes in the relevant physiological parameters. The health status check includes checking the blood parameters, ergometrical testing and anthropometrical status of young athletes (Cvejić, Pejović, & Ostojić, 2013).

PA is physiologic stress for the human body and regular physical activities induce important changes in many physiological, anthropological and biochemical parameters. Acute and long-term effects of PA influence the hematological, cardiovascular and body composition parameters (Mairbaurl, 2013).

Habitual monitoring of relevant physiological parameters in young athletes during different phases of training and the competition process could help to detect potential iron deficiency, anemia or other health problems, which are important for successful exercise planning and training programming (Anđelković et al., 2014). The permanence of hematological variable status is one of the key determinants of good health and a precondition for optimal exercise performance. Hematological variables in a young population, children and adolescents are exposed to changes during the growth and maturation of the relevant organs (Hero, Wickman, Hanhijarvi, Siimes, & Dunkel, 2005; Price, 2008).

Body composition is also affected by PA. Body composition analysis is important for evaluating nutritional status and growth level in children (Ellis, Shypailo, Abrams, & Wong, 2000). The assessment of body composition in children is basically demanding, and needs to be made constantly at certain periods of time because of the rapid growth-related changes in longitudinal and circumferential dimensions and all body components (Kyle, Earthman, Pichard, & Coss-Bu, 2015). Just as the whole body grows and matures, several physiological, hematological and anthropological parameters have also been shown to change with age. Maximal oxygen uptake ($VO2_{max}$) is measured, arterial oxygen content and oxygen extraction and in addition to the functionality of many organic systems and health and fitness status, it depends on age and gender (da Cunha, Farinatti, & Midgley, 2011). In adolescents as in adults, gender differences in $VO2_{max}$ have been accredited to several external and internal factors such as body composition, blood hemoglobin concentration and cardiac size and function, and amount of PA (Saghiv, Sherve, Sira, Saghiv, & Goldhammer, 2017). Changes that occur in body dimensions, body composition, hematological and cardio-physiological parameters should be quantitatively determined as they indicate good growth and development in a young person's body.

The aim of this study is to establish the reference values and the differences for the cardio-physiological, hematological and anthropological parameters for different age and gender subgroups in healthy physically active children and an adolescent population.

METHODS

This study included 608 participants (406 boys and 202 girls; age span 8 to 18 years), attending regular health checks including a laboratory investigation and exercise testing at our department. The investigated population was divided by gender into two groups, and by age into five different age subgroups: U10 (8.0 to 9.99 years); U12 (10 to 11.99 years); U14 (12 to 13.99 years); U16 (14 to 15.99 years) and U18 group (16 to 18.0 years). All of the participants fulfilled a sports medicine history questionnaire for assessing their PA, sports discipline, and a weekly training workload. Written informed consents for participation in the study was obtained from the all participants or their parents. The study was done at the Institute of Medical and Applied Physiology and Anthropology, Faculty of Medicine, UKIM, in Skopje, the Republic of North Macedonia, between September 2016 and March 2017. Some findings concerning the investigated population in this paper have been published before (Pluncević Gligoroska et al., 2019).

Anthropometric measurements

The anthropological procedure by Matiegka was used to assess body composition. The Matiegka protocol uses several anthropometric measurements: standing height, body mass, limb circumferences at certain measuring points (upper arm relaxed and flexed, forearm, thigh, calf), four limb diameters (wrist, elbow, ankle, knee) and seven skinfolds (biceps, triceps, forearm, subscapular, thigh, calf, suprailiac). Participants' height was measured to with a fixed stadiometer (Holtain Ltd., Crymich, U.K.). Their body mass was measured with the SECA beam balance (Seca, Hamburg, Germany) to the nearest 0.1 kg. For skinfold thickness, a Harpenden skinfold caliper (British indicators Ltd., Luton) was used with 0.1 mm accuracy and a Vernier caliper was used to determine the ankle diameters. Elastic tape was used to take circumferences with 0.01mm accuracy. The values of these measurements were used in the Matiegka protocol equations (Cartrysse et al., 2002) to assess absolute muscle mass (MM in kg), relative muscle mass (MM in %), bone mass (BM in kg), relative bone mass (BM in %), absolute body fat (BF in kg), body fat percentage (BF in %), lean body mass (LBM in kg), while the body mass index (BMI in kg/m^2) was also calculated.

Ergometrical procedures

Participants performed normal treadmill exercise testing according to the Bruce sub-maximal protocol and the ACSM guidelines (2000). The Bruce test is an ergometric test consisting of several stages of gradually increasing workloads, which is performed until reaching the previously established sub-maximum heart rate or until a subjective or objective reason has been noted. After the end of the test, the main variable is the duration of time (ET=exercise time) which is inserted in a software formula for calculating VO_{2max}, general endurance, specific endurance and speed abilities scores.

Hematologic measurements

A hematologic analysis was done using a automated hematology analyzer ABX Micros 60-OT (ABX hematology, Montpelier, France). Blood samples were collected from capillary vessel using sterile plastic containers with an anticoagulant (EDTA K3). The following hematological parameters were analyzed: Red blood cells count (RBC in

10^9/dl); hemoglobin level (Hb in g/dl); hematocrit (Hct in %); mean corpuscular volume (MCV in μm^3); Mean corpuscular hemoglobin (MCH in pg) and mean corpuscular hemoglobin concentration (MCHC in g/dl).

Ethics

Institutional ethical approval was received from the Ethics Committee of the Medical Faculty, Ss Cyril and Methodius University of Skopje. Informed consent was obtained from the parents.

Statistics

For statistical analyses, the software Statistica 7.0 for Windows was used. The data are presented as group means with the respective standard deviation (SD). After checking the normality and homogeneity of variances with Shapiro-Wilk's *W* test and Levene's test respectively, the data were analyzed by a two-way ANOVA/MANOVA. Whenever the ANOVA disclosed significant results, the post-hoc Tukey test was applied. The Spearman correlation coefficient was used to find specific linear associations. Statistically significant differences were considered at the level $p<0.05$.

RESULTS

The mean values (Mean±SD) for age and quantity of training duration for all the subgroups are presented in Table 1.

Table 1 Training characteristics of the age different groups (Mean±SD) of the boys and girls

Group	N boys/girls	Age boys/girls	Years of training boys/girls	Hours per weak boys/girls
U10	48/12	8.19 ± 1.04	1.6 ± 1.0	3.5 ± 1.59
		8.23 ± 1.17	1.35 ± 1.21	2.77 ± 0.83
U12	74/47	10.54 ± 0.5	3.46 ± 1.83	3.69 ± 1.27
		9.53 ± 1.9	2.37 ± 1.65	2.93 ± 1.03
U14	114/54	12.63 ± 0.48	4.68 ± 1.78	4.62 ± 2.18
		12.52 ± 0.5	2.82 ± 1.61	3.07 ± 1.59
U16	88/49	14.42 ± 0.5	5.67 ± 2.08	5.82 ± 3.36
		14.47 ± 0.5	4.37 ± 2.47	4.26 ± 1.35
U18	82/40	16.73 ± 0.74	7.04 ± 2.9	6.35 ± 3.33
		16.98 ± 0.77	5.28 ± 3.54	4.26 ± 2.38
Total	406/202			

Legend: U10-under 10 years; U12-under 12 years; U14-under 16 years; U18-under 18 years

The boys showed greater frequency of training session and training history (duration in years) than the girls in all the subgroups.

Table 2 Descriptive statistics and age and gender differences for anthropological parameters for the subgroups of boys and girls of different ages (Mean±SD)

Parameter	U10		U12		U14		U16		U18	
	male	female	male	female	male	female	male	female	male	female
Mass (kg)	38.88 ±15.86^{a}	34.46 ± 7.70^{a}	39.91 ± 9.89^{a*}	46.70 ±10.94^{b*}	54.35 ±15.85^{b}	53.25 ± 9.68^{c}	62.13 ± 13.25^{b}	56.15 ± 8.39^{c}	72.73 ±12.17^{c*}	61.04 ± 9.41^{d*}
Height (cm)	132.95 ±19.35^{a}	138.65 ± 9.72^{a}	146.29 ± 8.59^{b*}	152.18 ± 9.75^{b*}	162.08 ±10.48^{c}	160.22 ± 5.95^{c}	173.22 ± 7.91^{d*}	162.36 ± 6.33^{c*}	179.67 ± 7.76^{d*}	167.00 ± 5.12^{d*}
MM (kg)	16.45 ± 4.24^{a}	18.30 ± 3.97^{a}	20.87 ± 5.13^{b*}	24.38 ± 5.87^{a*}	28.72 ± 7.62^{c}	29.37 ± 9.67^{b}	33.77 ± 7.23^{d}	30.49 ± 4.95^{b}	39.66 ± 7.22e*	33.35 ± 3.34^{b*}
MM (%)	50.24 ± 3.41^{a}	52.12 ± 1.22	51.81 ± 2.95^{b}	52.22 ± 3.38	52.77 ± 2.77^{bc}	52.78 ± 3.46	53.56 ± 2.33^{cd}	54.11 ± 2.25	54.32 ± 3.06^{d}	54.50 ± 2.67
BM (kg)	6.64 ± 1.26^{a}	6.45 ± 1.33^{a}	7.99 ± 1.6^{bd}	7.74 ± 1.47^{a}	9.51 ± 2.75^{c}	10.14 ± 1.95^{a}	9.15 ± 1.23^{d*}	11.75 ± 2.46^{b*}	9.89 ± 1.23e*	12.82 ± 1.60^{b*}
BM (%)	19.93 ± 1.85	19.09 ± 1.43^{a}	19.92 ± 1.86*	17.64 ± 1.77^{ab*}	19.08 ± 2.28*	17.33 ± 2.07^{bc*}	18.81 ± 2.31*	16.29 ± 1.09^{d*}	17.84 ± 1.76*	16.29 ±1.45^{d}e*
BF (kg)	5.07 ± 2.05^{a}	6.08 ± 1.92^{a}	6.57 ± 2.76^{a*}	8.24 ± 3.41^{ab*}	9.10 ± 4.05^{b}	9.65 ± 3.49^{bc}	9.36 ± 2.93^{b}	10.16 ± 3.16^{bc}	11.33 ± 3.41^{c}	11.37 ± 3.51^{c}
BF (%)	15.39 ± 3.45	16.99 ± 2.55	16.05 ± 3.02*	17.45 ± 3.35*	16.10 ± 3.71*	17.46 ± 3.19*	15.54 ± 5.64*	17.53 ± 2.38*	16.79 ±14.78*	18.07 ± 3.42*
LBM (kg)	26.99 ± 4.90^{a}	29.35 ± 5.91^{a}	33.24 ± 6.82^{b*}	37.76 ± 8.21^{b*}	44.96 ± 9.80^{c}	44.02 ± 6.49^{c}	52.83 ± 9.57^{d*}	45.85 ± 5.72^{c*}	59.62 ±11.62^{e*}	49.39 ± 7.10^{d*}
BMI (kg/m^2)	17.52 ± 2.93^{a}	17.92 ± 2.32^{a}	18.73 ± 3.00^{a}	19.71 ± 2.93^{ab}	20.39 ± 3.57^{bc}	20.78 ± 3.32^{b}	20.82 ± 3.09^{c}	21.05 ± 2.47^{b}	22.95 ± 5.60^{d}	21.92 ± 3.32^{c}

Legend: [1]values are expressed as mean (standard deviation); For every metric, different superscript letters ($^{a, b, c, d}$) represents differences between the different age groups for each gender (read horizontal) and stars (*) represent differences between genders within each age group; MM-absolute muscle mass in kg; MM%-relative muscle mass; BM-bone mass in kg; BM%-relative bone mass; BF-absolute body fat in kilograms; BF%-body fat percentage; LBM-lean body mass in kilograms; BMI-body mass index in kg/m^2.

Table 2 displays descriptive statistics for anthropological parameters and body composition for subgroups of boys and girls of different ages. A high statistically significant difference was found for the main characteristics of the participants: age, height and mass. With an increase in the age of the participants, the mass also increased in both groups, the male and female. The boys had approximate mass in groups U10 and U12. Among the girls, groups U14 and U16 had approximate mass. A significant difference between females and males was noted in the U12 groups where girls were heavier than the boys (46.7 kg vs 39.91 kg) and in the U18 groups where the boys were heavier (72.73 kg vs 61.04 kg). Regarding height until the age of 12, the girls were taller than the boys. In the U14 group they have similar height, and after that boys older than 14 were taller than their female peers.

Absolute muscle mass (MM in kg) and relative muscle mass (MM in %) increased with significant differences between all the subgroups among the boys. Relative MM among the girls showed constant values for all the age groups. Regarding gender, relative MM was insignificantly different between the boys and girls.

Absolute bone mass (BM in kg) increased distinctively with age in all the male subgroups. Girls older than 14 had a higher BM than U10, U12 and U14 group. Although absolute bone mass increased with age, relative bone mass (BM in %) decreased with age, from 19.93% in the youngest to the 17.84% in the oldest group of boys, but without statistical significance. Among the girls the decrease of relative BM was significant, from 19.09 % in the youngest to the 16.29%, both in the U16 and U18 group. In all the age subgroups, except U10, boys had significantly higher relative BM than their female peers.

The amount of body fat (BF in kg) gradually increased with age, in boys and girls. Body fat percent (BF in %) was insignificantly different regarding age in all the subgroups in boys and girls. In terms of gender, the girls showed significantly higher relative BF than the boys, except group U10.

Lean body mass (LBM in kg), just like its subcomponents (MM in kg+BM in kg), showed a significantly distinctive difference between the age groups in both genders. In group U10 and U12 the girls showed higher LBM than the boys, and after the age of 14, in groups U16 and U18 the advantage for this parameter was in favor of the boys . The body mass index (BMI in kg/m^2) mean values were significantly different between the different age groups for both genders. Among the boys BMI increased from U10=17.52 to U18=22.95. Among the girls BMI rose too, from U10=17.92 to U18=21.92. There were no significant differences in the BMI between boys and girls.

Table 3 Descriptive statistics and age and gender differences for hematological parameters for different age subgroups of the boys and girls (Mean±SD)

Parameter	U10	U12	U14	U16	U18
	male female	male female	male female	male female	male female
RBC	4.99 ± 1.06^{a}	4.86 ± 0.33^{a}	$5.04 \pm 0.40^{a*}$	$5.26 \pm 0.41^{b*}$	$5.29 \pm 0.36^{b*}$
(10^9/dl)	4.91 ± 0.39	4.78 ± 0.42	$4.87 \pm 0.37^{*}$	$4.78 \pm 0.43^{*}$	$4.63 \pm 0.30^{*}$
Hb	12.87 ± 0.84^{a}	13.07 ± 0.96^{a}	$13.74 \pm 1.15^{b*}$	$14.40 \pm 1.19^{c*}$	$14.90 \pm 1.02^{d*}$
(g/dl)	12.83 ± 1.24	12.86 ± 0.96	$13.14 \pm 0.96^{*}$	$12.74 \pm 0.98^{*}$	$12.79 \pm 1.13^{*}$
Hct	40.62 ± 2.74	40.84 ± 4.89	$43.20 \pm 3.37^{*}$	$45.93 \pm 3.59^{*}$	$46.86 \pm 5.78^{*}$
(%)	40.99 ± 3.46	41.16 ± 3.32	$41.35 \pm 3.57^{*}$	$41.36 \pm 3.32^{*}$	$39.68 \pm 6.67^{*}$
MCV	84.12 ± 3.28^{a}	85.24 ± 3.54^{a}	85.88 ± 4.49^{ab}	87.27 ± 5.40^{b}	$89.90 \pm 3.98^{c*}$
(μm^3)	83.84 ± 6.90	86.45 ± 6.20	84.91 ± 6.38	86.51 ± 5.79	$87.75 \pm 5.90^{*}$
MCH	26.70 ± 1.40^{a}	27.09 ± 1.82^{a}	27.34 ± 2.06^{a}	27.37 ± 2.32^{b}	28.24 ± 1.93^{b}
(pg)	26.25 ± 2.30	26.90 ± 2.68	27.09 ± 2.10	26.81 ± 2.60	27.67 ± 2.51
MCHC	31.71 ± 1.25	31.42 ± 2.90	31.83 ± 1.66	$31.45 \pm 1.58^{*}$	31.45 ± 1.49
(g/dl)	31.33 ± 1.17	31.16 ± 2.69	31.92 ± 2.69	$30.42 \pm 3.87^{*}$	31.50 ± 1.80

Legend: [1]values are expressed as mean (standard deviation); For every metric, different superscript letters ($^{a, b, c, d}$) represent differences between the different age groups for each gender (read horizontal) and stars (*) represent differences between genders within each age group; RBC-red blood cells count in 10^9/dl; Hb-hemoglobin level in g/dl; Hct-hematocrit in %; MCV-mean corpuscular volume in μm^3; MCH-mean corpuscular hemoglobin in pg; MCHC-mean corpuscular hemoglobin concentration in g/dl.

Differences between mean values of the RBC count between the boys and girls are statistically insignificant for the U10 and U12 group. The RBC count is similar in boys younger than 14, and significantly higher in boys older than 14 (U16 and U18). Among the girls there was no difference in the RBC count. Hemoglobin concentration values

were insignificantly different for the U10 and U12 groups of boys (12.87 g/dl vs 13.07 g/dl), while between older groups there were significant differences in favor of the older boys (13.74 g/dl vs 14.4 g/dl vs 14.9 g/dl). Hemoglobin values (Hb in g/dl) among the girls did not show statistically significant differences between different age groups (12.83 g/dl vs 12.86 g/dl vs 13.14 g/dl vs 12.74 g/dl vs 12 79 g/dl). Hematocrit (Hct in %) did not show age differences either among the boys or the girls. Gender differences between mean Hct values are presented in boys and girls older than 12. Hematological indexes (MCV and MCH) show a tendency to rise with the increased age of the participants, and are statistically different between boys over the age of 14. Among the girls MCV did not differ between the age subgroups. Only in older groups under 18 was there a gender difference for MCV. MCHC was insignificantly different between the boys and girls regarding age and gender, with the exception of the gender difference in the U16 group.

Table 4 Descriptive statistics and age and gender differences for cardio-physiological parameters obtained from Brus ergometry for different age subgroups of the boys and girls

Parameter	U10 male female	U12 male female	U14 male female	U16 male female	U18 male female
HRR (bpm)	84.53 ± 7.56*	89.42 ±17.1	85.73 ±11.0*	84.67 ±13.8	84.40 ±16.0*
	105.00 ± 4.89*	94.59 ±13.39	98.95 ±15.01*	89.86 ±18.71	95.52 ±10.70*
ET (minutes)	9.00 ± 1.97*	10.76 ± 2.01	11.46 ± 2.19*	11.57 ± 2.23*	13.29 ± 2.51*
	5.89 ± 3.02*	8.37 ± 2.15	7.32 ± 2.00*	7.81 ± 2.37*	7.59 ± 1.45*
$VO2_{max}$ (ml/kg)	35.53 ± 6.19a*	35.72 ± 6.79a*	38.32 ± 7.34a*	40.85 ± 7.16b*	41.89 ± 7.01b*
	25.40 ± 8.76*	31.67 ± 6.54*	28.63 ± 5.69*	29.74 ± 8.21*	28.40 ± 7.01*

Legend: [1]values are expressed as mean (standard deviation); For every metric, different superscript letters ($^{a, b, c, d}$) represent differences between the different age groups for each gender (read horizontal) and stars (*) represent differences between genders within each age group; HRR-heart rate at rest in bpm; ET-exercise time in minutes; $VO2_{max}$-maximal oxygen consumption in ml/kg.

For heart rate at rest (HRR in bpm) gender differences were determined in the U10, U14, and U18 groups. In all the different age groups, HRR was higher among the girls (U10, U14, U16 and U18, $p<0.005$). Exercise time (ET in minutes), which is the time that every participant needed to achieve submaximal heart rate during the incremental treadmill test, was insignificantly different within the same gender, but ET was significantly different between the genders. Maximal oxygen consumption ($VO2_{max}$ in ml/kg) was significantly higher in boys older than 14 compared to the younger boys, while among the girls there was no significant difference for this parameter. $VO2_{max}$ was significantly higher for the boys compared to the girls in all the different age subgroups.

DISCUSSION

From this study the reference values for anthropological, physiological and hematological parameters for young healthy populations were obtained and analyzed. This study exposed that significant age and sex specific differences were observed among some different age subgroups; this indicates which period of growth and maturation those parameters are age differentiated and when they have reached constant values.

Anthropological parameters and body mass components regarding age and gender

Mass and height: The biggest rise in mass and height in the boys was noticed between the U12 and U14 group. Among the girls, the biggest difference in mass and height was between the U10 and U12 groups. The girls were considerably heavier and taller than the boys in the U12 group. The boys were significantly heavier and taller than the girls in the U18 group. All the remaining different age groups did not show a difference for height and mass between the boys and girls. In the different age subgroups, with a difference of two years between each, height increased significantly among the boys and the girls in all the subsequent groups. The boys groups U16 and U18 and the girls groups U14 and U16 were insignificantly different.

Body mass composition analyzed by the Matiegka protocol is separated into three components: the muscle, bone and fat component. All components can be expressed as absolute measurements in kilograms or as relative components (percent part of body mass). For comparison reasons we could get more relevant information if they are expressed as percent of whole body mass. An analysis of body composition shows that absolute muscle mass (MM in kg) among the boys increased distinctly with age with each older group. The boys showed a substantial increase in muscle mass after the age of 12. Relative muscle mass (MM in %) among the boys showed a trend of increase with the age, with a certain stable phase in group U14. Relative MM among the girls was insignificantly higher with age. The mean values for relative MM in all different age groups among the boys and girls were within the optimal range (>50%) and indicated well developed muscle mass. There were no differences between the same age subgroups for this anthropometric parameter between the boys and girls. The boys had a significantly higher amount of muscles (MM in kg) only in the oldest group, U18.

High bone mass could indicate the capacity of the person to grow in height, and our findings are consistent with this opinion because the participants in the phase of intensive growth showed the highest bone mass. The mean value of relative bone mass (BM in %) was highest in the youngest groups in both genders, boys and girls (19.93% vs 19.09%). Although the relative BM among the boys was highest in the U10 group, it was almost the same with all the other age subgroups and insignificantly lower in the oldest group (17.84%). Among the girls, bone mass significantly decreased in the older groups. The boys and girls have an approximate relative BM only in group U10, and after that, the girls have a smaller relative BM than the boys.

The amount of absolute body fat (BF in kg) gradually increased with the age of the groups, and body fat percent (BF in %) was insignificantly different between the different age groups of both genders. Mean values of body fat percent for both genders were at about the optimal value for healthy young people (15-20%). Relative BF was significantly higher among the girls in all the groups except group U10.

Lean body mass (LBM in kg) which represents a sum of non-fat body components, muscles and bones, was the most dynamic parameter and increased significantly with the increase in age among the boys and girls. The girls had a higher LBM than the boys until the age of 12; in groups U14 both genders have an approximate LBM, then after the age of 14, the values of this parameter were in favor of the boys. The mean values for the body mass index (BMI in kg/m^2) regarding gender, were insignificantly different, ranging from 17.52 to 22.95 among the boys and from 17.92 to 21.92 among the girls.

Reference values for body fat indicators for children are reported from studies which included different techniques (skinfolds, anthropometry, BIA, DEXA, etc.), which made direct comparison of data complicated. From the study of Plachta Danielzik et al. (2015), 24 children from Germany, aged 2 to 18, measured by BIA methodology (Tanita), derived reference data for anthropometric parameters which showed median values for relative BF for U10=18.7%, U12=19.4%; U14=17.7%; U16=17.8% for boys, and U10=21.2%, U12=20.6%; U14=24.6%; U16=27% for girls. Compared to the German results, our data showed lower relative BF for all age subgroups. The lower values in our participants could be due to different methodology or the fact that our study population was composed of physically active children and adolescent.

BMI which is acknowledged as an indicator of nutrition status differs in reference values for children and adolescents compared to adults. In a population younger than 18, reference curves and percentiles for BMI, FMI, LBM, height and mass are frequently used (Weber, Moore, Leonard, & Zemel, 2013). Kids with a BMI among the 85^{th} and 95^{th} percentiles are classified as overweight and those with a BMI in the 95^{th} percentile as obese (Krebs et al., 2000). The yearly increase in BMI from the middle of childhood onward is mainly due to increasing lean body mass rather than increasing fat mass (Wells, 2000; Maynard et al., 2001).

Studies of the children populations tend to use percentage body fat (BF%) as better parameters of obesity and to illustrate deficiencies in BMI as a substitute of adiposity in the young population (Flegal et al., 2010)**.** The use of relative BF as the gold standard of adiposity is also an incomplete solution that does not consider height, body proportions, and LBM (Wells, 2001). Assessment of body composition in adolescent school children in Manipur, India, using BIA methodology, in boys and girls aged from 12 to 19, divided at a one-year difference, found relative BF as follows: for boys between 12.9% for youngest, and 16.8% for 17 years old. For girls: the youngest, 12 years had BF 20.1%, and the oldest, 19 years=27.2% (Rajkumari, Akoijam, Akoijam, & Longjam, 2012). The increase in body mass, standing height, hip and waist perimeters, fat mass and fat percent which were noted among the boys could be due to the intensive physical development during the first phase of adolescence (Oner et al., 2004). According to some studies, among girls a relative BF increase is seen only up to age of 16 because at that age girls have a tendency to be more careful regarding their food intake (Lloyd, Chinchilli, Eggli, Rollings, & Kulin, 1998).

The general scientific attitude is that the anthropological differences which occurred between boys and girls during adolescence might be the result of sex hormones effects. In puberty, an increase in lean body components (muscle and bones) among boys was recorded, while girls showed an increase of body fat mass (Demerath et al., 2006). Until the age of 9 growth curves are similar between boys and girls. The highest values for body fat for boys are reached about the age of 11 while for girls they continue to increase throughout adolescence. Median BF% at the age of 18 is 17.0% and 27.8% for boys and girls, respectively (Laurson, Eisenmann, & Welk, 2011).

Red blood cell variables age and gender differences

It is well known, thoroughly investigated and documented that RBC variables depend on gender and change significantly with age (Taylor et al., 1997; Murphy, 2014; Mandala et al., 2017). Our aim was to confirm this on a current sample of our population. The results of our study showed that gender differences for hematological variables RBC and Hct occur in participants older than 12, in favor of the boys. Regarding age, RBC and Hb

had higher values among the older groups of boys, while among thet girls these parameters were not age dependent, they showed constant values in all age different groups. Hematological parameters (MCV, MCH and MCHC) were also insignificantly different in different age groups among the girls. Among the boys MCV and MCH showed significantly higher values in boys older than 14.

Gender differences in hemoglobin levels have been reported after the onset of adulthood in male mammals, even in the birds as they move away from the younger stages of development. Females also increase their hemoglobin level, but not to the same degree compared to males. Women have approximately 12% lower Hb concentration than men, which is a physiological phenomenon which is presented in many species of adult mammals, too. These gender related differences in the Hb level are probably he result of modulation of the erythropoietic response and differences in microcirculation in males and females (Murphy, 2014). The higher RBC counts and Hb levels in men compared to women result from the stimulation of erythropoiesis by androgens and its inhibition by estrogens. Observations of physiological studies lead to the conclusion that adult women uphold their hemoglobin at a lower concentration than adult men (Murphy, 2014). Other studies also found that the concentrations of Hb and Hct have similar trends during certain periods of development. Median Hb concentration is low in neonates and young children and it rises in males between the ages of 5-10, to achieve the highest levels (14.40 g/dL) at the age 15-20. Boys in the age group of 5-10 had significantly higher Hb (13.05 g/dL) and Hct (42.5%) compared to girls of the same age, 10.4 g/dL and 32.6% (Mandala et al., 2017). Several studies conducted among children in Caucasian (Taylor et al., 1997) and African populations (Menard et al., 2003; Onwurah et al., 2018), noted similar Hb and Hct levels despite of gender until the age of 10. Other studies on Hb values regarding age and gender (Yandamuri & Yandamuri, 2013) noted that boys had higher Hb values compared to girls from the age of 12 onward. Some other observations are that the age of 14 is the borderline when RBC variables (RBC count, hemoglobin level, and hematocrit) become typically higher in males compared to females. At the end of adolescencea, between the ages of 17 and 20, the RBC count increases to 4.9×10^6/μl in adolescent males and 4.7×10^6/μl in adolescent females. The average normal RBC count in adult males is 5.4×106/μl, (between 4.5-5.9×106/μl) and 4.8×106/ μl in women (between 4.1-5.1×106/μl) (Yandamuri & Yandamuri, 2013). Similar finding as in our study, that girls demonstrated no significant changes in hemoglobin in hematocrit as they progress through puberty, are reported by Willows, Grimston, Smith, & Hanley (1995).

Cardio-physiological parameters - age and gender differences

Cardio-physiological parameters analyzed in this study were parameters which originated from the Bruce ergometry test. We analyzed the resting heart frequency (HRR in bpm), at the preparatory phase for the ergometry, before the treadmill starts to move. The girls in all the age subgroups had a visibly higher heart rate than their male peers. In group U10, U14 and U18 group the difference was significant, around 10 beats higher. The boys showed significantly better exercise time (ET in minutes) than the girls in all different age groups. The longer time for reaching individual submaximal heart rates could be due to a lower resting heart rate in boys, longer training history and better endurance. Estimated values of $VO2_{max}$ are devised from ET, which is why $VO2_{max}$ is also significantly higher in boys in every age group. The only cardio-physiological parameter in

our study that showed age dependency was $VO2_{max}$ in the group of boys. Among the girls $VO2_{max}$ was not different regarding age.

Studies of the differences between adolescent males and females, (mean age 15.0±1.1vs 14.9±1.1 years; body fat percent: 15.5% vs 20.2%) indicated the following cardio physiologic parameters: HRR (bpm)=73.7 vs 78.1; VO_{2max} (ml/kg/min)=51.2 vs 48.4 (Saghiv et al., 2017). Contrary to adults, findings in pre-pubescent children demonstrate that the exclusive restraining factor of $VO2_{max}$ that distinguished boys from girls could be a poorer systolic volume (SV_{max}), and this gender difference vanished when normalized for LBM. Thus, the gender dissimilarity in heart size and cardiac function during exercise should be interpreted as only one significant aspect of the lower LBM in girls (Vinet et al., 2003). It is not completely explained how gender affects overall cardiac dimensions and amount of $VO2_{max}$ in boys and girls. It is not clear whether heart size differences between adolescent girls and adolescent boys are affected by general body dimensions (especially of lean body mass), or whether there are other essential functional differences (Saghiv et al., 2017).

CONCLUSIONS

This study has shown that age and gender made a difference in anthropometrical, hematological and cardio-physiological parameters in healthy active young participants. Until the age of 12, girls are significantly heavier and taller and have higher LBM than boys. In groups older than 14, boys had an advantage in terms of mass, height and LBM. Relative muscular mass (MM in %) is well developed in both group and insignificantly different regarding gender. Relative bone mass (BM in %) in boys decreased insignificantly with age, while among the girls relative BM decreased significantly with constant values in U16 and U18, which could be an indicator of the end of growth. Body fat percent is in optimal ranges for healthy and physically active pubescent and adolescent participants (between 15 and 18 %). Relative BF is of similar values for all the different age groups, among the boys and girls. Girls older than 12 have higher relative BF than their male peers. RBC variables among the girls showed no age dependency, while among the boys they are significantly higher in subsequent older groups. Gender differences for hematological variables are found in groups older than the age of 12. The analyzed cardio-physiological parameters did not show age dependency, except VO_{2max} in boys, which is higher in groups older than 14. The boys showed significantly higher VO_{2max} than the girls. In conclusion, this study presents the first reference physiological data for body composition, hematological and ergometrical results in children and adolescents conducted from a large sample of a healthy and physically active young population from the Republic of North Macedonia.

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ANTROPOLOŠKE, HEMATOLOŠKE I KARDIO-FIZIOLOŠKE VARIJABLE FIZIČKI AKTIVNIH DEČAKA I DEVOJČICA

Fizička aktivnost (FA) predstavlja stimulativni fiziološki stres za ljudsko telo koja izaziva značajne promene u mnogim fiziološkim, biohemijskim i antropološkim parametrima. Cilj ovog istraživanja je da se utvrde vrednosti i razlike kardio-fizioloških, hematoloških i antropoloških parametara različitih starosnih i polnih podgrupa zdrave fizički aktivne dece i adolescenata. Sprovedena je antropometrijska procena (Matiegka protokol), hematološka analiza, tj. broj eritrocita (RBC), nivo hemoglobina, hematokrit i ergometrijsko testiranje (Brus protokol). Što se tiče mase i visine tela do 12. godine (U12), devojčice su bile teže i više od dečaka. Srednje vrednosti relativne mišićne mase u svim uzrasnim kategorijama dečaka i devojčica su u optimalnom rasponu (>50%) i ukazuju na dobro razvijenu mišićnu masu. Ne postoje razlike između podgrupa istog uzrasta za navedeni antropometrijski parametar između dečaka i devojčica. U svim uzrasnim kategorijama devojčicama je utvrđen veći procenat telesne masnoće u odnosu na njihove vršnjake. RBC varijable devojčica nisu se razlikovale u uzrasnim kategorijama. Što se tiče pola, vrednosti svih varijabli RBC bile su značajno veće u muškim grupama, osim u U12. Kardio-fiziološki parametri broj otkucaja srca u mirovanju, vreme vežbanja i maksimalna potrošnja kiseonika ($VO2_{max}$), bili su značajno veći kod dečaka. $VO2_{max}$ je bio veći kod starijih dečaka u odnosu na mlađe dečake. Zaključak: Ovo istraživanje je pokazalo promene u antropološkim, hematološkim i ergometrijskim parametrima mlade i aktivne populacije muškog i ženskog pola. Devojčicama je utvrđen značajno niži nivo kardio-fiziološke kondicije, čemu mogu doprineti pol i manji obim FA.

Ključne reči: *Sastav tela, crvena krvna zrnca, hemoglobin, hematokrit, adolescenti*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 431 - 438
https://doi.org/10.22190/FUPES180831040D

Research article

PERCEPTION OF COHESION IN INTERACTIVE SPORTS TEAMS

UDC 796.035:316.7

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Abstract. *The aim of this study is to examine the perception of cohesion in highly interdependent sports teams, compare cohesion in different sports, and then compare social and task cohesion. The participants were 205 professional sports players in the city of Belgrade, Serbia. They are engaged in five different sports: Football/soccer, basketball, volleyball, handball, and water polo. The Group Environment Questionnaire (GEQ) was used to collect the data. All the analyses were carried out with the SPSS 22 statistical software. The results have shown moderately-high levels of all four aspects of cohesion (Group Integration-Task, Group Integration-Social, Individual Attractions to the Group-Task, and Individual Attractions to the Group-Social) in all sports. Overall, perception of task cohesion is higher than perception of social cohesion. The study also reveals that the type of sport played impacts the level of cohesion, with basketball players having the highest scores of all.*

Key words: *Sports Teams, Interactive Sports, Cohesion, Group Environment Questionnaire*

INTRODUCTION

Over the past decades, cohesion has been one of the most studied group characteristics (Widmeyer & Williams, 1991; Carron, Colman, Wheeler, & Stevens, 2002; Sabin & Marcel, 2014). In sport studies, the most widely used definition of cohesion is that of Carron, Brawley, and Widmeyer (1998): Group cohesion is "a dynamic process reflected in the tendency for a group to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs" (p. 213). Cohesion is one of the four most important motivational mechanisms in a team, together

Received August 31, 2020 / Accepted September 10, 2020
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with collective mood or group emotion, collective efficacy, and conflict. Team cohesion is especially important for teams which rely on the communication and coordination of its members, and whose members depend on each other (Bell & Brown, 2015). It leads to increased satisfaction (Widmeyer & Williams, 1991), decreased pre-competition anxiety (Eys, Hardy, Carron, & Beauchamp, 2003), higher perceived performance, viability, and satisfaction (Tekleab, Quigley, & Tesluk 2009), as well as higher perceived self-efficacy (Marcos, Miguel, Oliva, & Calvo, 2010). Cohesion also promotes group affiliation and network support in a team (Hassell, Sabiston, & Bloom, 2010).

Cohesion can emerge from two distinct groups of factors: social cohesion (based on social bonds and relationships between the team members) and task cohesion (based on the joint responsibility of accomplishing the team's tasks). Additionally, it develops on two levels: the personal (perception of individual attraction to the group), and group (perception about the group as an entity). With these subgroups of cohesion in mind, Carron, Widmeyer, and Brawley (1985) created the Group Environment Questionnaire (GEQ), today commonly used to determine perceptions of cohesion amongst adults. Carron (1982) claims that, in sports settings, task cohesion (to what degree the players are committed to and focus on a common task) affects performance more strongly than social cohesion (a degree to which members of a team like the other players, and how much pleasure and pride they take in the group). A meta-analysis of 17 studies by Filho, Dobersek, Gershgoren, Becker, and Tenenbaum (2014) showed a stronger link between task cohesion and performance than between social cohesion and performance. Moreover, Dunlop, Falk, and Beauchamp (2012) discovered that perception of task cohesion remains relatively stable across several exercise sessions, while perception of social cohesion varies over time. The research by Haddera (2015) also suggests that task cohesion is especially important in increasing team performance in sports teams.

Some authors claim there is a connection between interdependence and cohesion in sports (Cockerill, 2002; Cotterill, 2012; Murray, 2006). Murray's (2006) research underlined the importance of interdependence in team sports, and consequently the need for cohesion. The author found that even the smallest changes in interdependence can influence the need for team cohesion, and consequently can impact team performance. According to Cotterill (2012), sports that need more cooperation will also need a higher level of cohesion. The more players need others for success, the higher the level of task cohesion will be. In other words, cohesion helps performance in all sports, but much more so in sports where there is a high need for coordination and cooperation. In this paper we chose sports with high team interdependence (basketball, volleyball, football/soccer, handball, and water polo) to examine their levels of cohesion. In these sports, players' interaction is crucial for the team's performance, much more than their individual actions.

Fry, Kerr, and Lee (1986) contrasted highly interdependent sports, such as football, basketball, ice hockey, and volleyball, and low interdependence sports, such as golf, tennis, wrestling, swimming, and track. Keidel (1984) differentiated between pooled interdependence (each member acts relatively independently, with sporadic interaction with other members, like in baseball); sequential interdependence, where members interact in series, like in football teams (American football), and reciprocal interdependence, where every member interacts with all other members, like in basketball teams. Whereas in American football or cricket every player is assigned his/her own role, in basketball every player must be able to play offense, defense, and transition (Keidel, 2014). Feltz, Short, and Sullivan (2007) also found that different sports require different levels of interdependence, from golf (low), baseball, and American football (moderate) to basketball and soccer/football (high). Andersen (2005) emphasized basketball, water polo, and volleyball as interactive sports.

Based on Keidel's classification, Pescosolido and Saavedra (2012) examined the value of group cohesion for different sports, from basketball as one of the most complex (with team or reciprocal interdependence) to baseball as one of the least complex (pooled interdependence). For these authors, cohesion is a common social field, where the aim of increasing team performance comes through learning about each other. In this sense, not all teams benefit from higher social cohesion. It will be only the teams who make real-time decisions during games, where players participate in strategy creation together with their coach, with high coordination requirements.

In a meta-analysis spanning over ten years and comprising 17 studies on cohesion and performance, Filho and associates (2014) found their stronger positive correlation for players in coactive sports than in interactive sports. Regarding sport types, these studies focused either on coactive or interactive sports in general. However, to the authors' best knowledge, apart from Brisimis, Bebetsos, and Krommidas (2018), who found significant differences in group cohesion between sports, there were no studies comparing cohesion levels in different interactive sports.

The aim of this paper is twofold: first, to examine the level of cohesion in highly interdependent sports teams, and then compare social and task cohesion.

METHOD

Participants

In this research, non-probability-purposive sampling was used. The participants were 205 professional sports players in the city of Belgrade, Serbia. They are engaged in five different sports: football/soccer (N=25), basketball (N=67), volleyball (N=28), handball (N=51), and water polo (N=34), with respective percentage 12.2%, 32.7%, 13.7%, 24.9%, and 16.6%. Regarding their age, the participants were classified into the following groups: 18-25 years (51.7%), 26-30 years (43.9%), and over 30 years (4.4%); 66.3% were male, and 33.7% were female.

Design and procedure

The members of each team completed the questionnaire before training. All procedures took place at the sporting grounds of each team. Each athlete read and completed the questionnaire on their own. The data were collected from September 2017 to March 2018. All the analyses were carried out with the SPSS 22 statistical software.

Instrument

The data were collected via the Group Environment Questionnaire (GEQ). This questionnaire, created by Carron et al. (1985), is widely used to determine adult perceptions of cohesion. It splits cohesion into two subgroups: group integration and individual attractions to the group. They are later subdivided into task and social matters, making up four final dimensions. They are a) Group Integration-Task (GI Task) – the group's integration based on mutual goals; b) Group Integration-Social (GI Social) – the group's integration based on social interaction; c) Individual Attractions to the Group-Task (ATG Task) – attraction of individual members to the group's goals; and d) Individual Attractions to the Group-Social (ATG Social) – attraction of individual members to the group as a unit. This questionnaire is extensively used in sport psychology and has been found to be both reliable and valid in various respects (Widmeyer, Brawley, & Carron (1985); Brawley, Carron, & Widmeyer, 1987).

A previous study of Carless and De Paola (2000) was based on a modified GEQ, reduced to ten items to assess global cohesion. The GEQ has so far shown good psychometric characteristics in several different languages. For example, Iturbide, Elosua, and Yanes (2010) successfully used GEQ in Spanish sport settings. Several years later, Pulido, García-Calvo, Leo, González-Ponce, & Sánchez-Oliva (2015) used a shorter version of the GEQ, again in Spanish. Their research proved this version of the GEQ with twelve items to be valid and reliable. The questionnaire was also validated in Brazil for use in Portuguese by Nascimento Junior, Vieira, Rosado, & Serpa (2012), and in Czech by Prokešová, Musálek, and Chalupová (2012). Ohlert, Kleinknecht, & Kleinert (2015) adapted the GEQ for use in German speaking countries, while Sindik and Nazor (2011), and Sindik and Vukosav (2011) validated the Croatian version of the questionnaire.

To the best of the authors' knowledge, the GEQ was not used to measure cohesion in Serbian sports teams or any other teams for that matter. The original version of this questionnaire was translated into Serbian by a researcher with degrees in both English language and Management. Based on recommendations from two researchers from the field of psychology, instead of a 9-point Likert scale, a 5-point Likert scale was used, as is usually done in Serbia. Namely, people in that country are used to a five-point grading scale throughout elementary and secondary education, where 5 is always excellent, 2 is the lowest passing grade, and 1 means fail. Accordingly, in our questionnaire 5 signifies "I strongly agree," and 1 "I strongly disagree."

In this study, the four cohesion dimensions all proved internally consistent within the present sample, with Cronbach's (1951) alphas IATG-S, IATG-T, GI-S and GI-T exceeding Nunnally's (1970) criteria of 0.70 (Table 1).

Table 1 Reliability statistics for the instruments: IATG-S, IATG-T, GI-S, GI-T

Reliability statistics	Cronbach's Alpha	N of Items
IATG-S	0.87	5
IATG-T	0.82	4
GI-S	0.89	4
GI-T	0.91	5

Note: GI-S = Group Integration Social. GI-T = Group Integration Task.
IATG-S = Individual Attraction to Group-Social. IATG-T = Individual Attraction to Group-Task3.

RESULTS

Table 2 shows the descriptive statistics for four dimensions of cohesion. The data show moderately high levels of all dimensions of cohesion (higher than 4.0).

Table 2 Summary statistics for dimensions of team cohesion

Variable	Mean	SD	Skewness	Kurtosis
IATG-S	4.2107	0.60947	-0.403	-0.724
IATG-T	4.3878	0.5259	-0.503	-0.633
GI-S	4.028	0.61497	-0.005	-0.922
GI-T	4.0468	0.70025	-0.323	-0.816

Note: GI-S = Group Integration Social. GI-T = Group Integration Task. IATG-S = Individual Attraction to Group-Social. IATG-T = Individual Attraction to Group-Task. SD – Standard deviation

After obtaining the results, the authors conducted a one-way ANOVA, which compares the means of four dimensions of cohesion (IATG-S, IATG-T, GI-S, GI-T – dependent variables) in different sports (independent variable) in order to determine whether they are statistically significantly different from one another. The one-way ANOVA demonstrated significant variations between different sports for all of the cohesion dimensions scores on GI-S, $F(4, 200)=4.86$, $p.<.05$; for GI-T, $F(4, 200)=4.59$, $p<.05$; IATG-S, $F(4, 200)=4.39$, $p<.05$; and IATG-T, $F(4, 200)=5.79$, $p<.001$.

To further understand the data from the ANOVA, the post hoc Duncan test was conducted. The data in Table 3 show different means for different sports for each of the dimensions of cohesion.

Table 3 Levels of cohesion dimensions in different sports (Volleyball, Water polo, Football, Basketball, Handball)

	Volleyball M ± SD	Water polo M ± SD	Football M ± SD	Basketball M ± SD	Handball M ± SD	Total M ± SD
IATG-S	4.26 ± .72 [b c]	3.95 ± .66 [a]	4.18 ± .49 [abc]	4.42 ± .52 [c]	4.09 ± .60 [a b]	4.21 ± .61
IATG-T	4.37 ± .60 [a]	4.12 ± .54 [a]	4.29 ± .50 [a]	4.6 ± .44 [b]	4.35 ± .50 [a]	4.39 ± .53
GI-S	4.21 ± .66 [b]	3.83 ± .53 [a]	3.78 ± .45 [a]	4.22 ± .68 [b]	3.93 ± .53 [a]	4.03 ± .61
GI-T	4.21 ± .71 [b]	3.68 ± .52 [a]	4.16 ± .51 [b]	4.21 ± .69 [b]	3.93 ± .79 [a b]	4.05 ± .70

Note: If the means are marked with the same letter, the difference between the variables is not statistically significant. Different letters of the alphabet (a,b,c) represent a statistically significant difference between variables in the same row; M-Mean; SD – standard deviation.

In all cases, higher scores indicate perceptions of higher cohesiveness.

A paired-samples t-test was conducted to compare levels of social and task cohesion. There were significant variations in the scores of social cohesion ($M=4.12$, $SD=.53$) and task cohesion ($M=4.22$, $SD=.53$); $t(204)=-2.76$, $p = 0.006$.

The IATG-S mean scores in table 3 show that the level of this dimension of cohesion is highest in basketball teams and lowest in water polo teams. The results of the post-hoc Duncan test indicate that there are significant differences in the mean scores of IATG-S between water polo and two other sports (volleyball and basketball), while basketball is significantly different from handball.

The IATG-T mean scores in table 3 show that this cohesion dimension is highest in basketball teams and lowest in water polo teams. The Duncan test also shows significantly different mean scores between basketball teams and all others.

The GI-S mean scores in table 3 also show significant differences between sports. This dimension of cohesion is highest in basketball teams and lowest in football teams. Again, the data from the post hoc Duncan test indicate that there are significant differences in the mean scores of GI-S between sports.

The GI-T mean scores in table 3 show that this dimension of cohesion is highest in basketball teams and lowest in water polo teams. The results of the post hoc Duncan test demonstrate that this dimension is different between water polo teams on the one hand, and volleyball, football, and basketball teams on the other.

DISCUSSION

The aim of this study was to measure the level of cohesion in highly interdependent sports teams, and then to compare social and task cohesion.

The findings demonstrate that athletes playing in highly interactive sports teams have high levels of perception of group cohesion. Our results show moderately-high levels of all dimensions of cohesion (higher than 4.0). This is in accordance with the study of Brisimis et al. (2018), which revealed high levels of all four cohesion dimensions in the same sports as in our study. We also confirm the findings of Cotterill (2012), who claims that sports that need more cooperation will also need a higher level of cohesion. It can be concluded that players of highly interdependent sports will have high levels of cohesions.

The results of our study demonstrate higher perceived levels of task cohesion than social cohesion. This means that team players are more united towards achieving their mutual goal, instead of developing good relationships for social purposes. This supports previous findings by Carron (1982); Mullen & Copper (1994); Gledhill (2007); Prokešová et al. (2012); and Filho et al. (2014). Our results have led us to conclude that task commitment is the main element of group cohesion in sports teams.

Our findings also show differences in the overall levels of cohesion in different interdependent team sports. The one-way ANOVA has shown that the levels of all four dimensions of cohesion are significantly related to the type of sport played. The data have also shown that level of cohesion in all dimensions is highest in basketball teams (followed by volleyball) and lowest in most cases in water polo. This is in accordance with the study of Brisimis et al. (2018), which revealed significant differences in group cohesion depending on the type of team sport. The authors examined the same sports, namely football, handball, basketball, volleyball, and water polo, using the GAQ questionnaire. Their study showed a significant effect of team sport on ATG-S and GI-S, and a nonsignificant effect on ATG-T and GI-T. Similar to our study, they also showed that gender had no effect on cohesion. This differs from the research of Carron et al. (2002) which showed higher cohesion in female than in male teams. However, in this study the scores among team sports were distributed differently (volleyball players scored highest in AGT-S, and handball players scored lowest in GI-S).

Our results were more consistent, namely basketball players had highest scores in all cases, and water polo players lowest scores in three dimensions (and the second lowest in GI-S). High levels of perceived cohesion in basketball teams are in accord with the study of Pescosolido and Saavedra (2012), who argue that basketball, being one of the most complex sports (with high reciprocal interdependence), requires highest levels of cohesion. A potential explanation of the low score of water polo players could be that a significant proportion of effort is spent on maintaining buoyancy. Unlike other sports, water slows down movement, and there are also a lot of fouls and time wasting during the phases of transition (Hraste, Bebić, & Rudić, 2013). It is physically a very challenging sport, and many times players just have to "wrestle" with their opponent on their own. We have already mentioned Murray's (2006) research, who found that team cohesion is impacted even by the smallest changes in players' interdependence.

CONCLUSIONS

This paper has investigated perception of cohesion in various interactive sports teams (basketball, handball, volleyball, football, and water polo). Our findings show a moderately high perception of cohesion in all sports, especially task cohesion. The results have demonstrated that team cohesion is affected by the type of sport played, with basketball players showing the highest levels of all cohesion dimensions. The interaction and cooperation between basketball players is more important than just the sum of their individual actions. Cohesion is particularly critical because it creates team unity, necessary for good performance.

The limitation of our study is the geographical spread of participants. In some future research, it would be interesting to include other types of sports (with various levels of interdependence) and directly compare the dimensions of team cohesion. There could also be a wider, regional study that would include athletes from several countries from the Balkans.

Having in mind that cohesion affects team performance, the findings could have practical implications for sports teams and their coaches, in terms of understanding and enhancing cohesion in order to improve team efficiency. In interactive sports, cohesion promotes communication and teamwork, which are ultimately important for team performance. In sports teams, it is the force that keeps the team together.

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PERCEPCIJA KOHEZIJE U INTERAKTIVNIM SPORTSKIM TIMOVIMA

Cilj ovog istraživanja je bio da se utvrdi percepcija kohezije u visoko međuzavisnim sportskim timovima, da se uporedi kohezija u različitim sportovima, a zatim uporede socijalna kohezija i kohezija zadatka. Ispitanici su bili 205 profesionalnih sportista iz Beograda koji se bave različitim sportovima: fudbalom, košarkom, odbojkom, rukometom i vaterpolom. Za sakupljanje podataka korišćen je GEQ upitnik (The Group Environment Questionnaire). Sve analize su obavljene uz pomoć statističkog softvera SPSS 22. Rezultati su za sve sportove pokazali umereno visok nivo sve četiri dimenzije kohezije: grupna integracija na osnovu zadatka (GI-T), grupna integracija – socijalna dimenzija (GI-S), individualna privrženost grupi na osnovu zadatka (IATG-T) i individualna privrženost grupi – socijalna dimenzija (IATG-S). Ukupno gledajući, percepcija kohezije zadatka je viša nego percepcija socijalne kohezije. Istraživanje je takođe pokazalo da vrsta sporta utiče na nivo kohezije, pri čemu košarkaši imaju najviši nivo percepcije kohezije od svih sportova.

Ključne reči: *sportski timovi, interaktivni sportovi, kohezija, GEQ*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 439 - 446
https://doi.org/10.22190/FUPES200611041R

Research article

THE EFFECTS OF PILATES WITH A SWISS BALL PROGRAM ON FLEXIBILITY IN FEMALE COLLEGE STUDENTS

UDC 796.015.132-055.2

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Abstract. *Flexibility is a basic motor ability that significantly improves overall motor efficiency and reduces the possibility of muscle and joint injuries. The aim of this study was to determine the effects of Pilates exercise with a Swiss ball on flexibility development among female students. The sample of 45 participants, aged 19 to 22 years, was divided into experimental and control groups. The experimental group took part in a 12-week Pilates exercise with a Swiss ball, with a frequency of three training sessions with one hour of exercise per week. The control group was not involved in the training process. For flexibility assessment, four tests were applied (Sit and Reach, Straddle in Supine Position, Leg Lift from Supine Position and Backward Leg Lift from a Prone Position). The results of the multivariate analysis of covariance showed that there is a significant difference between the experimental and control groups. Univariate results showed significant differences in all flexibility variables. The authors conclude that the Pilates program with a ball has significantly improved the flexibility of the female students.*

Key words: *Pilates, Swiss Ball, Exercise Program, College, Females*

INTRODUCTION

Modern fitness programs with the use of exercise accessories such as a Swiss ball can cause structural and functional adaptations that improve the fitness components of the exercisers (Kyrolainen, Santtila, Nindl, & Vasankari, 2010). Research that has studied the effectiveness of Pilates with a Swiss ball, conducted in accordance with the appropriate health principles, in their concept of training emphasizes the importance of dynamic and static stretching exercises. Namely, training with a Swiss ball is preceded by warm-up dynamic stretching exercises, and after training, static stretching exercises are realized,

Received June 11, 2020 / Accepted June 23, 2020
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which significantly contributes to the development of muscle flexibility (de Oliveira, de Oliveira, & de Almeida, 2016).

Flexibility is affected by numerous internal, external, anatomical, and other factors (Dopsaj, 1994). For these reasons this motor ability developed following an integral approach that involves the application of various techniques to achieve optimal flexibility of the soft tissue in all movement planes (Hou, Tsai, Cheng, Chung, & Hong, 2002; National Academy of Sports Medicine-NASM, 2012). The full range of motion primarily depends on flexibility and neuromuscular efficiency regarding the ability of the nervous system to effectively control the range of motion achieved by efficient recruitment of agonists, antagonists, synergists and stabilizer muscles to produce force and to reduce force, as well as to dynamically stabilize body structures in all three planes of motion (NASM, 2012). Maximal neuromuscular efficiency is possible only if the muscular, skeletal, and neural components of movement function optimally and interdependently (NASM, 2012).

Flexibility training is a significant component of all training programs which require systematic progression based on continuous exercise. The optimal model of flexibility training consists of three phases: corrective, active, and functional flexibility (Wilson, Elliott, & Wood, 1992; Alter, 1996; Halbertsma, Van Bulhuis, & Goeken, 1996).

The benefits of improving flexibility are muscle imbalance correction, increase of the range of motion in the joints, excessive muscle tension reduction, joint stiffness reduction, improvement of the muscle and tendon extensibility, maintenance of the normal functional length of all muscles, improvement of the functional efficiency and neuromuscular efficiency and the reduction of risk of injury (Martin & Morgan, 1992; Magnusson, 1998; Hou et al., 2002; Reid & McNair, 2004; O'Sullivan, Murray, & Sainsbury, 2009).

Previous studies have shown that flexibility does not exist as a general motor space characteristic, but is specific to each joint in the body (Merni, Balboni, Bargellini, & Menegatti, 1981). According to Alter (1996), flexibility is specific to different groups of sports, as well as to different joints, movements and speed of movement.

In general, studies show that Pilates exercise with a Swiss ball in the population of high school students and middle-aged persons as well, can improve flexibility, especially in the torso region, due to increased range of motion compared to exercise on stable surfaces (Sekendiz, Altun, Korkusuz, & Akin, 2007; Sekendiz, Cug, & Korkusuz, 2010; Kloubec, 2010; Phrompaet, Paungmali, Pirunsan, & Sitilertpisan, 2010).

However, in the existing fund of scientific knowledge, the effects of exercise on an unstable surface on the flexibility of student population are still insufficiently researched. For these reasons, this study was conducted to determine the effects of Pilates with a Swiss ball exercises on the flexibility of female college students.

METHODS

The sample of participants

The sample of participants consisted of 30 female students (aged 19-22) of the College of Vocational Studies for the Education of Preschool Teachers and Sports Trainers in Subotica. By random selection, the participants were divided into two subsamples. The first subsample consisted of participants who conducted a Pilates with a Swiss ball exercise program (EG, n=15). The second subsample consisted of a control group of participants (CG, n=15) who were not exposed to any organized exercise program.

The experimental group includes participants that received a Pilates program of exercises with a Swiss ball, while the CG participants were not involved in any type of organized exercise or training process. All of the participants were healthy, athletically inactive, and voluntarily agreed to be included in the study.

The sample of measuring instruments

The initial and final measurements of the sample characteristics and flexibility were taken. The characteristics of the sample were evaluated using the following parameters:

1. Body Height (BH) in cm;
2. Body Mass (BM) in kg;
3. Body Mass Index (BMI) in kg/m^2.

BH measurements were performed with the recommendations of the International Biological Program, a guide designed by Weiner & Lourie (1969), with a measurement accuracy of 0.1 cm.

For flexibility assessment at teh initial and final measurement, the following tests were applied:

1. Sit and Reach (cm);
2. Straddle in Supine Position (deg) in the following text Straddle;
3. Leg Lift from Supine Position (deg) in the following text Leg Lift;
4, Backward Leg Lift from a Prone Position (deg) in the following text Backward Leg Lift.

Procedures and layouts for all the mentioned flexibility tests are described and have been found very reliable (ICC≥0.90) by Sporiš, Vučetić, Jovanović, Jukić, & Omrcen (2011).

Pilates with a Swiss ball program

The experimental program for EG consisted of Pilates with Swiss ball exercises (Table 1). The number of sets and repetitions progressively increased from 1-12 weeks. Rest periods between sets progressively decreased (45, 30, 10 s., at 1-4, 5-6, 9-12 weeks, respectively).

The experimental program was conducted in the gym of the Faculty of Economics in Subotica and the sports hall of the College of Vocational Studies for the Education of Preschool Teachers and Sports Trainers in Subotica.

Table 1 Pilates with a Swiss ball program design

Exercise	Weeks				
	1-2	3-4	5-8	9-10	11-12
	Sets/Repetitions				
Swiss Ball Straight Crunch	1/12-15	1/12-15	2/10	3/10	3/10
Swiss Ball Back Hyperextension	1/12-15	1/12-15	2/10	3/10	3/10
Swiss Ball Push-ups Feet Up	1/12-15	1/12-15	2/10	3/10	3/10
Swiss Ball Wall Squat	1/12-15	1/12-15	2/10	3/10	3/10
Swiss Ball Trunk Twist	1/12-15	1/12-15	2/10	3/10	3/10
Swiss Ball Dips	1/12-15	1/12-15	2/10	3/10	3/10
Swiss Ball Supine Bridge	1/12-15	1/12-15	2/10	3/10	3/10
Swiss Ball Plank	1/15 s	1/15 s	1/25 s	1/40 s	1/40 s

Statistical analysis

To determine the significance of the differences between the EG and at the initial and final measurements, a multivariate analysis of variance (MANOVA) was performed. The differences between the initial and final measurements for both the EG and CG were determined by the T-test for dependent samples. Effect size was determined by Cohen's (d) where the value of *d* below 0.20 is considered trivial; 0.20-0.50 small; 0.50-0.80 moderate; 0.80-1.3 large and >1.3 very large (Cohen, 1988). Multivariate and univariate analyses of covariance (MANCOVA/ANCOVA) were used to determine the effects of the experimental program. The differences were determined at a significance level of $p<0.05$. The data were processed using the IBM SPSS® 23 statistics program, and presented in 6 tables.

RESULTS

Table 2 and Table 3 show the results of the multivariate analysis of variance which represents the difference in flexibility between the EG and CG both at the initial and final measurement.

Table 2 Differences in flexibility between the EG and CG at the initial measurement

MANOVA				
Wilks Lambda	F	Effect - df	Error - df	p
0.734	2.260	4	25	0.091

Table 3 Differences in flexibility between the EG and CG at the final measurement

MANOVA				
Wilks Lambda	F	Effect - df	Error - df	p
0.721	2.424	4	25	0.075

Based on the obtained results shown in the tables 2 and 3, it can be concluded that there is no significant difference in flexibility at the initial and final measurement between the subsamples because the value of p is greater than 0.05 (Initial: p=0.091; Final: p=0.075).

Table 4 Differences in flexibility between the initial and final measurements for the EG

Variable	Ini	Fin	t	p	ES
	Mean±SD				
Sit and Reach (cm)	25.53 ± 9.93	31.20 ± 8.01	8.41	**0.000**	2.17
Straddle (deg)	117.13 ± 12.02	122.00 ± 8.35	3.56	**0.003**	0.92
Leg Lift (deg)	81.27 ± 13.22	87.67 ± 15.86	2.13	0.052	0.55
Backward Leg Lift (deg)	31.27 ± 10.14	34.67 ± 8.78	5.59	**0.000**	1.44

Legend: Ini – initial measurement, Fin – final measurement, Mean±SD – Mean and Standard deviation, t – T-test statistic, p – significance at $p < 0.05$, ES – Cohen's (d) effect size.

Table 4 shows the results of the T-test for dependent samples to determine the differences between the initial and final measurements of the EG. The results indicate that statistically significant differences were found for most of the analyzed variables at the level of statistical significance ($p<0.05$). Differences with very large effects were observed in the

variables Sit and Reach (p=0.000; ES=2.17) and the Backward Leg Lift (p=0.000; ES=1.44). Also, a difference with a large effect was observed for the variable Straddle (p=0.003; ES=0.92).

Table 5 Differences in flexibility between the initial and final measurements for the CG.

Variable	Ini	Fin	t	p	ES
	Mean±SD				
Sit and Reach (cm)	25.20 ± 9.81	26.40 ± 9.28	2.67	**0.018**	0.69
Straddle (deg)	114.13 ± 13.64	115.20 ± 13.03	2.54	**0.023**	0.66
Leg Lift (deg)	84.93 ± 18.51	84.00 ± 19.68	-0.47	0.643	-0.12
Backward Leg Lift (deg)	26.20 ± 6.41	26.20 ± 6.49	0.00	1.000	0.00

Legend: Ini – initial measurement, Fin – final measurement, Mean±SD – Mean and Standard deviation, t – T-test statistic, p – significance at $p < 0.05$, ES – Cohen's (d) effect size.

Table 5 shows the results of the T-test test for dependent samples to determine the differences between the initial and final measurements of the CG. The results indicate that statistically significant differences were found in the two variables at the level of statistical significance ($p<0.05$). Significant differences with moderate effects were observed in the variables of the Sit and Reach (p=0.018; ES=0.69) and in the Straddle (p=0.023; ES=0.66).

Table 6 Effects of the Pilates with a Swiss ball program on flexibility - MANCOVA

MANCOVA				
Wilks Lambda	F	Effect - df	Error - df	p
0.270	14.174	4	21	**0.000**

Table 6 shows the results of a multivariate analysis of covariance to determine the effects of Pilates with a Swiss ball exercise program on flexibility in college female students. After including the results from the initial measurement as covariates, the results indicate that significant differences of effects between the groups at the multivariate level were present (F=8.681; p=0.000). To obtain more precise information, it is necessary to perform further analyses at the univariate level.

Table 7 Effects of the Pilates with a Swiss ball program on flexibility - ANCOVA

Variable	EG	CG	F	p
	Adj. Mean	Adj. Mean		
Sit and Reach (cm)	15.78	11.82	32.95	**0.000**
Straddle (deg)	120.09	117.11	7.80	**0.010**
Leg Lift (deg)	90.84	80.83	5.34	**0.030**
Backward Leg Lift (deg)	32.37	28.50	22.04	**0.000**

In Table 7, the results of the univariate analysis of covariance are shown. After the neutralization and partialization of the results from the initial measurement, it can be seen that all variables in the system were responsible for the existence of differences at the multivariate level. The largest contribution was recorded for the variable Sit and Reach (F=32.95; p=0.000). The variable Backward Leg Lift also makes a great contribution

(F=22.04; p=0.000). The remaining variables Straddle (F=7.80; p=0.010) and Leg Lift (F=5.34; p=0.030) also make a smaller but still significant contribution. Observation of adjusted means indicates that the EG accomplished better results in all the mentioned variables than the students in the CG after a 12-week period. The presented results indicate that the effect of Pilates exercises with a Swiss ball on the EG was significantly superior compared to the CG for all the variables.

DISCUSSION

The study was conducted to determine the effects of Pilates with a Swiss ball exercises on the flexibility in college female students.

According to the obtained results, it can be concluded that in the EG which took part in a Pilates exercise program with a Swiss ball, there were significant differences between the initial and final measurement, and also significant effects after a 12-week period on flexibility among female college students.

The positive effects of Pilates training programs which used a Swiss ball as a prop on flexibility has been confirmed in previous research providing among other things, a higher awareness of women's health and physical fitness, and helping in the prevention of chronic and cardiovascular diseases, a reduction in the degree of non-structural scoliosis, increased flexibility and decreased pain, enhanced control-mobility of the trunk and pelvic segments, prevention and attenuation of the predisposition to axial musculoskeletal injury, an improvement in core strength training, in dynamic balance and EMG neuronal activity (Cosio-Lima, Reynolds, Winter, Paolone, & Jones, 2003; Sekendiz et al., 2010; Phrompaet et al., 2011; de Araújo et al., 2012; Kao, Liou, Huang, Tsai, & Wang, 2015; Kibar et al., 2016). Exercising on a Swiss balls due to an unstable surface affects proprioceptive neuromuscular facilitation (PNF) and generates greater muscle activity compared to similar movements on a stable surface and also effectively develops muscle ability (Cosio-Lima et al., 2003; Carter, Beam, McMahan, Barr, & Brown, 2006; Sekendiz et al., 2007, 2010; Kloubec, 2010; Smith, Mitcheltree, Kieffer, & Miller, 2018). Exercising on a Swiss ball can improve flexibility, especially of the torso region, due to the increase in movement amplitude compared to exercise on stable surfaces (Sekendiz et al., 2007, 2010; Kloubec, 2010; Phrompaet et al., 2010).

Training processes should be programmed in such a way that their impact and effect can cause optimal transformation in flexibility. Based on the obtained results, it can be concluded that Pilates exercise with a Swiss ball after 12 weeks contribute a positive effect on flexibility in female college subjects, aged between 19 and 22 years. If the goal is to improve flexibility in this population, the applied exercise program with a similar dose of exercise volume and intensity can be used.

CONCLUSION

The 12-week Pilates exercise program with a Swiss ball led to significant improvement in all flexibility variables. It can be concluded that Pilates with a Swiss ball program as a specific type of exercise on an unstable surface induces greater muscle elasticity and hip joint movement amplitudes and as such have positive effects on overall flexibility. These findings can provide conceptual guidance for designing similar exercise programs for female college students, also for comparing results with previous and future studies.

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EFEKTI PILATESA PROGRAMA SA ŠVAJCARSKOM LOPTOM NA FLEKSIBILNOST STUDENATKINJA

Fleksibilnost je osnovna motorička sposobnost koja značajno poboljšava ukupnu motoričku efikasnost i smanjuje mogućnost povreda mišića i zglobova. Cilj ove studije bio je da se utvrde efekti pilates vežbanja sa švajcarskom loptom na razvoj fleksibilnosti studentkinja. Uzorak od 45 učesnika, uzrasta od 19 do 22 godine, podeljen je u eksperimentalnu i kontrolnu grupu. Eksperimentalna grupa sprovodila je 12-nedeljne Pilates vežbe sa švajcarskom loptom, sa frekvencijom od tri jednosatna treninga nedeljno. Kontrolna grupa nije bila uključena u trenažni proces. U proceni fleksibilnosti primenjena su četiri testa (sed i doseg, položaj raznoženja iz ležećeg položaja na leđima, odizanje nogu napred iz ležećeg položaja na leđima i odizanje nogu unazad iz ležećeg položaja na stomaku). Rezultatima multivarijantne analize kovarijance utvrđeno je da postoji značajna razlika između eksperimentalne i kontrolne grupe. Univarijantnom analizom utvrđene su značajne razlike u svim varijablama fleksibilnosti. Autori zaključuju da je Pilates program vežbanja sa švajcarskom loptom značajno poboljšao fleksibilnost studentkinja.

Ključne reči: *pilates, švajcarska lopta, program vežbanja, koledž, žene*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 447 - 456
https://doi.org/10.22190/FUPES200222042K

Research article

SOCIODEMOGRAPHIC FACTORS AND LOW BACK PAIN IN MUNICIPALITY PHYSICAL ACTIVITY PROGRAMS FOR FEMALE PARTICIPANTS

UDC 796:63
796.01

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Abstract. *The purpose of this study was to investigate the relationship between low back pain (LBP) and factors such as education level and years of work in 131 women aged 42±1.10 years, participating in the "Sports for All" municipal physical activity (PA) programs in Greece. To evaluate how PA affects the intensity of pain, the questionnaires "Grading the Severity of Chronic Pain-GSCP" and the "A Fear-Avoidance Beliefs Questionnaire-FABQ" were used. Analysis of Variation and the Tuckey post hoc tests calculated the difference among the questions of each of the questionnaires. Statistically significant differences were determined for three questions. Female participants with a medium or low level of education show less or no improvement in LBP. Concerning years of work, participants with fewer years of work suffer from higher LBP levels than the ones already working for longer time. Future studies of the relationship between specific PA programs, the content and nature of one's job and the appearance of LBP are needed.*

Key words: *Low Back Pain, Intensity, Working Experience, Education Level*

Received February 22, 2020 / Accepted August 13, 2020
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INTRODUCTION

Low back pain (LBP) constitutes a common daily problem for the general population and is recognized by the medical community as a very important public health problem with particular economic and social implications. LBP results in reduced productivity due to reduced working time, increased absenteeism, and early retirement due to disability, while also contributing to poor quality of life as it negatively affects both physical as well as one's mental, emotional and social well-being (Shahzad, 2017).

Leclerc et al. (2009) reported that the two dominant categories of LBP relate to either factors of the work environment (movement mode, content, and type of work, loads, years of work, etc.), or demographics and the sociological characteristics that shape employees' lifestyles (gender, age, education level, tobacco and alcohol consumption, etc.). The socioeconomic status of individuals, as a multifactorial approach to the phenomenon, is a factor that significantly influences the occurrence of LBP (Ikeda et al., 2019). Other variables that affect LBP concern the socio-economic level of the participants, in particular level of education and years of work.

Research results have shown that low education levels correlate with various diseases and pathological conditions, including musculoskeletal diseases and more particularly LBP (Dionne et al., 2001; Hagen, Zwart, Svebak, Bovim, & Stovner, 2005; Aittomäki, Lahelma, Rahkonen, Leino-Arjas, & Martikainen, 2007; Schmidt et al., 2007). In particular, a negative correlation between education level and LBP has been reported in research, with participants with low or intermediate levels of education suffering more from LBP, and an even stronger correlation with participants reporting lower levels of education; on the other hand, for participants with higher education levels the only correlation found was when they were in a driving position for more than four hours (Shiri et al., 2019). The relative risk of suffering from LBP appears to be higher for those with low education levels compared with those with higher levels of education (Ikeda et al., 2019).

Several researchers' findings that studied the relationship between years of work and LBP appear to be inconsistent, but rather divergent. More specifically, the results of studying the relationship between LBP and with limited activity show a positive association of the intensity of LBP and age, and years of work (Loy, Warner-Czyz, Tong, Tobey, & Roland, 2010). On the contrary, a different survey (Wami, Abere, Dessie, & Getachew, 2019) regarding LBP among hotel employees showed that these employees with fewer working years had higher rates of LBP compared to those who had many years of work. In 2018 Lallukka and associates, after 28 years of research in the field, concluded that employees with few years of work presented statistically significantly higher levels of LBP compared to those who already worked for more years. In addition, in the same study, women were more likely than men to report having LBP, with those with a low level of education reporting having LBP more often.

Many studies have focused on physical activity (PA) and exercise as a means of reducing LBP, reducing movement restrictions due to pain, and reducing the fear-avoidance feeling concerning movement due to pain, while also improving the patients' overall quality of life (Kosmas, Georgiou, Marmara, & Fotiou, 2019; Salas et al., 2019; Vanti et al., 2019; Đurđević, Mazić, Janković, & Isaković (2019). In Greece, popular PA programs named "Sports for All", aimed at mass citizen participation in PA and exercise activities, are primarily focused on improving the health of the participants in total, contributing significantly to the improvement of public health. These programs are implemented by Municipal Sports Organizations on municipal premises and refer to female

trainees (Alexandris, Papadopoulos, Palialia, & Vasiliadis, 1999; Afthinos, Theodorakis, & Nassis, 2005). However, these programs follow specific standards in their content that refer to the general population and not to participants with specific characteristics such as those suffering from LBP.

The literature review does not show any research attempt involving a group of women participating in municipal PA programs who suffer from LBP. More specifically, there no research has been implemented to investigate the relationship between LBP and labor and social-demographic variables, such as education level and years of work. The purpose of this study is to investigate the relationship between LBP and the factors of education level and years of work among women participating in the "Sports for All" municipal PA programs in Greece.

METHODS

This survey was conducted from January 2017 to June 2017. From a population of approximately n=1500 women who participated in the "Sports for All" programs, those who reported suffering from LBP were n=131. The mean age of the women reporting LBP was M=42±1.10 while the two extremes were identical to the values of those of the total sample (*min*=18 and *max*=66 years).

To evaluate LBP intensity, the questionnaire "*Grading the Severity of Chronic Pain*" by Von Korff, Ormel, Keefe, and Dworkin (1992) was used. At the same time the Waddell, Newton, Henderson, Somerville, and Main (1993) "*A Fear-Avoidance Beliefs Questionnaire* (FABQ)" questionnaire was also used to measure whether and how PA affects the intensity of pain from the intra-articular corticosteroids.

The FABQ questionnaire consists of 8 questions on a five (5) point Likert scale rated from totally disagree (1) to totally agree (5). Concerning the GSCP, there are 8 questions on a ten (10) point Likert scale, from 0=no pain to 10=the worst possible pain (questions 1-4). The fifth question "*For how many days, during the last six months, have you been absent from your usual activities (work, school, home, sports) due to back pain*? (*Number*) *days of abstinence*". The sixth question, about the effect of pain on any activity, is rated from 0=no effect up to 10=impossible to exercise. The seventh question about changes in the ability to participate in creative/social/family activities due to pain is rated from 0=no change up to 10=huge change. The eighth question about the ability to participate in creative/social/family activities due to pain is rated from 0 up to 10 where 0=no change and 10=huge change. For the GSCP questionnaire the Cronbach *a* coefficient ranged between 0.811-0.976, while for the FABQ questionnaire the Cronbach *a* coefficient ranged between 0.877-0.984.

The correlation in the test-retest control (questionnaire reliability) was within the accepted values. The reliability of an instrument is defined as its relation to the consistency or repeatability of the measurement (Thomas, Nelson, & Silverman, 2015). In the present survey, the questionnaire was translated into the Greek language, completed by 55 persons. Furthermore, the questionnaire was redistributed to the same persons after 48 hours without them being informed beforehand that a test-retest control will take place to test the reliability (Chaory et al., 2004). The results of each question were separately and overall compared to those provided in the new questionnaire.

Table 1 Test-retest control correlation

	GSCP		FABQ	
Q1	p<0.01	0.811	p<0.01	0.977
Q2	p<0.01	0.976	p<0.01	0.956
Q3	p<0.01	0.937	p<0.01	0.853
Q4	p<0.01	0.970	p<0.01	0.951
Q5	p<0.01	0.976	p<0.01	0.984
Q6	p<0.01	0.960	p<0.01	0.877
Q7	p<0.01	0.884		
Q8	p<0.01	0.925		
M		0.929875		0.933

RESULTS

Years of work

The years of work reported by participants ranged from *min*=1 to *max*=36 and the mean was M=14.25±0.795 (Table 2). This shows us a level of variance concerning the participation's mass character of the PA programs, the different ages and the different work years of the participants.

Table 2 The average value and standard deviation for years of occupation

	Mean	Standard Deviation
Years of work	14.25	0.795

The descriptive statistics and the analysis of variance show that in three questions (Question 12b Question Q4, Question Q5) there are statistically significant differences F(5,125)=4.07, p=0.002, F(5,125)=3.49, p=0.05, F(5,125)=5.09, p=0.000, respectively. No statistically significant differences were observed for the remaining questions (p<0.05).

The Tukey post hoc analysis of statistically significant differences between different groups of working years indirectly showed for Question 12b "*How will you rate at present the pain you feel?*" there was a statistically significant difference between women who had 1 to 6 years of experience at work (M=4.44±1.48) and women with working experience of 13-18 years (M=3.34±0.70). In other words, participants with most years of work experienced less LBP at present, while those with fewer years of work declared significantly higher levels of pain. For Question Q4 "*I should not do activities that could aggravate my pain*", there was a statistically significant difference between participants with 1-6 years of work experience (M=5.69±1.63) and participants with 13-18 years of work experience (M=4.21±1.33). Participants with fewer years of work were more determined to participate in activities that would make their LBP worse than the participants who had more years of work. Similarly, for Question Q5 "*I cannot do activities that would exacerbate my pain*" there was a statistically significant difference between participants who had 1-6 years of work experience (M=5.08±1.77) and participants whose work experience was 13-18 years (M=3.18±1.61). This shows that women in training programs with fewer years of work experience are not willing to do activities that would exacerbate their pain, while participants who worked more years (13-18) were not sure if their LBP would be worsened or not.

Table 3 Descriptive statistics and ANOVA of years of work

Question	Source of Variance	Sum of squares	df	Mean Squares	F	p
que12a	Groups	12.188	5	2.438	1.766	.125
	Error	172.545	125	1.380		
	Total	184.733	130			
que12b	Groups	30.325	5	6.065	4.078	**.002***
	Error	185.904	125	1.487		
	Total	216.229	130			
que12c	Groups	3.512	5	.702	.631	.677
	Error	139.190	125	1.114		
	Total	142.702	130			
que12d	Groups	2.638	5	.528	. 470	.798
	Error	140.278	125	1.122		
	Total	142.916	130			
que12e	Groups	22.787	5	4.557	1.260	.285
	Error	452.130	125	3.617		
	Total	474.916	130			
que12f	Groups	13.961	5	2.792	1.195	.315
	Error	291.948	125	2.336		
	Total	305.908	130			
que12g	Groups	15.040	5	3.008	2.223	.056
	Error	169.128	125	1.353		
	Total	184.168	130			
que12h	Groups	3.297	5	.659	.405	.845
	Error	203.603	125	1.629		
	Total	206.901	130			
Q1	Groups	10054	5	2.011	.719	.610
	Error	349.488	125	2.796		
	Total	359.542	130			
Q2	Groups	11.781	5	2.356	1.265	.283
	Error	232.769	125	1.862		
	Total	244.550	130			
Q3	Groups	2.320	5	.464	.194	.964
	Error	298.474	125	2.388		
	Total	300.794	130			
Q4	Groups	40.228	5	8.046	3.498	**.005***
	Error	287.497	125	2.300		
	Total	327.725	130			
Q5	Groups	71.443	5	14.289	5.091	**.000***
	Error	350.802	125	2.806		
	Total	422.244	130			
Q6	Groups	18.245	5	3.649	1.728	.133
	Error	263.999	125	2.112		
	Total	282.244	130			

Legend: Significance set at level * $p<0.05$

Level of education

The level of education of the participants in PA programs is shown in Table 4. There are two prevailing levels of education. One is primary school graduates (34.3%) and the other is junior high and high school graduates (48.9%). Women who hold a university, postgraduate or doctoral degree are the least present (16.8%).

Table 4 Level of training of participants in PA programs (N=131)

	N	f (%)
Primary School	45	34.3
Junior High School-High School	64	48.9
University	22	16.8
Total	131	100.0

Table 5 shows statistically significant differences for three questions (Question 12c Question 12d, Question 12f, respectively), [F (2.128)=5.93, p=0.003, F(2,128)=4.02, p=0.020, F(2,128)=6.65, p=0.002]. No statistically significant differences were observed for the remaining questions (p<0.05).

The Tukey post hoc analysis of statistically significant differences showed that for Question 12c "*During the last six months how intense was the worst LBP you felt*" there was a statistically significant difference between participants who were primary school graduates (M=3.93±1.07) and participants who were junior high school and high school graduates (M=3.26±0.97). Interpreting this means that the primary school graduate participants felt more intense pain than the junior high or high school graduate participants.

For Question 12d "*During the last semester and on average, how severe was the LBP you felt?*" a statistically significant difference was noted between primary school graduate participants (M=3.84±0.97) and junior high school and high school graduate participants (M=3.36±1.09). The usual pain that the primary school graduate participants felt was on average more pronounced than that of the junior high school-high school participants during the last semester.

For Question 12e "*How many days in the last semester did you abstain from your usual activities (work, school, home, sports) due to LBP (days off)*" a statistically significant difference was noted between primary education graduate participants (M=5.2±1.53) and junior high school- high school group of participants (M=4.15±1.55). The number of days of absence from various activities of the first group of graduates was higher than that of the second group, respectively.

For Question 12f "*During the last semester, how much did the LBP affect you in your daily activities in your daily activities?*" no statistically significant differences were found between participants with different levels of education.

Table 5 Descriptive statistics and ANOVA of the level of education

Question	Source of Variance	Sum of squares	df	Mean squares	F	p
que12a	Groups	2.569	2	1.285	.903	.408
	Error	182.164	128	1.423		
	Total	184.733	130			
que12b	Groups	3. 474	2	1.737	1.050	.355
	Error	212.755	128	1.662		
	Total	216.229	130			
que12c	Groups	12 .100	2	6.050	5.930	**.003***
	Error	130.603	128	1.020		
	Total	142.702	130			
que12d	Groups	8.452	2	4.226	4.023	**.020***
	Error	134.464	128	1.050		
	Total	142.916	130			
que12e	Groups	18.209	2	9.104	2.552	.082
	Error	456.707	128	3.568		
	Total	474.916	130			
que12f	Groups	28.816	2	14.408	6.656	**.002***
	Error	277.092	128	2.165		
	Total	305.908	130			
que12g	Groups	3.422	2	1.711	1.212	.301
	Error	180.746	128	1.412		
	Total	184.168	130			
que12h	Groups	15.255	2	7.627	5.094	**.007***
	Error	191.646	128	1.497		
	Total	206.901	130			
Q1	Groups	11.966	2	5.983	2.203	.115
	Error	347.576	128	2.715		
	Total	359.542	130			
Q2	Groups	2.801	2	1.401	.742	.478
	Error	241.749	128	1.889		
	Total	244.550	130			
Q3	Groups	8.176	2	4.088	1.788	.171
	Error	292.618	128	2.286		
	Total	300.794	130			
Q4	Groups	2.017	2	1.008	.396	.674
	Error	325.708	128	2.545		
	Total	327.725	130			
Q5	Groups	4.835	2	2.417	.741	.479
	Error	417.409	128	3.261		
	Total	422.244	130			
Q6	Groups	.937	2	.469	.213	.808
	Error	281.307	128	2.198		
	Total	282.244	130			

Legend: Significance set at level * $p<0.05$

DISCUSSION

The purpose of this study was to investigate the relationship between education level, years of work and LBP among female participants of municipal mass sports programs "Sport for All". The determination of the relationship between socio-demographic factors and LBP, in participants in mass participation PA programs is an open field with a high research interest. In the research community there are insufficient research results regarding LBP issues related to proportionate factors, except very few studies that contribute significantly to their useful conclusions (Kosmas, Marmara, & Stergioulas, 2008).

The results of this study concluded that female participants in the “Sport for All” PA program with a medium or low level of education show less or no improvement in LBP. These results are in line with resent results of the investigated area where the education level acts as a predictor of LBP (Alonso-García & Sarría-Santamera, 2020). Probably the nature of the participants’ work, due to their relatively low education level associated with elevated levels of physical job requirements and the specificity of the movements that the specific job requires, do not contribute to the reduction or the elimination of the symptom of LBP. The usual pain reported by participants with lower education levels participants was, on average, more intense than that of participants with higher education levels. The possible misunderstanding of the instructions given by the physical education (PE) teachers with the participants’ level of education might be a factor which plays a key role in the final result of the intensity of LBP, such as misunderstanding the instructions by using obscene terms on behalf of the PE experts can lead to wrong execution on the part of the participants, which results in no improvement at all and can even be harmful. Besides, the number of days of absence from various activities (including work) of primary school graduates was more than those who had completed a junior high school-high school education, a finding which agrees with previous results (Dionne et al., 2001; Hagen et al., 2005; Schmidt et al., 2007; Aittomäki et al., 2007).

Concerning years of work, the results of the present study show that participants with fewer years of work declare that they suffer higher LBP levels than the ones already working for a longer time. Though the participants with fewer years of work seem to be more determined to follow PA programs that might make their LBP worse than participants with more years of work, they are less willing to do other kinds of activities that might exacerbate their LBP than those with more years of work. This specific ambiguity of the results of the present study can be reflected in the results of previous research. Some of them show that the severity and the levels of LBP where higher in the groups of participants with fewer years of work (Lallukka et al., 2018; Wami et al., 2019), while others surveys present their results that more years of work contribute to higher levels and more severe incidents of LBP (Loy et al., 2010). The conclusion that follows from the above is that the results of the present research are ambiguous, just like the results of previous research and no clear picture can be deduced. However, participants with more years of work felt less LBP, while those with fewer years of work had significantly higher LBP levels. This may indicate that the multitude of years of work creates a culture of prior knowledge which leads to experience and then acts as a deterrent to such phenomena.

The designers of such programs should also introduce specialized programs targeting a special population with special needs, among them individuals who suffer from LBP. Programs should be adapted to socio-demographic factors such as years of work and the education level of the participants. PE teachers should, on the one hand, formulate and

adapt the content of the programs according to the physical condition of the participants, while on the other hand, they should use simple words without possible obscure scientific expressions, to make their instructions more comprehensible and thereby avoid any possible misunderstanding on the part of the participants that may lead to incorrect performance of some exercise, thus either creating or exacerbating an existing LBP problem.

This kind of segmentation should meet the challenges of our time, as we live in a very dynamic era where adaptation and flexibility are a must to any form of change. At the same time this gives an advantage to any sports organization if flexible and perhaps personalized programs are presented, with some of them based on the relationship between socioeconomic factors and the LBP. This would be a step in the right direction since it would not serve the impersonal implementation of programs, but the deeper purpose of mass sports programs which are ultimately to improve the physical, mental and social well-being of citizens, with direct and indirect beneficial effects.

CONCLUSIONS

It is likely that less educated women and people in general are engaged in manual or even heavy tasks that over the years lead to the emergence of LBP, while those with a higher level of education are occupied as specialized staff and in administrative positions. Future investigations of the relationship between specific PA programs and the content and nature of the job and the appearance of LBP may give useful recommendations and lead towards the creation of new specialized and appropriate PA programs for specific populations.

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SOCIODEMOGRAFSKI FAKTORI I BOL U DONJEM DELU LEĐA UČESNIKA ŽENSKOG POLA U OPŠTINSKIM PROGRAMIMA FIZIČKE AKTIVNOSTI

Cilj ovog istraživanja bio je da se istraži povezanost bola u donjem delu leđa (LBP) sa faktorima nivoa obrazovanja i godina rada 131 žene, starosti *42±1.10 godina, koje su učestvovale u fizičkim aktivnostima u okviru opštinskih programa „Sport za sve“ u Grčkoj. Da li i kako PA utiče na intenzitet boli korišćeni su upitnik o ocenjivanju težine hroničnog bola-GSCP i* Upitnik *u vezi sa izbegavanjem usled* straha-*FABQ. Upotrebljeni su Analiza varijanse i Tuckey post-hoc kako bi se utvrdila razlika među pitanjima svakog od upitnika. Statistički značajne razlike utvrđene su u tri pitanja. Učesnice sa srednjim ili niskim nivoom obrazovanja pokazuju manje ili nikakvo poboljšanje LBP-a. Što se tiče godina rada, učesnici sa manje godina rada trpe više nivoe bola u donjem delu leđa od onih koji već rade duži vremenski period. Neophodna su buduća istraživanja odnosa određenih programa PA, sadržaja i prirode posla i pojave LBP-a.*

Ključne reči: *bol u donjem delu leđa, intenzitet, radno iskustvo, nivo obrazovanja*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 457 - 464
https://doi.org/10.22190/FUPES200630043V

Professional article

SECURITY MANAGEMENT IN SPORT

UDC 796.075

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Abstract. *The paper deals with the practical application of management and commercialization in sports. It also examines the forms of endangering internal security, prevention of violence and misbehavior at sporting events and the security of the state and society. Management as a dynamic discipline represents leadership in each organization. It implies optimal use of resources, organizing the processes and activities of subordinates, delegating tasks and responsibilities, coordination of all resources through planning, organization, management and control. Management in sport, or in a sport organization is in the function of transferring ideas to the ultimate goal. In this regard, it can be said that application of management in sport is a successful pursuit of the idea to the realization of the goal. Management of each organization, including management in sports, gives special attention to security as the basic condition of survival and prosperity. Different organizations have different security challenges, risks and threats, so the risks that the state as an organization exhibits differ greatly from the challenges that business entitles are exposed to, including sports and sports organizations. Challenges, risks and threats that an organization is exposed to, especially in sport, as well as the responsibilities of an organization towards the environment in terms of safety, have a decisive influence on management in sport, that is, to the manner in which the decisions regarding security and protection of persons, property and business will be made.*

Key words: *Management in Sport, Security, Misconduct at Sports Events*

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INTRODUCTION

When it comes to management as a discipline, it is applicable in different fields and organizations. There is educational management, public services management, company management, police management, etc. Hence, there are many different types of human practice and techniques of management. The basic task of management in every organization is to increase the vitality of organization and its ability to survive in different circumstances, including the prosperity and growth of an organization. The way that management handles questions of safety in the first instance depends on the general goals of the organization. In that way a difference between safety management and management of cooperative safety in organizations which provide safety to other users and customers can be made. They are both in the function of the preservation and growth of the organization. Most economic and sport subjects, sport organizations, have certain properties, infrastructure, capital and other values which can be at risk of physical destruction and other forms of expropriation (Đukić, 2017: 3). Millions of people around the world are excited and fascinated by competition sport. People are willing to pay to see elite athletes and elite sport performances. Sport dominates the media, it can bring millions in just one season and sport goods are always so very popular. Today the word "safety" is quite present in all of the languages and cultures i.e., in different areas such as sport, politics, health, IT technology, ecology, psychology, economy, finance, architecture etc. When it comes to inner safety, what is worth mentioning are sociopathological types of endangerment (criminal, drug abuse, prostitution, alcoholism, gambling), extremities, obstruction of public peace and safety etc. (Đukić, 2018: 142). There will be a special accent on the endangerment of sport activities, performances and other sport festivities.

The paper deals with the practical application of management and commercialization in sports. It also examines the forms of endangering internal security, prevention of violence and misbehavior at sporting events and the security of the state and society.

THEORETICAL CONSIDERATIONS OF THE PROBLEM

Defining management in sport

Management in general is a multiple concept which requires different elements of the market. In its first and most common meaning it represents the process of managing different businesses and activities, the correlation of jobs and responsibilities, organizations, leadership and control. The word *management* is an English word which means to manage companies or different public resources. Its beginnings are related to the terms of industrialization. Although its roots stem from the early past it is important to mention that providing new methods and technologies increases profit, and the term itself becomes more popular (Životić & Veselinović, 2018). The division of capitalist society into the public and private sphere found its expression in management. But, the term of management has been used more often in managing companies while the police and army used other terms, such as leadership and commanding as the special functions of management. Managers are people that basically rent out their knowledge and leadership (Životić, Ilić, Veselinović, & Bačevac, 2019). Management means coordinating activities connected to businesses. Being a manager means to act efficiently and effectively perform a job in organizations connected to work, or it is at least what managers are trying to achieve (Đukić, 2017: 10). In the case of the term of "sport",

in the modern world its main meaning is related to the competition and struggle for the best results, but it can also be seen in a much broader meaning. There are so many different definitions of sport which define the term and its meaning.

The common characteristic of different definitions is that it is public work (a physical activity) and it is a struggle for higher accomplishments. Regarding that we will number some of the definitions of sport: "By sport we mean defining different physical activities as a subject of mastery, strength, ability of a man to incorporate different elements of competition, leadership, record or maximal results as a specific form of competition" (Matveev, 2008: 81). Based on these definitions it is clear that sport is fun, a game, physical practice and psychophysical activity connected to competition (struggle) for measurable results (Nešić, 2008: 10). When seen as a human activity sport has the following characteristics: 1) Competition; 2) Result; 3) Specialization; 4) Utility (sport has through its whole evolution been in the service of educational, health and recreational needs); 5) Complex social phenomena. Sport activity is an organized activity of a larger number of people with a basic function - providing conditions for the needs of groups of people or a whole society. An activity that is based like this has in the goal of setting the standards of certain subjects (Nešić, 2008).

The basic and fundamental part of sport are sport resources, too. Sport people and sport organizations are a part of a system basic to the sport. A sport organization itself is an "organism" which provides a sportsman with its full potentials and new values. Management in sport, and in sport organization, means that all of the processes and resources are in the function of transfer to its final goal. It can be said that management in sport represents successful leadership of ideas to the final goal. By defining it this way, management in sport provides the functioning of the whole system of sport organization, from talent selection to the professional work of organizing sport competitions, providing material and financial resources and communication of all the processes in one sport organization. In the first place it concerns its stability and position in society, sport results, business results, work efficiency, etc. At the same time, it has the function of basic development of sport in general and of the sport organization, too.

When it comes to defining the basic principles of management in sport according to Tomić (2001) they include: 1) Developing sport by conserving its mission and spirit; 2) Fulfilling the goals of multiple publicity; work efficacy, etc.; 3) Developing a stable sport organization; 4) Development of creative capacities; 5) Decentralization and delegation of authorities; 6) Application and development of all the functions of management. Management in sport must apply and develop all the functions of management: planning, organizing, prediction, leadership and control. Every function by itself would not mean anything without the interaction of all its parts (Nešić, 2008: 79).

Practical application of management in sport

The practical application of management in sport, as the organization of work in sport organizations and management in sport, consists of: 1) aspect of studying and 2) aspect of practical knowledge which is being studied. In the first part of the paper it was mentioned that management is a process, which means cyclic process through five functions which managers realize by preparing and controlling an organization and its process. Regarding that, management in sport as an academic discipline unites knowledge on the management of sports organizations. As an example, there is the United Commission for Physical

Education and Sport Management of North America, for the evaluation of sport managers at the Universities of North America. Its standards are given as follows: a) Studying of sociocultural dimensions of sport; b) Management and leadership in sport; c) Ethics in sport management; d) Marketing in sport; e) Communication in sport; f) Budget and finance in sport; g) Law aspects of sport; h) Economy of sport; i) Management of sport objects and festivities; f) Leading bodies and structures in sport; and h) Practical experience in sport management (Raić & Maksimović, 2001: 5-6).

The efficient and well-designed organizational structure of a sport organization is a basic necessity the for realization of defined plans. Forming an organizational structure includes the entire spectrum of actions on defining roles and assignments, competitions and regulations, norms of behavior, as well as hiring resources in sport organizations which are in function of certain goals and the defined policies for its realization. Structural defining, or the design of one organization is a major activity of a manager in sport. In economic activities, as in sport organization, managers assign jobs and divide the activities of integration-grouping jobs by sectors. After that division, leadership takes its part in the coordination of activities and management of efficient communication inside the organization (Veselinović, 2012: 78).

In the case of control in sport, it is always applicable on measurements of results of one club i.e., the projected goals of a sport organization. In companies, the control process functions between planned and accomplished and corrective actions. Regarding the obligation of one club, especially in professional sport, there is a need for business books and balances which are delivered once a year. The financial aspect of a club is among one of the most significant terms of functioning. Control as a function of a training process and sport activities are of great significance. Clubs that have precisely regulated financial aspects of business are better positioned than the ones that do not have it. Clubs can also hire professional managers (Jones, Wicks, & Freeman, 2002).

In this case there is a need for the management strategy of. Financial aspects are defined by sport federations which are doing their part of the work, while the internal part of business in clubs is done by the committee of the club. Publicity in the work is perhaps the best way of controlling the management in certain club. Managing leadership and above all financial control in terms of guaranteed deposits of future candidates for leading functions in elite sport is the only way to restrain bad practice (Šurbatović, 2014: 103).

Commercialization of management in sport

Commercialization in sport, especially in the professional one imposes the following questions, of which the second one is crucial: “Which moral principles need to restrain sport commercialization?” Whose responsibility is it to maintain those principles?” Part of the commercialization process is a transformation of many sport professional organizations into corporations. Companies are not in the world of sport. It is not in the best interest of professional teams, sport organizations or the best sport players to encourage violent behavior between players or inside the whole society. The term “corruption” means falling apart, distancing from the original principles which were noble in the first place. Corruption means that the original values that have been in sport such as fair play, sport behavior and a constant search for excellence. The fact that elite sport is connected highly with commercialization is especially problematic, as is the connection between mass sport and mass players. Critics have always claimed that the promotion of elite sport and elite competitions has a

very bad influence on sport. For example, in his quite provocative book "Sport in America" Michener (1976) claimed that promoting talented sport players between 15 to 22 years of age is not good in general, because in that way we are not promoting the ones that are between 23 and 75 years of age. Since Michener's book has been published there has been a significant decline of physical activity in public schools in USA and consequently higher rates of obesity among American youth, hypertension and diabetes, problems that earlier had been connected only to middle age people.

Maybe the biggest concern is the one that commercialization can endanger the sport itself. For example, changes in the rules of the game can make a game more interesting and popular for some people. However, it can have enormous side effects. For example, with baseball players in the American League the game became more interesting to those that needed more action and more home runs, but it decreased a need for subtle strategy decisions, such as replacement of the players or rejection of the ball. Maybe an even better example is judging the NBA league. Commercialization can influence sport competitions in many other ways. For example, during the "television time out" the game is interrupted for the purpose of commercial breaks during TV shows, especially in professional and college basketball, which influences game results in general. There is a significant impact of large amounts of money in professional sport which gives the richest clubs a chance to win. If wealthier clubs can buy best players and have a better team even before the game started, is there a question of ethics? In the same way a need for profit can prolong the whole season and the players in that case do not give the best performances until the very end of the game. They do not play the best they can during the season and the usual season is merely an adaption for a post seasonal game. At the same time, onlookers pay more and more to watch games during the regular season.

Besides, influence of the money can change the relationship between players and those who watch the game. With the commercialization of the sport in general, players also become goods that can be bought, sold and changed between teams. As a result there is less humane treatment and more commercialization which is not good. Players become untouchable and distanced. Professional teams aspire to create profit, the prices of tickets are very high (Robbins & Coulter, 2005). As sport becomes more and more interesting and less balanced it focuses more on knowledge and respect for tradition. Commercialization of sport, transformation of elite sport into the final product which can be bought and sold, ruins sport itself. Values of sport can be contrary to traditional postulates of the sport. As McNamee (2015) said, commercialization of sport introduces search for the money and fame and eliminates those involved in sport to compete, to win and to express other human qualities.

Experience in sport according to Morgan et al. proscribes a corruption thesis, becomes an instrument for the biggest external awards such as money, fame and fortune. The significance of internal awards is being diminished. Whether the commercialization corrupted sport or has it made to feel more acceptable for millions of viewers is a question for further discussions.

Moral responsibility of sport management

When it comes to business in general and about the moral aspects the question is which moral restrictions are applied onto professional sport teams and major leagues. According to one perspective sport teams must provide protection for the environment, but no other obligations are needed. There is a constant race for profit in every team and sport is becoming more and more commercialized (Radaković, 2016).

If the sport industry is only for fun and entertainment then what happens with the moral principles and other positive aspects that sport should bring?

According to Barry (1989) if personal profit is left on one side, would it be morally correct to change the game and its basic values? What if one team is that much superior that it cannot put any limits on its work, and the other team is that much inferior that it cannot compete with a much stronger team. It seems that these arguments are opposite to the moral principles they represent.

Based on these views it can be concluded that owners of the clubs and players make profit, while supporters enjoy the given game.

Preserving fundamental values of sport is what keeps fundamental principles alive and makes sport interesting. For those reasons members of the sport industry should not let those values disappear or diminish.

Security management in sport

By the law of nonviolence and nonviolent behavior on sport events there are different measures that prevent violence and indecent behavior during sport festivities and about the obligations of the public services in conducting those measures (Official Gazette of the Republic of Serbia, 2003; 2005; 2007; 2009; 2013; 2018; 2018a). The organizer of a sport event, in the terms of this law, is a sport club or other legal or physical person that organizes sport events or executes other sport activities. The sport event, in the meaning of this law, is framed in a time interval of two hours before one sport event and two hours after the sport event (when there is a higher security risk). Participants in this sport event are, in the term of this law, all the persons present in one sport manifestation. Sport objects in terms of this law should have a part for the spectators and can have other spaces such as a wardrobe, sanitary facility and basement. A sport course, in terms of this law, is a place a where sport activity takes place (sport game, competition).

The organizer of a sport event, in cooperation with the Ministry, is obligated to have safety at a higher level of security and to prevent indecent behavior. Violence and indecent behavior during different sport events includes: a) physical assault on the participants of one match during one sport manifestation; b) throwing objects on sport court or the audience seats; c) entering a sport object with indecent signs which disrespect national, political and other feelings which can lead to physical assault; d) destroying sport objects, inventory, installation and other facilities where the sport event is being held; e) causing trouble or destroying property when coming or going from a sport event or endangering other participants at a sport event or a third party; f) illegal entrance on the sport court and other public places or objects for the spectators; g) attempt to bring pyrotechnics into a sport object and other objects which can endanger other participants; e) attempt to enter a sport object with alcohol or other opioids; h) igniting fireworks and other related objects; and i) wearing hats, scarfs and masks with the intention of hiding one's identity.

In relation to the abovementioned, there is a to-do list for clubs in order to prevent indecent behavior:

1) To promote organizing and good behavior of the players and spectators during and after sport manifestations;
2) To inform its spectators on the consequences of bad behavior;
3) To coordinate organizing activities with the police;
4) To take other measures and activities according to the law and based on sport rules;

5) To forbid access to a sport object for persons who are intoxicated or are manifesting indecent behavior;
6) To separate entrances and exits of sport objects;
7) To mark exact places by numbers for the spectators to sit on;
8) To enable entrance of spectators on a sport court and their moving from one part of the court to another;
9) To disable consumption of alcoholic drinks during sport events;
10) To disable entrance to sport objects to persons carrying pyrotechnics and bottles, mirrors, lasers, signs which promote racial and national beliefs;
11) To disable the promotion of symbols of bigger dimensions which can be a problem for other spectators;
12) To remove spectators who are dangerous for sport events or endanger others.

The organizer should have very close contact with the Police Department in enforcing those measures and also to organize medical help and other similar services such as the Fire Department, Inspections and Communal Services.

Ways to endanger inner safety in sports

When it comes to safety of the society and state, it is integral and united. Modern states are being attacked on every field (family, faith, government, politics, economy, sport, etc.) and should be defending themselves with all their might (Đukić, 2018). Considering the classification of safety, it could be divided into inner (individual, social and national) and external safety (regional, global, collective and cooperative). Each of them has special values of a safety system and social precautions. Inner safety refers to the economy, politics, the law and social security of the citizens.

Public peace and safety is the result of coordinated interaction between citizens according to the Law of public peace and safety, caused by their public behavior and by organizations in public life and citizens guaranteed by the Constitution (Official Gazette of the Republic of Serbia, 2016; 2018).

Disturbance of public peace and safety during sport events is very common and it has no implications for a sport but to all sports in general (local, international or national). Some sport events are considered of "higher risk" and involve the police force and Police Department.

CONCLUSION

Management in sport, or in sport organizations is in the function of transferring ideas to the ultimate goal. In this regard, it can be said that the application of management in sport is a successful pursuit of the idea to the realization of a goal. Management of each organization, including management in sports, gives special attention to security as the basic condition of survival and prosperity. Different organizations have different security challenges, risks and threats, so the risks that the state as an organization exhibits differ greatly from the challenges that businesses are exposed to, including sports and sports organizations. Challenges, risks and threats that an organization is exposed to, especially in sport, as well as the responsibilities of an organization towards the environment in terms of safety, have a decisive influence on management in sport, that is, on the manner in which decisions regarding security and protection of persons, property and business are made.

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MENADŽMENT BEZBEDNOSTI U SPORTU

U radu se razmatra praktična primena menadžmenta i komercijalizacija u sportu. Takođe, razmatrani su najvažniji aspekti zakonskog okvira u pogledu sprečavanja nasilja i nedoličnog ponašanja na sportskim priredbama i bezbednost države i društva. Menadžment kao dinamična disciplina, predstavlja vođstvo u nekoj organizaciji. Menadžment podrazumeva optimalno korišćenje resursa, rukovođenje procesima i aktivnostima podređenih, delegiranje poslova i odgovornosti, koordinaciju svih resursa putem planiranja, organizovanja, vođenja i kontrole. Menadžment u sportu, odnosno u sportskoj organizaciji je u funkciji transfera ideje do konačnog cilja. S tim u vezi, može se reći da primena menadžmenta u sportu predstavlja uspešno vođenje ideje ka realizaciji cilja. Menadžment svake organizacije, pa tako i menadžment u sportu, posebnu pažnju poklanja bezbednosti, kao osnovnom uslovu opstanka i prosperiteta. Različite organizacije imaju različite bezbednosne izazove, rizike i pretnje, pa se tako rizici kojima je izložena država kao organizacija u velikoj meri razlikuju od izazova kojima su izloženi privredni subjekti, odnosno sport i sportske organizacije. Izazovi, rizici i pretnje kojima je izložena neka organizacija, posebno sportska, kao i odgovornosti koje organizacija ima prema okruženju u pogledu bezbednosti, presudno utiču na menadžment u sportu, odnosno na način na koji će biti donete odluke vezane za bezbednost i zaštitu lica, imovine i poslovanja.

Ključne reči: *menadžment u sportu, bezbednost, nedolično ponašanje na sportskim priredbama*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 465 - 474
https://doi.org/10.22190/FUPES190515044D

Narrative review article

PSYCHOLOGICAL ASPECTS OF MOTIVATION IN SPORT ACHIEVEMENT

UDC 159.9.01
796.015.01

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Abstract. *The aim of this paper is to point out the importance of motivation in sport achievement and to describe the psychological aspect of motivation, as one of the most important psychological factors for success. Motivation theories give definitions of terms and previous knowledge of different authors, and the second part of this paper gives the most commonly used techniques: Goal settings, cognitive restructuring, and imagination, and how to apply them. When it comes to motivation in sports, some important concepts and some of the most important interventions for motivating athletes presented in this paper can be analyzed in the psychological training of athletes. Special attention given to the importance and the role of trainers in the process of motivating athletes emphasizes psychology as a key factor in sport achievement.*

Key words: *Psychology, Motivation, Theories, Athletes, Trainers, Success in Sport*

INTRODUCTION

In the psychology of sport, motivation is emphasized as a key factor in sporting success (Gould, Dieffenbach, & Moffett, 2002), but it is also believed that it contributes to the persistence of athletes during exercises and competitions (Wilson & Rodgers, 2004, according to Vallerand, 2007). Both athletes and trainers point out that motivation is one of the most important psychological factors for success in sports (Gould, 1982).

There are a number of challenges on the road to successes of athletes. These are long-lasting and painstaking training sessions, unpleasant rehabilitation after injuries, but also frequent agonies and disappointments after defeat. In order to overcome all these difficulties,

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in addition to talent and good physical preparation, the athlete's psychological stability is also significant (Vallerand & Losier, 1999).

Research shows that athletes can talk about two main types of motivation: internal or intrinsic (Sun, Li, & Shen, 2017, according to Karaoglanidis, Mouratidou, Kanellopoulos, Karamavrou, & Parisi, 2020), and external or extrinsic motivation (Vallerand, Deci, & Ryan, 1987). Athletes who show inner (intrinsic) motivation enjoy the sports activity and performance itself, and this is what gives them pleasure. For extrinsic, or external motivation, participation in sports is determined by the acquisition of some benefits that can be of a material (e.g. monetary reward) or social nature (e.g. status).

Intrinsic motivation in sports performance best illustrates activities of athletes who are task-oriented, and the successful realization of a certain activity leads to a feeling of satisfaction. The development of intrinsic motivation favors the satisfied psychological needs of the athlete: the experience of autonomy and personal initiative, the experience of competence and the desire for advancement, as well as the sense of connection with the team, which offers them the impetus to succeed and achieve their goal (Vallerand, 2007).

In the case of extrinsic motivation, which is based on external motives and in which orientation of the outcome is dominant, athletes' competences come to the forefront, and in that case they are more important than the way in which the task itself is performed (Walling, Duda, & Chi, 1993; Fredrick & Ryan, 1995, according to Cox, 2005). In this case, sports activity itself is perceived as imposed, and the motivation for this activity may be less intense. In a situation where an athlete is focused solely on the outcome of an activity, the assessment of his success is viewed through an external reference framework and he expects a "reward" for the effort involved. The prize in this case means a certain achievement, or "being better" than others.

Throughout the process of motivation, success in sport and the achievement of good results is largely the result of developed internal motivation, but the importance of external motives should not be overlooked.

In addition to this general division of motivation, which is based on the theory of target orientation, we wanted to show other psychological motivation theories.

The aim of this study is to point out the importance of motivation in sport achievement and to describe the psychological aspect of motivation, as one of the most important psychological factors for success.

THEORETICAL CONSIDERATIONS OF THE PROBLEM

Motivation theories

Achievement goal theory

The basis of this theory is the thesis that people experience success differently. Generally, two orientations are recognized: orientation to the task and orientation to the outcome (Ames, 1984; Nicholls, 1984; Dweck, 1986).

Task-oriented people perceive themselves as successful when they make a maximum effort, learn something new, or reach a personal maximum. Their activity has been observed to be more concentrated on the process itself, and less on the outcome. Therefore, athletes with this orientation have an individual target for the task and the improvement of sports skills. On the other hand, outsiders see themselves as successful

only when they are better than others. With athletes with this orientation we have an individual goal-oriented performance as a result. The difference between these two orientations can be described as a desire for advancement (orientation to a task) and a desire to prove (orientation to the outcome) (Hodge & Petlichkoff, 2000).

Research (Duda & Nicholls, 1992; Newton & Duda, 1999; Duda & Treasure, 2006) show that two types of target orientation are actually an orthogonal dimension. Therefore, an athlete can be both highly task oriented and low on outcome, and it is also possible to be high or low-oriented both on the task and on the outcome.

Research further shows that athletes with a high outcome orientation and a low orientation to the task tend to develop maladaptive behaviors compared to athletes, who experience the reverse. Maladaptive behaviors include: motive for status, excessive competence, unsportsmanlike attitudes and aggressive behavior. The results of the meta-analytical study (Bidlle, Wang, Kavussan, & Spray, 2003) indicated a positive relationship between the outcome orientation and the previously described maladaptive behavior. This is especially demonstrated in situations where they lose. Also, there is a positive link between highly expressed orientation to the task and low expressed orientation to the outcome, on the one hand, and adaptive behavior: good teamwork, positive effect on the other.

Research also shows that when an athlete sees a high task orientation, combined with a high outcome orientation, this results in a desirable competitive profile of an athlete who has a strong desire to win, but also a strong motivation to achieve progress, readiness to learn and reach his personal maximum (Roberts, Treasure, & Kavussan, 1996; Tod & Hodge, 2001). In this case, the loss of a match is perceived as part of the learning process and the investment of the masculine effort in order to achieve the ultimate goal.

In accordance with the existing theory, what is needed in working with athletes is to strengthen orientation to the task. By developing this orientation, the athlete has the experience of greater control over the situation, which further leads to a reduction of stress and anxiety, and to an increase of intrinsic motivation. Such a psychological state and approach inevitably lead to a greater chance of success.

Work with athletes should certainly include work on changing the definition of success. Instead of seeing success as a victory, a different vision of success is needed - as a process of learning, improving, investing effort to achieve victory. This leads to better coping with failure or injuries.

Attribution theory

Attribution is the process by which individuals explain the causes of behavior and situation (success/failure). The literature discusses three dimensions of attribution (Weiner, 1985): controllability - the degree of impact that can be expressed above the pattern (whether the person causing the event perceives that it is under their control or not), the causality - whether the person attributes the cause of events to inner or external factors (other people or circumstances), and stability - an estimate of the duration of the cause (whether the person sees the cause of the event as being stable over time or not). In the last decade, there are two more dimensions: globality, if a person sees the cause of events as something that relates to many situations or as something that relates to very specific situations and universality, ie., whether a person perceives the cause as relevant to many people or just to individuals (Rees, Ingledew, & Hardy, 2005).

The research of Coffee & Rees (2008, 2009) and Allen (2010) shows that the reasons for sporting failure should be considered in the context of events for which internal,

controllable and unstable factors are responsible. In other words, it is desirable to attribute failure to itself but at the same time regard it as an immediate rather than a lasting state. In doing so, it is important to show a readiness to appreciate that a different approach may yield different results.

When it comes to success, it needs to be explained by internal, controllable and stable factors, i.e. success is desire to attribute to yourself and believe that with good access, success will be sustained. It is considered that for success in sports, it is much more important that an athlete experiences failure, and in dealing with it, it is necessary to emphasize the attitude towards failure.

In the process of training and competition, it is important to teach athletes to take on personal responsibility, both for their successes and for their failures. This is the way in which the athletes strengthen their personal sense of control over the situation, which then leads to an increase in internal motivation.

Self-efficacy theory

Self-efficacy theory perceives sports efficiency in interaction with the environment and it is a decisive factor in behavior change. This theory has several key assumptions. Bandura (1986, 1997) points to six factors that are crucial in the experience of the self-efficacy of each athlete: previous experience, vicarious learning, positive verbal messages by other important physiological and emotional states of the athlete, visualization of success.

If an athlete has previously experienced success, he will expect the same in the future. Also, if an athlete watches another athlete successfully carrying out a particular movement, that experience will have a positive impact on the experience of self-efficacy. The impact will be greater if the observed model is similar to the observer (by age, gender, ability, etc.). Further, if the athlete is exposed to positive verbal messages (instructions or motivational sentences) from significant people, he will experience himself as being effective. The physiological state also plays an important role. Due to the connection between mind and body, the assessment of self-efficacy affects whether the athlete is tired or excited. In situations where excitement is emphasized, thoughts are oriented toward failure. In addition to the physiological state, there is the emotional state in which an athlete finds himself influenced by the experience of self-efficacy. Emotions and thoughts are connected, and even emotional states like frustration or anger can negatively affect the assessment of the athlete's self-efficacy. In the end, the visualization of success (the athlete imagines himself doing a successful task) also positively influences the assessment of self-efficacy.

In a meta-analytical review, Moritz, Feltz, Fahrbach and Mack (2000) report a positive link between self-efficacy and success. Nevertheless, Schmidt and DeShon (2009) warn of the danger of over-estimation and self-assessment of self-efficacy. If an athlete overwhelmingly believes in his success, he will invest less time and energy into exercise, which will result in less success.

Feltz, Short, & Sullivan (2008) describe several methods for increasing self-efficacy in athletes:

- Modeling - an athlete focuses on a model that produces desirable behavior. The model can be ideal (a professional in a particular sport or skill) or similar athletes who carry out certain skills in an adequate way. It also often happens that an athlete achieves better results if the model is more similar to his own because the identification process is easier;
- Setting appropriate goals;

- Recording past success - this method reminds the athlete of what he is able to achieve and has a favorable effect on the increase in self-efficacy. The realization of this method is possible through imagination or watching videos;
- Optimistic thinking and self-confident behavior;
- Being surrounded by people who are supportive.

Self-determination theory

According to this theory (Deci & Ryan, 1985, 1991) intrinsic motivation will exist with an athlete when three main psychological needs are satisfied: competence, connectivity and autonomy. Competence refers to the subjective experience of an individual that can achieve success. A relationship implies a sense of belonging and acceptance by significant people. Autonomy is the need to experience one's own behavior as freely chosen and not imposed by others.

Research shows that athletes with a high level of self-determination (a strong experience of competence, connectivity and autonomy) have better sporting performances than athletes with a low level of self-determination (Gillet, Berjot, & Gobance, 2009).

Increasing the sense of competence of an athlete is achieved by pointing out to athletes that they can control the causes that lead him to success. For a better connection experience, it is important to focus on building the best possible relationship between athletes and trainers, as well as between athletes and other team members. The experience of the autonomy of an athlete is left in such a way that no pressure is exerted by the coaches, teammates or others from the immediate environment.

Expectancy value theory

According to this theory, what defines success is the belief that success will be achieved (expectations), and the assessment of the importance (value) of success for a particular person. For example, one can believe in his success, but he lacks the desire to achieve it. On the other hand, one may be highly interested, but does not believe in his ability to achieve success. In both cases, good results are missing.

Wigfield, & Eccles (2020) state that the subjective value defines four components: importance (value of achievement), interest (intrinsic value), usefulness (utilitarian value) and prices (perceived cost). The importance (value of achievement) refers to how many people estimate that it is worth the success on a particular task. Interest (intrinsic value) represents the level of satisfaction of a person because of being engaged in a particular task. Usability (utilitarian value) implies how the performance of a specific task can help a person achieve the short-term and long-term goals. The price (perceived cost) refers to the assessment of the effort to satisfy a specific task, the assessment of restrictions in the choices of other activities, and the psychological assessment of potential failure in the task.

In a situation where an athlete believes in his skills but lacks motivation, it is necessary to find individual value in further sports activities. If despite the effort an athlete can no longer find value, then withdrawal is considered.

Motivation techniques

A number of techniques are used to motivate athletes. The three most commonly used ones include: goal setting, cognitive restructuring and imagination.

Setting goals

The main source of motivation are the goals set by the athletes. However, it is very important that goals are adequately formulated. When it comes to this topic, the so-called. SMART model defines the necessary characteristics of the defined goal (Doran, 1981). The main characteristics of the goal are to be: S - (specific), concrete, clear; M - (Measurable) measurable result, it can be checked whether and to what extent the goal is achieved; A - (achievable), achievable with the available resources at a given time; R - relevant, relevant to contribute to the realization of the vision; T - (time constrained) has the definite final time for realization.

The aim is to say that it is specific when it is clearly defined and fully understandable. This implies answering three questions: how, why, and what? This specifies what is meant to be achieved, how this is planned and what the motive is. If the goal requires the engagement of more people, it is necessary to define precisely who they are and what their tasks are.

The second characteristic, the measurability of the goal, refers to the criterion based on which an individual will know whether and how the achievement of the goal is progressing. For example, it is not clear what exactly good sport success for a current year means. How will an athlete know at the end of the year whether his success was good or not? How is the success measured? If the goal relates to the team and is not measurable, then everyone has the freedom to interpret what is good for anyone, whether success was good at the annual level or not. In such situations, it is necessary to define a goal that will answer the question - how much? For example. The goal is to achieve at least 30 wins in the season.

The third characteristic of the goal is to be achievable. Therefore, it is important to know your boundaries and therefore avoid potential underestimation or overestimation of yourself. This would mean that goals should not be defined as something that is realistic in itself, without much effort, because then the goals are not motivating and do not contribute to development. They need to be ambitious and their realization to require additional effort, but at the same time they should not go beyond the capabilities and skills of the individual / team. In order to make this step well, it is important to recall the previous experience. For this goal planning segment, it is important to be flexible, ie., it is okay if the goal changes, if the need arises for the team. For example, the goal "stay in the first league this year." can be revised after a while. If the team succeeds and no longer remains in the first league, the goal can be redefined, for example: "Be among the top eight teams at the end of the season."

The goal is relevant when it actively contributes to achieving predefined visions. If the goal is not related to the ultimate vision to be achieved, then it is considered irrelevant.

When not defined outwardly, it is important to set a time limit until the target is achieved. And it is important to be aware of your possibilities. It is not good to allow too much time because the goal will be lost in the sea of other obligations, but insufficient time is not a solution because it will not be achieved in that time.

An example of a well-defined goal would be: we want to win this year's medal at the national championship. If the team showed a good result last year, then the goal formulated like this is relevant, achievable but also specific, measurable and time-limited.

Cognitive restructuring

Another important technique is to change the irrational beliefs of athletes, whether it be the beliefs about coaching or the beliefs about their performance (successes/failures). This

technique is based on the premise of Cognitive-Behavioral Therapies according to which there are no events that affect how we feel and behave but our interpretation of these events (Beck, 2011). When a person irrationally interprets certain aspects of the situation, this leads to unhealthy emotions and dysfunctional behavior. When, in a rational way, a person sees the events or aspects of these events, it stimulates healthy emotions and functional behavior. Therefore, it is important to work with athletes to identify irrational beliefs and to replace them with rational beliefs, which in turn leads to healthy emotions and functional behavior. Examples of irrational beliefs are: "I will never succeed!", "I suffered defeat. I am not in this sport.","I have to win the championship!","I cannot stand defeat." Rational versions of the previous beliefs are: "Success requires effort and investment. The results are not achieved immediately, I progress gradually."; "Defeat does not define me as a player."; "I would very much like to win the championship, but that does not mean that I have to. I will try to give my maximum."; "I'm not comfortable when I experience a defeat, but I can certainly handle it. Moreover, it can serve as a good lesson. "

Imagination

Imaginations are included in common techniques used with athletes in order to increase motivation and achieve good results. What is important for imagination is that it is necessary to refer to images that include all the senses (sight, hearing, taste, smell, touch, etc.) in order to be a more graphic experience for the brain. It is important that a person conceives that a particular movement is successfully carried out (Montuori et al., 2018).

There are two variants of imagination. Internal imagination implies that a person, from a personal perspective, imagines himself performing the movement successfully. External imagination implies that an athlete sees himself from the perspective of other people, as if watching himself on television. The experience of virtual success increases self-confidence, which further leads to increased motivation (Montuori et al., 2018).

The role of a coach in the motivational climate

The behavior of the coach is most desirable for the motivation of an athlete (Vallerand & Losier, 1999). It is considered that the most important interpersonal relationship that is created in sports is the connection between the coach and the athlete. This connection is important because it significantly affects not only the sports performance (Horn & Carron, 1985), but also the experience of the athletes' pleasure (Challadurai, 1993). For example, research results aimed at examining interpersonal relationships between coaches and athletes have shown that a positive perception of attitudes with a coach by athletes is more important than a high intrinsic motivation and focus on achievement (Vallerand & Losier, 1999).

The basic point of view is, when the athletes' motivation is concerned, that the behavior of the coach can have a significant impact on the athlete's motivation, because it depends on his experience of competence, autonomy and sense of belonging.

It turned out that coaches working with athletes develop two different behaviors. One is called a controlling style and the other autonomous - or supporting. Coaches who nurture a controlling style of behavior in interaction with athletes foster a highly directive style of communication (for example, "You'll play like I tell you; otherwise you will still be sitting on the bench!"). On the other hand, coaches who nurture autonomy and a supportive style will leave the players room for independent decisions (e.g. "We have three different strategies, and during the match, you will evaluate which is the most appropriate for the given situation."). Research in this field shows that in athletes whose coaches use the autonomous – supporting

style observed a higher level of indicative motivation compared to those athletes whose coaches cherish the controlling style (Deci, Nezlek, & Sheinman, 1981). The next research in this field confirms this finding. Exploring the motivation of a university swimmer's club, it was noticed that swimmers whose coach fostered a controlling style, during the competition show a significantly lower degree of intrinsic motivation (Pelletier, Tuson, & Green-Demers, 1998). On the contrary, fostering an autonomous - supportive style by the trainer leads to the experience of competence, autonomy and sense of belonging to athletes. Athletes with an experience of competence, autonomy and sense of belonging show greater motivation for achieving success, and they are seen higher on the level of intrinsic motivation (Blanchard and Vallerandar, 1999b).

One of the main tasks of the trainer is to create a positive motivating environment that is task oriented, i.e. leads to skills development. Such an approach to an athlete creates a sense of satisfaction. The climate, in which the orientation towards the achievement of a particular goal dominates, creates pressure and tension among athletes, especially in the younger ones, which can adversely affect their further interest and experience of pleasure in sports (Abernethy, Hanrahan, Kippers, Mackinnon, & Pandy, 2012).

In addition to the fact that personal success in sports is observed differently, it is conditioned by age. At a younger age, it is measured in relation to previous achievements. Later, at the elementary school age, success is measured in comparison with other children, i.e. ego orientation develops. With the advent of adolescence, one can expect young people to display one of these two orientations, in sports achievement depending on the situation (Duda, 1987). We should not neglect social factors, above all the interpersonal relations between the athletes themselves, as well as between athletes and coaches. It is important that friends of the club maintain friendly relations and that the talented individuals do not "rise" to the star. It happens that talented children are physically superior because their development is faster than others', and therefore, they achieve better results in sports. They are often paid more attention to, while other athletes become neglected by the coaches.

Regardless of whether it is an individual or group sport, it is desirable that the coach defines the concept of success for each individual. Each of them needs a personal promotion, not a win in the competition. If victory is taken as a criterion of success, at each competition there will be a large number of unsuccessful and far fewer successful ones. Repeated failure leads to a weakening of motivation and abandonment of sport. What is needed for a coach to be rewarded by his athletes is effort, commitment, desirable behaviors, and "fair play", responsibility, perseverance, perseverance.

It is important that the coach creates a climate that will ensure that all athletes they feel equally important and are provided with conditions for developing personal competence, which is a requirement for every sporting success.

CONCLUSION

When it comes to motivation in sports, some important concepts and some of the most important interventions for motivating athletes presented in this paper can be considered in the psychological training of athletes. Special attention given to the importance and the role of trainers in the process of motivating athletes emphasizes psychology as a key factor in sport achievement.

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PSIHOLOŠKI ASPEKTI MOTIVACIJE U SPORTSKIM OSTVARENJIMA

Cilj ovog rada je da ukaže na važnost motivacije u sportskim ostvarenjima i da opiše psihološki aspekt motivacije, kao jednog od najvažnijih psiholoških faktora uspeha. Teorije motivacije daju definicije pojmova i prethodnih znanja različitih autora, a drugi deo ovog rada daje najčešće korišćene tehnike: postavljanje ciljeva, kognitivno restrukturiranje i maštu i kako ih primeniti. Kada je reč o motivaciji u sportu, neki važni koncepti i neke od najvažnijih intervencija za motivisanje sportista predstavljeni u ovom radu mogu da se uzmu u obzir u psihološkom treningu sportista. Posebna pažnja posvećena značaju i ulozi trenera u procesu motivisanja sportista ističe psihologiju kao ključni faktor u sportskim ostvarenjima.

Ključne reči: *psihologija, motivacija, teorije, sportisti, treneri, uspeh u sportu*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 475 - 481
https://doi.org/10.22190/FUPES200607045H

Research article

PHYSICAL ACTIVITY LEVELS IN PHYSICAL EDUCATION TEACHERS BEFORE AND DURING SCHOOL SUSPENSION BROUGHT BY THE COVID-19 QUARANTINE

UDC 796: 615.01

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Abstract. *The aim of this paper was to compare the physical activity (PA) levels in physical education (PE) teachers before and during school suspension brought by the COVID-19 quarantine. Thirty-seven PE teachers participated in the descriptive cross-sectional comparative methodological design study. In order to evaluate the PA levels, the International Physical Activity Questionnaire (IPAQ) was applied. As a statistical method, the equality of variance was calculated using the Student t test for independent samples. The results revealed less total PA MET-minutes/week in PE teachers (p=.005), with a percentage difference of 69.8 Δ%, during the COVID-19 quarantine compared to the state before the COVID-19 pandemic. PE teachers are considered professionals who help public health by reducing sedentary lifestyle in society. In that context, decrement in PA level, i.e., their inactivity determined during the COVID-19 pandemic is unacceptable.*

Key words: *Teacher, Physical Education, Physical Activity, COVID-19.*

INTRODUCTION

The quarantine meant to prevent the spread of COVID-19 has limited the daily practice of physical activity (PA) in the population (Blocken, Malizia, van Druenen, & Marchal, 2020). To battle this problem, and maintain the health benefits, PA at home through physical exercise of different modalities has been recommended (Halabchi, Ahmadinejad, & Selk-Ghaffari, 2020), such as resistance training with one's own weight, aerobic exercise, dancing, using ergometer stationary bicycles (Hammami, Harrabi, Mohr, & Krustrup, 2020), as well as relying on technology with audiovisual material from the internet, and mobile applications for guidance and motivation to perform PA (Tate, Lyons, & Valle, 2015). In addition, exercise

Received June 07, 2020 / Accepted September 10, 2020
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during quarantine has also been recommended due to the negative mental, and physical consequences of a sedentary lifestyle brought by the quarantine (Jiménez-Pavón, Carbonell-Baeza, & Lavie, 2020).

For adults, the World Health Organization (WHO) recommends a minimum of 150 minutes per week for the practice of moderate intensity aerobic PA, or 75 minutes of vigorous aerobic PA per week (Arias-Palencia et al., 2015). It is estimated that due to the physical inactivity of the population caused by the COVID-19 quarantine, there will be an increase in cardiovascular diseases associated with a sedentary lifestyle (Lippi, Henry, & Sanchis-Gomar, 2020). In this sense, the physical education (PE) teacher is considered a professional from the field of education in the public health context who contributes to the reduction of this problem (Webster et al., 2015). In the case of teachers, a systematic review which included them reports that PA is considered positive for their health (Rosales Ricardo et al., 2016). Even though, high levels of PA in teachers is related to a better quality of life (Gümüş & Isik, 2018), the presence of 53% to 73% of a sedentary lifestyle, or low levels of PA among teachers, has been reported in Latin America (Rodríguez Guzmán, Díaz Cisneros, & Rodríguez Guzmán, 2015). A research reports higher practice of PA and less sedentary behavior in people with outdoor occupations (Smith, et al., 2016), as PE teachers whose level of PA has been assessed, reporting 27% with low levels of PA (Hall López, Ochoa Martínez, Sáenz-López Buñuel, & Monreal Ortiz, 2009).

The aim of this paper is to compare the PA levels in PE teachers before and during school suspension brought by the COVID-19 quarantine.

METHODS

Participants

A total of 37 teachers participated (22 men and 15 women), age 27.8±6.1 years (Mean±SD), and teaching experience of 6.4±3.3 years (Mean±SD) in the public and private educational system in the city of Mexicali, Baja California, Mexico.

The present study was approved and registered in the Office of Graduate Studies and Research of the Autonomous University of Baja California (Protocol No. 149/1823), under a cross-sectional methodological design, with non-probability sampling for convenience (Thomas, Nelson, & Silverman, 2015), following the ethical principles of the research involving human subjects of the declaration of Helsinki (Puri, Suresh, Gogtay, & Thatte, 2009).

Procedures

In the educational context, information and communication technologies have been essential to managing learning (Lorgelly & Adler, 2020). Regarding the field of health, attempts have been made to identify the PA level in people who exercise during the COVID-19 quarantine by means of questionnaires (de Oliveira Neto et al., 2020). In a technological context, the current study utilized Google Drive as a teaching tool to assess PA at a distance (Álvarez Ferrón & Sánchez Cañizares, 2014), using the International Physical Activity Questionnaire-IPAQ (Craig, et al. 2003), and comparing the PA levels of PE teachers before and during the quarantine caused by COVID-19.

The responses to the IPAQ questionnaire were recreated, classifying the score into three categories: low, moderate, and high. According to the methodology, the PA performed in

the last 7 days was categorically and continuously measured. The continuous score was estimated using a weekly energy expenditure (minutes/week) expressed as a metabolic equivalent (MET). This was obtained by multiplying the value of energy expenditure for PA according to the weekly frequency (days per week), and the time in minutes (minutes per day), valuing the modalities of walking in an average of 3.3 MET, all the PA of moderate intensity with a value of 4 MET, and PA of vigorous intensity with a value of 8 MET.

Statistical analysis

Descriptive statistics was in use In order to determine the percentage difference (Δ%) before and during the COVID-19 quarantine ([(Average-2 – Average-1) / Media-1] × 100) (Vincent, 2012). For inferential statistical analysis, the normality of the groups, and the homogeneity of the variance of the data were verified using the Shapiro-Wilk test with the level of the significance set at 0.05; As a cross-sectional study when comparing as fixed variables of two groups 1) before the COVID-19 quarantine or 2) during the COVID-19 quarantine, and PA performed by PE teachers as a numerical random variable. The student's t-test for independent samples calculating the equality of the variance was utilized, establishing the level of the significance $\alpha \leq 0.05$.

RESULTS

The percentage distribution of the level of PA in PE Teachers before and during the COVID-19 social distancing is presented in Table 1.

Table 1 Category of PA in percentage, before and during quarantine by COVID-19 in PE teachers

Physical Activity Level	Before COVID-19	During COVID-19
Low	25.2 %	49.8 %
Moderate	37.8 %	25.5 %
High	37 %	24.7 %

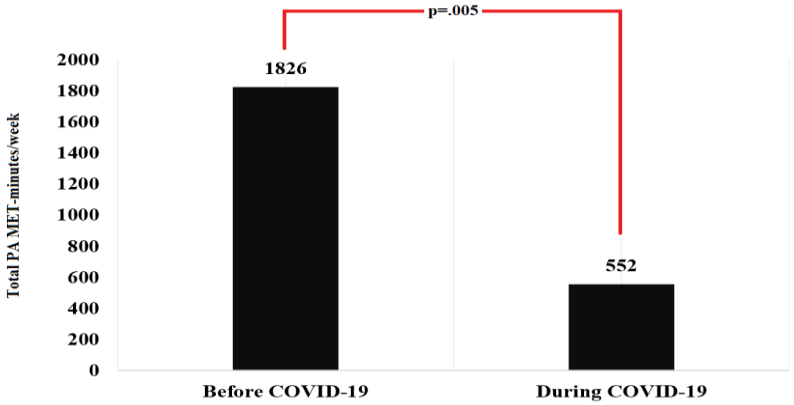

Fig. 1 Total PA MET-minutes/week=sum of Low+Moderate+High PA levels, before and during the COVID-19 quarantine in PE teachers (p=.005).

Figure 1 reflects the results of the student's t-test for independent samples, calculating the equality of the variance of total PA MET-minutes/week, before (1826) and during (552) the COVID-19 quarantine in PE teachers, significant differences values where found (p=.005). Figure 2 shows the percentages difference (Δ%) by category of low, moderate, and high PA levels.

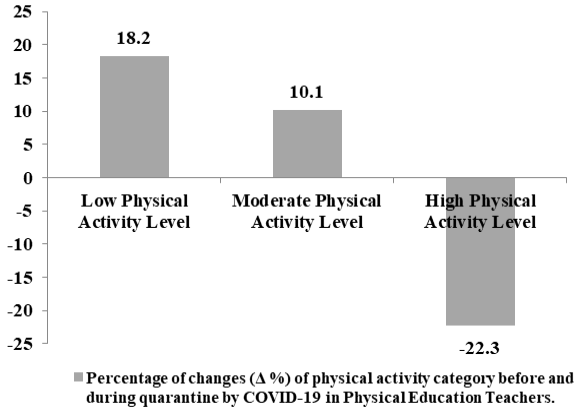

Fig. 2 Percentage change (Δ%) of PA category before and during the COVID-19 quarantine in PE.

DISCUSSION

The main result of this research was that the level of PA MET-minutes/week of PE teachers decreased during the COVID-19 quarantine (69.8 Δ%). Hence, due to limitations brought by the COVID-19 quarantine, the possibilities of doing PA in different modalities were lower (Blocken et al., 2020). In Mexico, according to the national health and nutrition surveys, nearly 50% of adults spend more than two hours a day in front of a screen, occupying an average of 1h40min of their day in motorized transportation, and at least 3h30min of their time sitting (Medina, Janssen, Campos, & Barquera, 2013). When comparing the level of PA percentages reported by research that also evaluated PE teachers using the IPAQ questionnaire as a methodological instrument, values with similar trends can be observed in the low, moderate, and high categories (Hall-López et al. 2009). Another study that evaluated professionals in the teaching of physical culture reported similar PA percentages (Hall-López, Ochoa Martínez, & Alarcón Meza, 2012).

PE teachers work mostly of the time in outdoors environment, and according to Smith et al. (2016), professions and occupations with less energy expenditure, and more presence of sedentary behaviors work in indoor environments. Hypothetically, it is inferred that suspension of school activities due to social distancing in the population, is associated with PA reduction in PE teachers (Ramos, 2020), since it has been documented that the energy expenditure made by teachers during PE class also comes with lighter activities such as office work, and PA with moderate energy expenditure when conducting, supervising, and monitoring PE classes (Trudeau, Laurencelle, & Lajoie, 2015). It has been documented i.e., evaluated by pedometers, that in a PE class of the first and the second grade of primary

school, a teacher walks on average 925 steps (Rodriguez-Negro, & Yanci, 2019). According to Rodriguez-Negro & Yanci (2017) teacher makes 1020 steps per session in 90-minute sessions according to the manual-eye coordination content taught, a balance content of 864.67 steps per session, and body expression of 591.25 steps per session. When conducting PE classes using analytical and global methodologies, the number of steps was of 1296 in motor activities content, and of 1493 in basketball content (Rodriguez-Negro & Yanci, 2017). Concerning Mexican PE teachers, Ochoa-Martínez, Hall-López, Campos, & Meza (2020) determined that they should increase PA level of the students during the PE class, respecting the recommendations for children and adolescents established by the WHO for the achievement of a minimum of 60 minutes of PA in a day of moderate to vigorous intensity.

The Google Drive tool was utilized in a timely manner to assess the level of PA (Álvarez Ferrón & Sánchez Cañizares, 2014) in two moments of the COVID-19 health crisis. Limitation of the study is low number of the participants. Performing a cross-sectional design without inferring into other causal variables, and only addressing teachers in the Mexican educational context, is however, a reliable, valid, low-cost assessment instrument, with values easily comparable to other studies due to it being an international questionnaire (Craig et al., 2003).

PE teacher is among the groups of professions with optimal levels of physical condition, particularly aerobic capacity (Chen & Yan, 2017). Regarding PA performed in PE class, the factors that promote intensity are diverse and multifactorial (McKenzie, & van der Mars, 2015). Nevertheless, from the educational field, PE teachers are considered professionals who help in the context of public health to reduce sedentary lifestyles (Webster et al., 2015). It is a reason for which we consider it paradoxical for them to present physical inactivity patterns similar to those of the general population (Medina, et al., 2013), even though during the COVID-19 quarantine, the level of PA in the PE teachers evaluated decreased. Reason for which it is important to follow the recommendations for physical distancing to avoid COVID-19, and increase the level of PA from home (Hammami et al., 2020).

CONCLUSION

During school suspension caused by COVID-19 infection, PA MET-minutes/week of PE teachers decreased significantly. PE teachers are considered professionals who help public health by reducing sedentary lifestyle in society. In that context, decrement in PA level, i.e., their inactivity determined during COVID-19 pandemics is inacceptable.

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NIVOI FIZIČKE AKTIVNOSTI NASTAVNIKA FIZIČKOG VASPITANJA PRE I TOKOM OBUSTAVE NASTAVE USLED COVID-19 KARANTINA

Cilj ovog rada bio je da se uporede nivoi fizičke aktivnosti (FA) nastavnika fizičkog vaspitanja (FV) pre i za vreme obustave nastave usled COVID-19 karantina. Korišćen je deskriptivni transferzalni komparativni metodološki pristup u istraživanju u kome je učestvovalo trideset sedam nastavnika FV. U proceni nivoa FA primenjen je Međunarodni upitnik za fizičku aktivnost (IPAQ). U statističkoj obradi podataka korišćen je studentov t test za nezavisne uzorke. Rezultati ukazuju na manji ukupni nivo FA nastavnika FV izražen u MET-minuta/nedeljno, tokom karantina usled COVID-19, u odnosu na vreme pre karantina (p=.005), sa razlikom od 69.8 Δ%. Nastavnici FV smatraju se profesionalcima koji pomažu javno zdravlje umanjujući sedentarni način života u društvu. U tom kontekstu, utvrđeno smanjenje nivoa FA, tj., njihova neaktivnost tokom COVID-19 pandemije je neprihvatljivo.

Ključne reči: *nastavnik, fizičko vaspitanje, fizička aktivnost, COVID-19*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 483 - 490
https://doi.org/10.22190/FUPES200620046D

Research article

STUDENTS' PHYSICAL ACTIVITY LEVELS AT UNIVERSITY

UDC 796: 012.01

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Abstract. *The aim of this research was to determine the difference in the level of physical activity (PA) in students of four faculties of the University of Niš whose curricula do not include physical education (PE) classes. The PA level was evaluated using a questionnaire for the self-evaluation of PA (IPAQ-long form). The research included students of the Faculty of Philosophy, Faculty of Economics, Faculty of Law and Faculty of Electronic Engineering of the University of Niš (n=109; age: 22±0.6 months). A significant difference was determined in the level of PA among the students of the University of Niš (p=0.000). However, differences in PA during leisure time have not been determined (p=0.109). One of the reasons is the active leisure time of the student population, which through sports activities compensates for the lack of PE classes at the faculties in question.*

Key words: *Students, Activity, IPAQ, Higher Education*

INTRODUCTION

Physical activity (PA) induces the body to use its fat deposits (prevents overweight), increases the level of "good" cholesterol in the blood (HDL cholesterol) and maintains normal blood sugar levels. PA is the most natural means of spending energy and is an important regulator of body mass. During exercise, there is an intense energy metabolism, which leads to the creation of heat energy and the warming of the blood in the entire body, preventing an increase in body mass and obesity-related diseases. According to Bubanj & Obradović (2002) regular physical exercise has a favorable effect on the work and functioning of the locomotor apparatus, strengthening the bones (it is reflected in the favorable level of calcium, which leads to an increase in bone density). The influence of appropriate PA on the respiratory system is great, since lung capacity increases and the oxygen uptake from the surrounding air is improved (Mazzeo & Liccardo, 2019). It is known that of the 21% of oxygen (the amount

Received June 20, 2020 / Accepted July 18, 2020
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in which it is found in the normal atmosphere) only 15-18% is used (Qi et al., 2019). A decrease in anxiety and depression is evident among individuals who have their own regular PA program, which has a favorable effect on mood, cheerfulness and a more stable psychological state (McDowell, Dishman, Gordon, & Herring, 2019; Pascoe, & Parker, 2019). PA influences the development of motor skills and abilities, which is a basis for their future improvement and application in life (Stanković, Veljković, Marković, & Herodek, 2020). Achieving mature patterns regarding these skills cannot be left entirely up to the spontaneous process of maturation, and instead it is necessary to create possibilities for learning and practice (Gallanue & Ozmun, 1998). An active way of life during childhood is directly beneficial for health in later years, and in that way an active child becomes an active adult who is exposed to a reduced risk of illness.

The Higher Education Law, which was adopted at the end of August 2005, introduced several changes to the higher education system of the Republic of Serbia: a) using the European Credit Transfer System and accreditation and quality assurance of study programs and higher education institutions. The previous duration of graduate studies at the Serbian universities was changed from four to six years. According to research conducted by the Center for Education Policy from Belgrade, statistical data show that the officially expected duration of studies in practice is often transformed into a much longer period of the average duration of studies (the time that elapsed from enrollment to college to graduation): for four-year studies the average duration of studies was 6.76, for five-year studies it was 7.51 years, and for six-year studies it was 7.62 years. The number of students dropping out of college, as well as the average length of study were unreasonably high, and the most frequently mentioned reasons for this situation were a rigid system of study and a large student load (Turajlić, Andrejić, Rudić, & Todorović, 2004). According to Vukasović (2007) the estimated drop-out rate for studies in this period was 45 percent. This means that in the period before the Bologna process, only 55 percent of enrolled students finished their studies. A previous quantitative study Vukosavić (2007) determined factors such as student motivation, systemic (institutional and non-institutional) student support programs, parent or peer support and their impact on the effectiveness of studying as stumbling stones of low efficiency of studying. The Bologna study model in Serbia was conducted in "spartan conditions" without financial opportunities. The Bologna Declaration provided only cutbacks to education reform, but did not administratively restrict national universities. The inability to provide financial assistance to state universities was also reflected in the reduced number of hours of certain subjects that are considered socially useful and important in the countries of the European Union - the area of PA at the universities in Serbia. The University of Niš is one of the four universities in Serbia that does not have the a physical education (PE) course in its curriculum, which is one of the important factors for reducing the risk of contemporary diseases of the society: addiction, cardiovascular disease and obesity. Health risks which are tied into the PA of adolescents, middle-aged and elderly people primarily depend on one’s state of health (previous injury, the quality of one’s diet, obesity, current conditions), the level of fitness components (a sedentary or active individual), types of activity, intensity (appropriate for the functional capacity of the individual), as well as the duration and frequency of the activity. The available information indicates that moderate PA corresponds to 40-50% of heart frequency levels. It is connected to the relatively low risk of orthopedic and cardio-vascular complications. Injuries to the locomotor system represent a risk for high-intensity PA, which can sometimes be found in as many as 55% of the active participants included in an

exercise program. The intensity, frequency and duration of the PA are directly connected to risk of injury (Tinetti & Kumar, 2010). In the initial phases of exercise, if there is an overdose in recreational activities, pain may occur in the muscles, exhaustion may set in, or orthopedic injury might occur. Strenuous aerobic training offers low level of additional improvement to cardio-respiratory fitness and is connected to a high rate of injury (Tinetti & Kumar, 2010). The fundamental role of PA can be the healing of chronic disease (Haskell et al., 2007), so the mortality rate can be decreased (Warren et al., 2010).

The aim of this research was to determine the difference in the level of PA among students of four faculties of the University of Niš whose curricula did not include PE classes. In the evaluation of activity levels the IPAQ-long form questionnaire was used.

METHODS

There are objective methods used to evaluate PA (the usage of accelerometers and pedometers, monitoring heart rate frequency, direct observation); and methods based on self-evaluation i.e., questionnaires, journal logs, daily recordings (Warren et al., 2010; Kisko et al., 2012).

The International Physical Activity Questionnaire (IPAQ) was developed in 1997 to evaluate the level of PA on a global level (Craig et al., 2003). The IPAQ questionnaire addresses and evaluates the level of frequency, duration and intensity of PA during a single week. The long form of the questionnaire is designed for adults aged 18-65 and is more informative than the short one: it includes activities for leisure time, around the home and garden, at work, PA related to commuting to work and back. The IPAQ has good reliability and validity results for 70 countries, and it is available in several languages (Hallal et al., 2010; Lee, Macfarlane, Lam, & Stewart, 2011; Helou et al., 2017; Minetto et al., 2017).

Research into the evaluation of the PA of a population by using the IPAQ is quite plentiful (Ishikawa-Takata et al., 2008; Polito et al., 2016; Hwa Hsu et al., 2017). Polito et al. (2016) evaluated the PA of Italian people aged 18-50 by using the questionnaire developed for monitoring PA and inactivity in national frames. The results have shown that the participants were far more active at home and in the garden than when commuting, or during their leisure time. Classifying activities based on intensity revealed significant differences between the genders in terms of moderate and high-intensity PA; in addition, participants aged 18-30 indicated a lower level of PA than participants aged 40-50. It was concluded that the national strategy for increasing PA should in particular focus on the younger population.

The sample of participants includes 109 fourth-year students, aged 22±0.6 months, from four different faculties of the University of Niš: the Faculty of Economics (n=30), the Faculty of Electronic Engineering (n=30), the Faculty of Law (n=25) and the Faculty of Philosophy (n=24). The participating students voluntarily agreed to fill out the Serbian version of the questionnaire (Serbian Institute of Sport and Sports Medicine, n.d.). The approval of the Ethics Committee of the University of Niš was obtained.

In initial data processing descriptive statistics were used. In order to determine the normality of the distribution, the Shapiro-Wilk test was used. The comparison of the level of PA was performed using a method for determining inter-group differences and an analysis of variance. To compare pairs of faculties, the non-parametric Kruskal-Wallis test was used. This test is analogous to the Mann-Whitney test, but also allows for a

comparison of several independent groups per sample. The Kruskal Wallis test is used for all types of activities included in the questionnaire. In this way it was possible to determine whether there are significant differences in the levels of activity in different fields from the viewpoint of the overall PA over the course of a studied week.

In statistical analyses, the SPSS statistical package version 24 was used, at the $p \leq 0.05$ level of significance.

RESULTS

All indicators of IPAQ scoring protocols are presented as metabolic equivalents (MET) in hours per week. Compared activities are divided into four categories: activities at work, activities which include transportation, activities around the house and garden and leisure time activities (recreational activities, sport, etc.). Descriptive statistics are presented in Table 1.

Table 1 The descriptive parameters of students from the University of Niš

Faculty	Type of activity (MET/Week)	N	Mean	Median	Min	Max	SD	Skew	Kurt
Philosophy	Work	9	172.60	162.60	6.00	470.40	158.64	.856	-.123
	Commute	17	32.07	23.10	6.60	92.40	24.11	1.401	1.596
	Household	22	32.49	17.88	3.00	144.00	34.74	1.979	4.296
	Free time	23	107.75	83.80	6.60	370.60	109.42	1.233	.588
Economics	Work	2	22.69	22.69	12.38	33.00	14.58	/	/
	Commute	30	30.42	28.95	8.25	49.50	13.69	.007	-1.554
	Household	17	4.62	3.00	1.50	7.50	2.21	.043	-1.852
	Free time	29	38.94	35.10	9.90	78.20	16.70	.675	.356
Law	Work	10	295.19	242.10	176.50	734.40	161.20	2.694	7.799
	Commute	25	49.73	46.20	6.60	261.30	50.39	3.294	13.432
	Household	25	31.79	18.00	1.50	130.00	33.76	1.700	2.357
	Free time	25	59.48	55.60	3.30	116.40	36.10	.057	-1.344
Electronic	Work	7	86.78	108.00	1.33	147.80	56.46	-.898	-.891
	Commute	29	28.03	19.80	1.10	268.80	48.55	4.670	23.474
	Household	25	26.17	20.00	3.50	163.00	31.89	3.618	14.946
	Free time	28	60.34	24.38	3.30	279.00	75.21	2.049	3.506

Legend: N-number of participants who provided a response in this group of questions; Mean-mean value; Median-median; Min-minimal value; Max-maximal value; SD-standard deviation; Skew-skewness; Kurt-kurtosis.

Table 2 shows the values of the median of the groups presented in MET hours per week, as well as the values of the 95% confidence interval, which includes 50% of the data.

Table 3 presents the types of activities with their *p*-value. It can be noted that these values, except for leisure time activities, are statistically significant.

Table 2 Physical activity of students from the University of Niš (in MET hours/per week)

Faculty		Work	Commute	Household	Free time	Total
Philosophy	The median	162.6	23.1	17.9	83.8	132.8
	95% confidence int.	(19.8-350.4)	(16.5-46.2)	(9.0-45.0)	(23.1-130.8)	(72.3-346.8)
	Interquartile range	254.4	31.4	36.2	116.7	304.9
Economics	The median	22.7	29.0	3.0	35.1	72.1
	95% confidence int.	(12.4-33.0)	(19.8-41.2)	(3.0-7.0)	(31.1-47.6)	(65.2-88.3)
	Interquartile range	/	29.7	4.0	21.5	27.8
Law	The median	242.1	46.2	18.0	55.6	201.9
	95% confidence int.	(199.6-331.8)	(39.6-46.2)	(13.0-37.0)	(31.6-83.4)	(138.9-354.6)
	Interquartile range	97.4	29.7	33.0	68.0	224.15
Electronic Engineering	The median	108.0	19.8	20.0	24.4	73.4
	95% confidence int.	(1.3-147.8)	(11.6-23.10)	(12.0-25.0)	(17.2-66.2)	(47.9-124.2)
	Interquartile range					
	The median	110.8	14.9	15.9	55.7	117.3
	95% confidence int.					
Entire sample	Interquartile range	169.6	23.1	14.0	39.6	93.8
	The median	(96.0-232.8)	(21.6-34.7)	(10.5-20.0)	(31.6-54.2)	(77.5-112.4)
	95% confidence int.	188.1	29.7	21.0	57.3	145.4

Table 3 Kruskal-Wallis test of the inter-group differences of students from the University of Niš

Activities	Work	Commute	Household	Leisure time	Total
N	28	101	89	105	109
Chi-square*	13.066	12.964	27.752	6.047	23.973
p - value	.004	.005	.000	.109	.000

Legend: *df=3 in all the tests; N-the number of participants per group

DISCUSSION

Programmed PA has a positive effect on the health of people. Not participating in programmed PA leads to pre-obesity, abdominal obesity and problems with physical and psychological health. The World Health Organization - WHO (1997) and the International Federation of Sports Medicine determined that one half of humanity is insufficiently physically active. Obesity has been declared a global epidemic as far back as some twenty years ago (WHO, 2000). If obesity were to emerge in childhood, it usually persists into adulthood and presents a risk factor for many mass non-contagious diseases (WHO, 2000; Janssen, Katzmarzyket, & Ross, 2002) and leads to significant health and socio-economic complications (Wolf, 2003).

The relationship between PA and quality of life is connected to a better mood, a more positive self-image, higher level of self-respect and self-efficiency, a decrease in psychological and physiological stress (Berger & Motl, 2001), an experience of enjoyment and entertainment (Csikszentmihalyi & Le Fevre, 1989) which can play an important role in how one experiences their quality of life. PA cannot be replaced and needs to become a crucial issue for a healthy lifestyle. However, quality of life does not directly depend on one's state of health. Some individuals live a quality life and are satisfied with their life choices, despite their ailing health. A positive connection between the level of PA and quality of life might motivate healthy individuals to be more physically active. PA can

reduce the risk of chronic illnesses, and have a general tendency for individuals (Weinstein, 1989). According to Rejeski & Mihalko (2001) quality of life is a conscious cognitive evaluation of satisfaction with one's life.

The results (Table 2) indicate that students from the Faculty of Economics are less physically active at work. These data were observed with only two participants, who were employed during their studies. That is a very small sample, so it must be taken into account only conditionally. Students from this faculty are less interested in participating in household activities. The students of the Faculty of Law take the lead in PA at work, while the students of the Faculty of Philosophy are active during their leisure time. The results point us in the direction of the conclusion that there are differences in the activities of students attending various faculties. Thus, it should be further determined whether these differences are statistically significant.

The results (Table 3) lead to the conclusion that students from four faculties have significantly different levels of PA, despite the fact that they do not have PE classes as part of their university curriculum. Based on their choice of faculty, statistically significant differences were determined [χ^2 (3.10)=23.97, p=.00<0.01]. Significant differences in the activities were noted in all types of activities except in leisure time PA. Significant differences in the activities were found in all types of activities (work p=.00; commute p=.00; household activities p=.00). Leisure time PA, which includes recreational and other types of sport and physical activities (p=.10) showed no signs of significant differences. A lack of statistical significance was indicated because students spend their free time in an active manner. The location of the University of Niš and sports-recreational facilities and centers which provide different services for students are motivating for students to be included in all active sports life activities.

CONCLUSION

The current collaboration between the Council of Europe and the Ministry of Education, Science and Technological Development of the Republic of Serbia in our country has resulted in projects which started in 2017. These projects refer to the field of higher education and are focused on tolerance, the struggle against discrimination, and corruption in the educational system. It was determined that the higher education reform in Serbia is not yet complete, and there is still room to adapt to the standards of the European Union. By adhering to these standards, young people will be given the opportunity to have a high-quality education. The Bologna process in higher education is still not complete. This refers to the inclusion of new technologies in the process of education, but it also neglects PE which is a part of the tradition of the Serbian people. The relationship towards PA in elementary and high school education differs drastically compared to university-level education, so there is need for systematic PA to be included, due to the circumstances of modern-day life, i.e., the problem of obesity, cardiovascular issues, changes in the skeletal-muscle system, which result in excessive obesity and depression. The preparation for any systematic solution to this problem in higher education must be preceded by studies of social relations.

Acknowledgement: *This research is a part of the project "Anthropological characteristics of children and youth of South East Serbia - situation and trend changes" of the Faculty of Sport and Physical Education, University of Niš, Republic of Serbia.*

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NIVO FIZIČKE AKTIVNOSTI STUDENATA NA UNIVERZITETU

Cilj ovog istraživanja bio je da se utvrdi razlika u nivou fizičke aktivnosti (FA) studenata četiri fakulteta Univerziteta u Nišu. Predmet istraživanja je studentska populacija čiji nastavni programi ne uključuju časove fizičkog vaspitanju (FV) na Univerzitetu bez uključenih nastavnih programa nastave FV. U proceni nivoa fizičke aktivnosti korišćen je upitnik za samovrednovanje fizičke aktivnosti (IPAQ-duža verzija). Istraživanje je obuhvatalo studente Filozofskog, Ekonomskog, Pravnog i Elektronskog fakulteta Univerziteta u Nišu (n=109; starost: 22±0.6 meseci). Utvrđena je značajna razlika u nivou FA među studentima Univerziteta u Nišu (p=0.000). Međutim, razlike u FA tokom slobodnog vremena nisu utvrđene (p=0.109). Jedan od razloga je aktivno provođenje slobodnog vremena studentske populacije, koja sportskim aktivnostima nadoknađuje nedostatak FV na fakultetima.

Ključne reči: *studenti, aktivnost, IPAQ upitnik, visoko obrazovanje*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 491 - 496
https://doi.org/10.22190/FUPES200226024M

Professional article

THE SIGNIFICANCE OF DIDACTIC MEDIA IN TEACHING PHYSICAL EDUCATION

UDC 796: 37.026: 792.09

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Abstract. *The aim of this paper is to present the significance of modern, electronic didactic media in the realization of physical education (PE) classes. PE helps students become skilled, active, healthy, responsible, independent and competent, able to think analytically and critically, and ready to act in new and unexpected situations. The didactic media open up wide application in contemporary PE classes that seeks to overcome the disadvantages of traditional teaching. It involves the introduction of innovative models of PE, as well as the use of modern didactic media. Advantages of the implementation are numerous, and most often emphasized: better motivation, and better communication between PE teachers and students in the educational process.*

Key words: *Physical Education, Didactic Media, Student, Teacher*

INTRODUCTION

A review of the available literature concerning the importance of didactic media for physical education (PE) revealed emergence and significant increment in new ways of presenting information, which entails the requirement for the students' capacity to correctly perceive, absorb and visualize educational material, simultaneously creating schematic images that differ in completeness, integrity and generalization (Kalina, Aydarov, & Aydarova, 2019).

The Society of Health and Physical Educators-SHAPE (2017) and the International Society for Technology in Education-ISTE (2017), which are educational organizations, responded upon this issue by indicating indispensable technology-related standards i.e., knowledge and skills which teachers need to integrate technology. These standards influenced the restructuration of physical education teacher education (PETE) programs or enhanced preparation of the teachers with relevant knowledge, experience, and the

Received February 26, 2020/ Accepted May 21, 2020
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propensity to integrate technology adequately into instruction within the existing curricula (Jones, Bulger, & Wyant, 2012 in Baek, Jones, Bulger, & Taliaferro, 2018).

There is a dilemma between academics, those who make decisions and schools, based on whether technological innovations are “good” or “not”, or how technology can be used in the best possible way to fulfill educational aims. In the context of the place that technology takes, it is an interesting field to research and limits the broad lens of technology incorporation into a special field of society (Sargent, 2018).

PE teachers adopted wearable technologies, mobile phones and apps, PC, diverse gaming systems into quotidian physical activity and fitness (Beighle, Morgan, & Pangrazi, 2004; Phillips, Rodenbecka, & Clegga, 2014 in Baek et al., 2018).

PE helps student become skilled, active, healthy, responsible, independent and competent, able to think analytically and critically, and ready to act in new and unexpected situations.

The education priority goal is to form such standards that could help a person quickly adapt to the contemporary lifestyle, create the urge for constant self-improvement and a critical attitude to life (Gorovaya et al., 2017).

Education is a social activity involving both teachers and students. Hence, a good relationship between teachers and students is essential in the smooth completion of educational and teaching activities. Moreover, it also has an important impact on the personality development and psychological health of teachers and students (Lu, 2019).

Modern schooling should pay attention to the student's self-reliant action, the organization of independent learning surroundings and training that includes experiments and practice, where students can choose actions and use both inventive and flexible training programs while working in an agreeable rhythm (Yakovleva & Yakovlev, 2014).

Student education should contain characteristics such as: basic knowledge acquisition, scientific preparation and the ability to use different technologies related to the field (Oliveira, & Morais, 2019).

Skilled teachers can facilitate the process of learning if they motivate students to think, question, test ideas and to explain and represent them. They should be well educated about the subject they teach, but also flexible when it comes to their teaching methods (Jack, 2017).

PE teaching, as an interactive relationship between teacher and student, is achieved through various forms of communication, guided by the principles of obviousness, accessibility to age, rationalization and economy, as well as the rules of gradual learning set by Komensky: from proximal to distal, from easier to harder, from familiar to unknown, from simple to complex. Teaching is situated in the area of didactically shaped sources and communication media, called "media" or "teaching media".

Relationships between students and teachers should be supportive and warm and that includes open talks, teacher participation, reliance and taking responsibilities.

The positive relationship makes students perceive teachers as trustworthy, approachable, and encouraging, but they also see themselves as capable and valuable (Wang, Leary, Taylor, & Derosier, 2016).

The main condition that makes teachers successful is their wide knowledge on the taught unit, scientific degree for training in this area, related units in the overall education; finally, familiarity with the methodology of the subject they teach and understanding of the general didactic principles (Roman & Nadezhda, 2018).

The learning process can be considered successful if the educational goals can be realized. The realization of goals can be influenced by many technical and non-technical factors. Teachers and students not only facilitate the learning process, but also some aspects of the

teaching and learning strategies. Teaching and learning strategies are based on the teacher's decision what learning approaches will be used, and appropriate to the learning objectives and learning materials that will be taught (Hanipah, Florentinus, & RC, 2018).

The nature and character of the PE content enable the application of different teaching media in the processes of learning and teaching.

The effectiveness of learning achievement goals needs to be improved by learning media when it comes to learning communication (Widodo, 2018). It is the PE teacher's obligation to provide as rich a source of immediate experiences as possible, which are the basis of all knowledge, opinion and attitude development.

In order to be effective, teachers should be able to come up with an acceptable quantity of instruction, they need to work on the organization and management of the classroom, the instruction time and the structure of instructional material should be used effectively, students should be able to practice and apply what they learned, the classroom should provide a good environment, and teachers should have moderately satisfactory knowledge of the subject (Toraby, & Modarresi, 2018). The use of didactic media is based on the fact that they are less abstract than words. Their proper use has a positive effect on the quantity, quality, durability of knowledge and development of students' skills. In his preparation for direct PE teaching, the teacher must foresee what, when, and how didactic media will be used. The correct choice and application of didactic media determine the extent to which the expected effects of their application will be achieved. Didactic media should be adapted to the age, previous knowledge and experiences of the students, as well as their ability to perceive, and abstract thinking.

The aim of this paper is to present the significance of modern, electronic didactic media in the realization of PE classes.

The Significance of Didactic Media in the Physical Education

In everyday use, by medium we mean a means of mediating and transmitting information in the communication process. The media in conceptual terms (books, e-textbooks, a whiteboard, computer, internet, film, camera, video projector, etc.) are not teaching media until they begin to exercise a didactic function.

Teaching media are in the function of achieving the goals and objectives of the teaching if it "motivates students, stimulates their interest, serves to understand a phenomenon more easily, helps a student to practice an action" (Vilotijević, 1999, author's translation).

Multimedia learning is based on the premise that students can better understand an explanation if it is presented with both words and figures instead of a presentation with only words. Multimedia messages can be used as information delivery vehicles or sometimes they are aids to sense making. For instance, a multimedia message on a computer could include narration and animation, while the same type of message in a book could be printed text and illustrations. An example of such message is the one with words and figures intended as an explanation of an athlete demonstrating sport technique (O'Donoghue & Holmes, 2014).

In order to see the cognitive consequences of multimedia learning, teachers can ask their students to recall information that was presented to them through the test of retention or by answering questions concerning the information that they got through the test which examines transfer (Mayer & Moreno, 1998).

A possible learning outcome could be no learning, which refers to poor retention and poor transfer performance. Another possible outcome is rote learning where there is good retention but poor transfer performance. Finally, the best outcome is meaningful learning where students show good retention and transfer performance. Whether the students will learn meaningfully, depends on their cognitive activity while they are learning, which is more important than the teacher's behavior during the teaching process . Besides that, according to a cognitive theory of multimedia messages, humans use dual channels for information processing: one that processes visual and pictorial, and the other that is intended for audio and verbal. Both are limited by their abilities to process, and coordination of cognitive processes for active learning is required.

Meaningful learning usually requires a heavy amount of cognitive processing and due to the limited information processing system of the student, multimedia instruction should be designed in such a way that unnecessary cognitive load is minimized (Mayer & Moreno, 1998).

It is important to emphasize that humans have cognitive resources they use for learning that are limited. There are three components that determine the level of cognitive load. To begin with, by the intrinsic cognitive load, which refers to the level or quantity of interacting concepts. These elements are processed in working memory at the same time in order for the subject being taught to be learned. The second one is an extraneous cognitive load that refers to unnecessary cognitive demands and the last one is germane cognitive load. This one is connected to learning activities that foster schema acquisition (Park, Flowerday, & Brünken, 2015). One of the implications of this study is that instructional planners, teachers and learners should consider the working memory capacity of the students and to adapt materials to the learning situation.

Innovative teaching media design will significantly provide students with motivation and achievement (Duckworth & Yeager, 2015). The learning will go quickly and on target. When it comes to the students' perceptions about teaching learning media in didactic lectures, research conducted by Manohar, Dashputra, & Suresh (2015) shows that the majority of students preferred Power Point presentations as the best medium, which suggests that effectiveness of this medium should be increased. These results show that teaching learning media play very important role in the learning process of students.

In his work "Audiovisuals and their use", Jacob Danon argues that teaching media enable students to understand the basic thoughts of the teacher in the teaching process, and to translate the ideas he wants to present into verbal and visual language, understandable for the students (according to Mandić, 2001).

Teachers have access to a variety of didactic media used in the educational process and create them independently. However, in order to improve teaching, it is important for the teacher to develop a critical attitude towards the accessible didactic media. For the quality use of didactic media in teaching, PE-related content must be didactically and methodically designed. Teaching PE gives PE teachers great opportunities to apply various didactic media to enrich educational practice.

Choosing the right medium for teaching and learning is a very important didactic issue. In order for the teacher to make the best choice of media to use in the teaching process, he/she should know their advantages and disadvantages.

Didactic media are characterized by multimedia, the possibility of an interactive approach and interdisciplinary learning, which is a feature of the teaching of nature and society.

Lack of an adequate training on skillfulness and capability to teach using technology in PE settings, has an insufficient effect on the proficiency of PE teachers (Baek et al., 2018).

According to Baek et al. (2018), there are two types of the barriers to technology integration: 1) external barriers for teachers to use technology (lack of insight into technologies, insufficient budget and time required to master technological skills, improper technical and organizational support, and class size); 2) internal factors (opinions, knowledge, competence, and self-adequacy).

Education programs for teachers should prepare them to adopt technology in such way that will help them perform the pedagogical strategies used in outdoor environment sor in a gymnasium where PE is usually taught. Traditional sport even became a part of the virtual world grace to the new possibilities of contemporary media (Baltazarević & Baltazarević, 2019). Teaching skills need to be adopted and exerted by PE teachers in a similar context they will face later. PE teachers are expected to be familiar with PC devices and other technological gadgets aimed at data collection, the analysis, assessment and evaluation of student knowledge and health-related physical fitness (Juniu, Shonfeld, & Ganot, 2013).

CONCLUSION

The didactic media open wide application in contemporary PE classes which seek to overcome the disadvantages of traditional teaching. They involve the introduction of innovative models of PE, as well as the use of modern didactic media. Advantages of the implementation are numerous, and the ones most often emphasized include: better motivation, and better communication between PE teachers and students in the educational process. The extent to which didactic media will be used to acquire knowledge through PE teaching or through free and optional physical activities depends a lot on the affinity and interest of the PE teacher, as well as the school management. Although this paper has covered one segment of pedagogical work - the application of didactic media in PE teaching, these lines should hopefully arouse new interest in further research in this field.

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ZNAČAJ DIDAKTIČKIH MEDIJA U FIZIČKOM VASPITANJU

Cilj ovog rada je da se predstavi značaj modernih, elektronskih didaktičkih medija u realizaciji nastave fizičkog vaspitanja (FV). FV pomaže učenicima da postanu vešti, aktivni, zdravi, odgovorni, nezavisni i kompetentni, sposobni da razmišljaju analitički i kritički i spremni da deluju u novim i neočekivanim situacijama. Didaktički mediji otvaraju široku primenu u savremenim časovima FV kojima se želi prevazilaženje nedostataka tradicionalne nastave. To uključuje uvođenje inovativnih modela FV, kao i upotrebu savremenih didaktičkih medija. Prednosti implementacije su brojne, a najčešće se ističu: bolja motivacija i bolja komunikacija između nastavnika FV i učenika u obrazovnom procesu.

Ključne reči: *fizičko vaspitanje, didaktički mediji, učenik, nastavnik*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 497 - 507
https://doi.org/10.22190/FUPES200323047D

Research article

THE DEVELOPMENT OF MOTOR ABILITIES OF YOUNG ATHLETES AND GYMNASTS IN THE INITIAL PREPARATION PHASE

UDC 796.41-053.5
796.012.015-053.5

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Abstract. *The aim of this study is to determine the effect of sports gymnastics and athletics training on the development of athletes' motor abilities in the initial preparation phase. The study was conducted on a sample of 81 girls and boys of about 9 years of age, who train athletics (N=34) and gymnastics (N=47). A total of 9 variables were observed, three to assess anthropometric characteristics (body height, body mass and the body mass index) and 6 to assess the participants' motor abilities (explosive leg power, repetitive power, agility, power endurance, flexibility, cardiorespiratory endurance). The one-sample t-test was used to compare the results with mean values of the general population of the same age, whereas a univariate ANOVA was used to compare the results between the athletes and the gymnasts of different genders. The results show that the level of motor development in girls is significantly higher than in the general population, while in boys, significant progress was not registered in power endurance and cardiorespiratory endurance, regardless of the sport they are engaged in. Regardless of gender, gymnasts have better flexibility compared to athletes, while athletes have significantly higher explosive power and agility.*

Key words: *Power, Endurance, Agility, Flexibility, Children*

Received March 23, 2020/ Accepted September 20, 2020
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INTRODUCTION

Modern sport and trends in its development impose the necessity of a constant improvement of all factors that influence the outcome. Long-term planning concepts considering the overall sports career of an athlete from the beginning of a training process until the end of the sports career emerged a long time ago and have been developing ever since through the Long-Term Athlete Development model (LTAD). Given that the unique biological and psychosocial development of an individual is one of the basic goals of sport as a social phenomenon it is important to consider the overall career of an athlete, which additionally gains in significance. A sports career involves several linked and interdependent stages, with its own goals, that an athlete goes through. Various models according to which a career is divided into smaller parts consider the issue associated with the beginning of sports engagement in a relatively similar way. This period is very important and sensitive since it represents the beginning of a long-term process, where possible errors cannot later be corrected even with great effort. It is a basic training period and a period of basic instructions (Wilke & Madsen, 1986), a non-specific training period (Lazlo, 1986), a period of preliminary sports preparation and basic training (Vorontsov, 1998), or an initial preparation phase and previous base (Platonov, 1999), i.e., initiation phase (from 6 to 10 years of age) and period of sport fitness (up to 14 years of age) (Bompa, 2009).

The initial preparation phase implies diverse and interesting training sessions lasting up to 60 minutes 2 to 4 times a week. The training is not oriented towards a specific sport or sports discipline, but primarily towards a specific child. In this sense, the training sessions are much like physical education classes organized at schools (and they are even complementary), that affect versatile and harmonious child development by encouraging and stimulating natural child development and defect correction. According to the aforementioned LTAD model, the initial preparation phase includes training and development through play and fun ("FUNdamental") as one of the key processes, where the sports disciplines belonging to the group of basic sports provide the basic abilities necessary for all other sports and they are athletics, gymnastics and swimming (Balyi, 2001).

It is of utmost importance to develop most motor abilities in the initial preparation phase, i.e., to provide a good motor base for a further sports development by encouraging the development of these abilities timely during certain sensitive periods. Specifically, the work should be done to develop all the motor abilities whose sensitive period is current during this phase and special attention should be paid to those abilities that are crucial to success regarding a specific sports discipline. Thus, an athlete's body should be prepared for what follows in the upcoming phases of their sporting career. Physical activity aimed at motor ability development is most efficient between the ages of 7 and 17 (Malina, Bouchard, & Bar-Or, 1991), and the period between the ages of 9 and 12 has been referred to by many authors as the most important interval in child motor development (Rushall, 1998; Viru et al., 1998; Balyi & Hamilton, 2004).

Since the development of young athletes' motor abilities represents a priority in the initial preparation phase and given that the contents of basic sports are recommended for such a development, the aim of this study is to determine the effect of sports gymnastics and athletics training on the development of athletes' motor abilities in the initial preparation phase. Specifically, this paper includes an analysis of the development of young athletes and gymnasts' motor abilities in the initial preparation phase, i.e., during the period of the children's first contact with organized sports, by comparing the mean values of the general population of children in the Republic of Serbia (Milanović & Radisavljević, 2015).

METHODS

This research is of a transversal character conducted on a sample of children of both genders who are engaged in athletics and gymnastics. The children's motor abilities and the parameters of their physical development were assessed and then compared with the reference values of the population of boys and girls of the same age.

The sample of participants

This study was conducted on a sample of 81 girls and boys aged 9 years with training experience of 1-2 years. The participants are members of the Athletics Club "Crvena Zvezda", Belgrade (N=34) or the sports Gymnastic Club "DIF", Belgrade (N=47) for 60 minutes per training, 3 times a week according to the official program of the Gymnastics Association of Serbia (www.gssrb.rs) and the program of the athletics school of the Athletics Club "Crvena Zvezda" (www.akcrvenazvezda.rs). The total sample is divided into four groups according to gender and the sports they are engaged in as follows: male gymnasts (♂G; N=19), male athletes (♂A; N=16), female gymnasts (♀G; N=28) and female athletes (♀A; N=18).

Experimental protocol

All the measurements were carried out in the morning hours, in the sports facilities where the children practice, i.e. in the gym of the Faculty of Sport and Physical Education in Belgrade (gymnasts) and in the Indoor Athletics Hall in Belgrade (athletes). A total of 9 variables were examined, 3 variables to assess the participants' anthropometric characteristics and 6 variables to assess their motor abilities. The participants' physical characteristics were measured first and then their motor abilities were tested.

Measurement of physical characteristics

Body height (BH) and body mass (BM) were measured to assess the physical growth and body composition and Body Mass Index (BMI, in $kg \cdot m^2$) was calculated using the obtained data. A Martin type stadiometer (Seca Instruments Ltd., Hamburg, Germany) was used to measure body height, and a Tanita Inner Scan Model BC-578 scale (Tanita Europe GmbH., Sindelfingen, Germany) was used to measure body mass.

Testing of motor abilities

The following tests were used to assess motor abilities: the Standing long jump (LJ in cm) to assess explosive leg power, 30 seconds sit-up test (SU30 in repetitions) was used to assess repetitive power, 4x10 m agility shuttle run test (4x10 in s) to assess agility, the Flexed-arm hang test (FH in s) used to measure power endurance, the Sit and reach test (SnR in cm) used to assess flexibility, and the 20 m progressive shuttle run test (SR20 in s) to assess cardiorespiratory endurance. The selected motor tests correspond to the battery of tests used in the study which was conducted on a sample of about 12.000 participants to test the specified motor abilities and physical characteristics of children aged 9-14 and the obtained results have been set as the parameters for this population (Milanović & Radisavljević, 2015).

The testing of motor abilities was preceded by a standard warm-up procedure lasting 7-10 minutes which consisted of different variants of a running and shaping workout. Prior to carrying out each test, the participants were instructed in detail on how the test should be performed, and each participant was allowed one attempt, except in the case of the 20 m progressive shuttle run test. The same examiner carried out all the measurements within one test.

The Standing long jump (LJ) was carried out on a flat non-slip surface which contains the take-off line clearly marked and a metal tape set up along the landing area to measure the jump distance. The participant's task was to jump as far as possible using a two-foot take-off and landing. The test result is the distance between the take-off line and the nearest point of contact with the ground on the landing. The results are given with an accuracy of 0.01m. The participant is allowed three attempts and the best score is taken into account for the analysis.

Sit-ups in 30 seconds (SU30) was performed on a gym mat where the participant is lying on his/her back, knees bent at an angle of 90° and feet flat against the floor at the hips width, hands behind the head while the legs are firmly fixed by an assistant. The participant's task is to perform as many sit-ups as possible within a period of 30s. The result is expressed by the total number of correct sit-ups completed in 30s.

The 4×10 m Agility shuttle run test (4×10) was performed on a 10m-long track marked with two lines of 1.2 m in length. At the end of the track, behind the line, there were two sponges. The participant's task was to run along a distance of 10 m four times as quick as possible. At the examiner's signal the participant sprints as fast as possible to the opposite side, places one foot across the marked line, takes one sponge and then runs backwards to the start line, crosses it with one foot and leaves the sponge. Then the participant repeats the same task once again, but with another sponge in their hand and sprints over the starting line. The test result is the time in which the participant performs the entire task and it is expressed with an accuracy of 0.1 s. If the participant fails to perform the test correctly, i.e. fails to step across the line with their foot every time, the measurement should be repeated.

The Flexed-arm hang test (FH) was performed on a horizontal bar with a stool placed beneath it, which enables the participant to assume the initial position easily. The participant stood on the stool and gripped the overhead bar using an underhand grip, hands placed at shoulder width, while the chin is placed above the overhead bar or at the height of the bar. The participant, having assumed the correct initial position, the stool was removed and the examiner started timing. The participant's task was to hang for as long as possible and the timing was stopped when the participant's chin fell below the bar level. The participant's body must not swing during the test and the legs must be hanging straight. The test result is the total hanging time and is expressed with an accuracy of 0.1 s.

The Sit and reach test (SnR) was performed using a wooden box (0.45 m × 0.35 m × 0.32 m), a ruler and a slider on the top edge of the box (0.6 m × 0.35 m). The participant sat in front of the box, barefoot, legs stretched out in front of the box and both feet flat against the front end of the test box. The top edge of the box was fixed so that 0.15 m of it extended over the front end and this extension was positioned over the participant's legs. Holding this position, the participant leaned forward and reached out with their arms outstretched and their hands on top of each other and pushed the slider as far as possible. The result was read out using the ruler and was expressed in centimeters. The participant performed the test twice, and the better score was taken for analysis.

The 20m progressive shuttle run test (SR20) was performed on a 20m-long track, where the participants ran following the pace given by a sound signal, i.e. beep. The participant's task was to run as far as possible, i.e., to run at the given pace as long as possible. The initial speed was 2.36 m/s (8.5 km/h) and it increased by 0.14 m/s (0.5 km/h) every minute. As a rule, before the beep, the participant had to be standing with both feet behind the marked line. The test was over when the participant could no longer follow the given pace, i.e., if the participant failed to cross the line three times in a row before the beep sound or if he/she gave up voluntarily. The test result was recorded as the total time run expressed in seconds.

Statistical data processing

All the data obtained by the tests performed were processed by statistical procedures using the programs SPSS version 20.0 and Excel. Arithmetic means (Mean) and standard deviation (SD) were determined as descriptive indicators. The one sample t-test was used to compare the obtained results with the mean values of the general population of the same age, whereas a univariate ANOVA was used to compare the results between the athletes and the gymnasts of different genders.

RESULTS

Table 1 shows the descriptive indicators of the physical characteristics and motor abilities of the studied athletes and gymnasts as well as the reference values of the general population of boys and girls of the same age.

Table 1 Physical characteristics and motor abilities (arithmetic mean±standard deviation)

	Boys			Girls		
Variables	Sports gymnastics (N=19)	Athletics (N=16)	Reference values	Sports gymnastics (N=28)	Athletics (N=18)	Reference values
BM (kg)	29.0 ± 3.2	34.2 ± 6.3	35.8 ± 8.4	27.9 ± 3.9	33.1 ± 4.9	35.2 ± 8.4
BH (m)	1.3 ± 7.2	1.4 ± 0.1	1.4 ± 0.1	79.4 ± 64.1	1.4 ± 0.1	1.4 ± 0.1
BMI (kg·m^2)	16.9 ± 1.4	17.1 ± 2.6	18.1 ± 3.2	16.1 ± 1.5	17.0 ± 1.9	17.9 ± 3.3
LJ (cm)	143.6 ± 22.8	156.8 ± 20.5	130.0 ± 22.0	135.7 ± 14.1	162.1 ± 13.8	118.0 ± 19.0
SU30 (reps.)	21.7 ± 5.5	23.0 ± 3.2	18.7 ± 5.0	20.8 ± 4.4	23.2 ± 2.4	16.7 ± 4.7
4x10 (s)	14.0 ± 1.1	11.6 ± 0.8	13.4 ± 1.4	14.5 ± 0.7	11.4 ± 0.6	14.0 ± 1.4
FH (s)	24.4 ± 17.9	21.5 ± 12.6	20.0 ± 17.0	27.0 ± 19.8	25.1 ± 18.9	14.0 ± 13.0
SnR (cm)	21.5 ± 4.1	15.0 ± 6.6	18.3 ± 6.0	25.3 ± 6.2	23.9 ± 3.4	20.5 ± 5.8
SR20 (s)	206.8 ± 82.5	210.2 ± 75.2	200.0 ± 94.0	191.1 ± 56.4	216.3 ± 90.0	157.0 ± 66.0

Legend: BM-body mass; BH-body height; BMI-body mass index; LJ-long jump; SU30-sit-ups; 4 × 10-agility shuttle run 4×10 m; FH-flexed-arm hang; SnR-sit and reach; SR20-20 m progressive shuttle run test

Table 2 shows the results of the t-test which compared the physical characteristics and motor abilities of the young athletes and the general population of boys and girls of the same age. The indicators of physical development have shown a significantly lower growth, lower body mass and BMI in the boys and girls who are engaged in sports gymnastics in relation to the general population. The girls engaged in both sports disciplines

achieved better results in all the tests measuring motor abilities in relation to the girls of the same age belonging to the general population. The boys showed a better developed explosive power, repetitive power and agility and the gymnasts were found to have even better flexibility in relation to the boys of the same age of the general population.

Table 2 Comparing the physical characteristics and motor abilities of the gymnasts and athletes of both genders in relation to the mean values of the general population of the same age

	Boys						Girls					
	Sports gymnastics			Athletics			Sports gymnastics			Athletics		
Variables	Mean Diff.	t	*p*	Mean Diff.	t	*p*	Mean Diff.	t	*p*	Mean Diff.	t	*p*
BM (kg)	-6.84	**-9.42**	0.000	-1.58	-1.00	0.331	-7.26	**-9.78**	0.000	-2.14	-1.86	0.081
BH (m)	-0.064	**-5.41**	0.000	0.016	0.99	0.334	-0.106	**-8.43**	0.000	-0.004	-0.28	0.784
BMI (kg·m^2)	-1.64	**-5.50**	0.000	-1.02	-1.58	0.135	-1.43	**-4.61**	0.000	-0.92	-2.02	0.059
LJ (cm)	13.61	**2.61**	0.018	26.81	**5.23**	0.000	17.7	**6.64**	0.000	44.11	**13.57**	0.000
SU30 (n)	2.98	**2.37**	0.029	4.3	**5.30**	0.000	4.12	**4.96**	0.000	6.52	**11.70**	0.000
4×10 (s)	0.62	**2.39**	0.028	-1.83	**-8.63**	0.000	0.55	**3.99**	0.000	-2.58	**-17.14**	0.000
FH (s)	4.43	1.08	0.296	1.54	0.49	0.633	13.01	**3.47**	0.002	11.11	**2.50**	0.023
SnR (cm)	3.23	**3.45**	0.003	-3.3	-2.02	0.062	4.79	**4.07**	0.000	3.39	**4.24**	0.001
SR20 (s)	6.84	0.36	0.722	10.19	0.54	0.596	34.14	**3.20**	0.003	59.33	**2.80**	0.012

Legend: Mean Diff.-arithmetic means difference; BM-body mass; BH-body height; BMI-body mass index; LJ-long jump; SU30-sit-ups; 4×10-agility shuttle run 4x10 m; FH-flexed-arm hang; SnR-sit and reach; SR20-20 m progressive shuttle run test

The comparison of the physical characteristics (Figure 1) and motor abilities (Figure 2) of the gymnasts and athletes of different genders has been presented only for those variables for which the ANOVA showed that there were differences between the groups: BM (F=9.143), BH (F=17.604), LJ (F=9.964), 4x10 (F=75.849), SnR (F=13.566); the significance for all the variables was set at the level p<0.0001. The gymnasts of both genders had a lower body mass and body height compared to the athletes of both the same or different gender, whereas the differences between the gymnasts of opposite genders were not found to be significant.

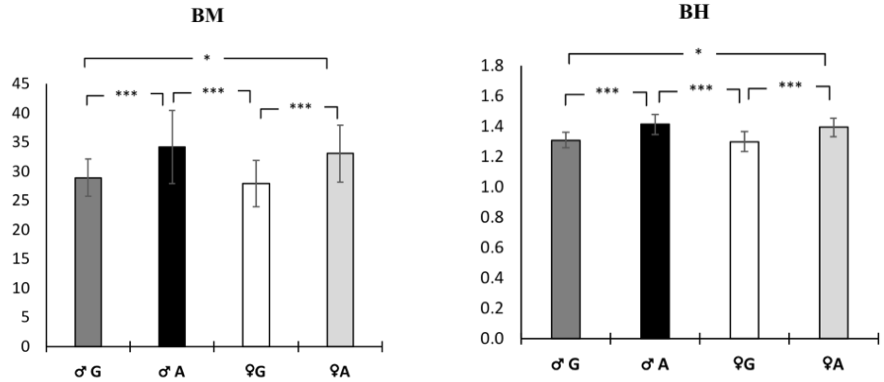

Fig. 1 Comparison of the results of the anthropometric characteristics of the gymnasts and athletes of different genders (Univariate ANOVA) - *p<0.05, ** p<0.001, *** p<0.0001 (♂G-male gymnasts, ♂A-male athletes, ♀G-female gymnasts, ♀A-female athletes)

According to gender, the differences between the groups in the Long jump test were found in the girls, in favour of the female athletes (Figure 2). There were no differences between the genders within the same sport found in the results achieved on this test, whereas the differences were determined between the boys and girls engaged in different sports and they were in favour of the athletes of both genders. In the 4x10 test, the athletes of both genders scored better than the gymnasts of both genders. Within the same sports discipline there were no differences in the results achieved on this test between the genders. Similar to the Long Jump test, the analysis of the results achieved by the boys and girls engaged in different sports has shown that the athletes of both genders achieved better results. In the SnR test, the gymnasts of both genders achieved better results than the boys engaged in athletics, while there were no differences determined in comparison with the female athletes. Within the same sports discipline, the differences in the SnR test were observed only between the boys and girls engaged in athletics, in favour of the girls.

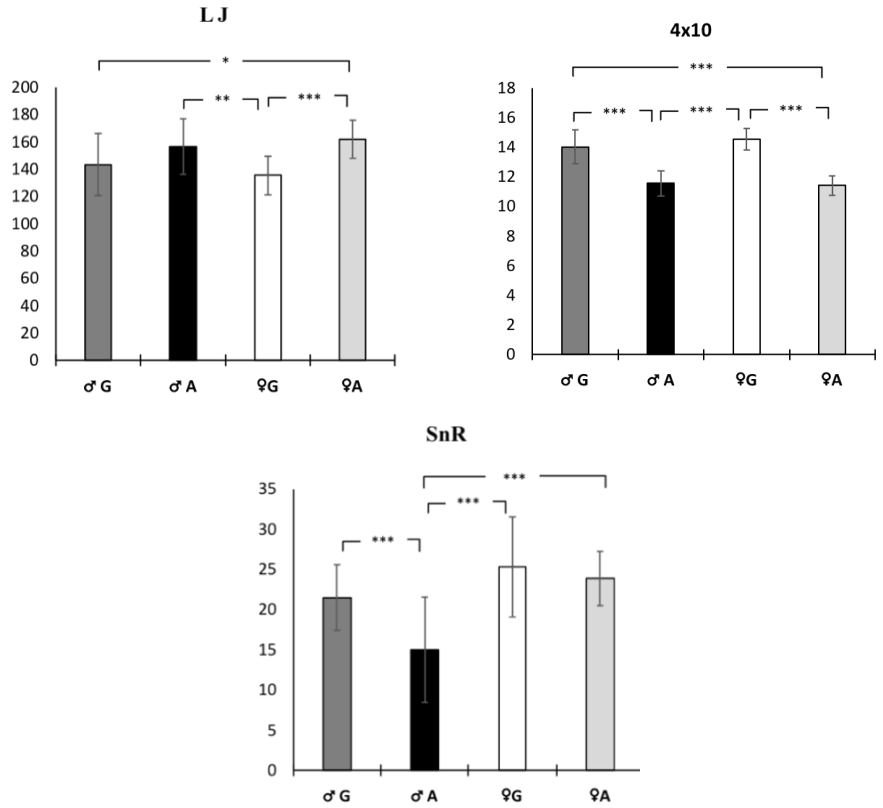

Fig. 2 Comparison of the results of the motor abilities of the gymnasts and athletes of different genders (Univariate ANOVA) *p<0.05, ** p<0.001, *** p<0.0001
(♂G- male gymnasts, ♂A- male athletes, ♀G- female gymnasts, ♀A- female athletes)

DISCUSSION

In this paper, the physical characteristics and the development of motor abilities of young athletes in the initial preparation phase were analysed in order to determine the effect of training on the studied physical and motor qualities of young athletes during this phase of their sporting careers.

The results of the analysis of anthropometric characteristics have shown that the gymnasts had significantly lower values of BM and BH compared to the average population of children of the same age. Sports gymnastics belongs to the sports of an early specialization (Balyi, 2001), which indicates the need to single out individuals who fit the model of an athlete relevant for this sports discipline, according to their physical characteristics through preliminary selection (Atiković, Kalinski, & Čuk, 2017). Specifically, after a one-year training experience, the nature of this sports discipline may have resulted in a certain selection, i.e., a possible dropout, due to a more directed program that is more easily realized by shorter practitioners. Also, it may be assumed that the parents themselves involve their children in exercise primarily according to the model of physical characteristics of the athletes engaged in a specific sports discipline. When it comes to athletics, the observed anthropometric characteristics have not shown significant deviations from the mean values of the population of children of the same age. It should be noted that the program including initial selection in athletics implies work on the basic technical elements belonging to various events (running, jumping, throwing), that the selection of competitors per specific event is carried out during the later phases of the sporting career, as well as that children have not spent enough time participating in sports to develop their sport specific qualities (Opstoel et al., 2015). The differences in the anthropometric characteristics found between the athletes and the gymnasts of the same gender are exactly in line with the aforementioned statements, since these athletes' characteristics showed no deviations from the mean values of the population of children of the same age, whereas they were significantly different in the gymnasts. Having analysed the results of the BMI, it may be concluded that BM is affected by BH and not by any another factor.

A higher degree of development of motor abilities in athletes and gymnasts was noticed in almost all observed abilities compared to the average population of children of the same age, which is in line with previous studies that observed the development of these abilities at the same stage of sports career development (Dobrijević, Moskovljević & Milanović, 2015; Paunović, Đurović, Veličković, Živković, & Stojanović, 2019; Stanković, Veljković, Marković, & Herodek, 2020). The period between 9 and 12 years of age is the most important phase in child motor development (Rushall, 1998; Viru et al., 1998; Balyi & Hamilton, 2004), and the sensitive periods regarding the development of most motor abilities occur somewhat earlier in girls (Gužalovski, 1984; Drabik, 1996). Thus, it can explain why the girls made more progress in all motor tests compared to the general population of the same age, whereas it was not the case with the boys. Namely, the boys did not show any significant progress in cardiorespiratory endurance and power endurance regardless of the sports discipline, i.e., they showed no differences in these motor abilities in relation to their peers belonging to the general population.

The gymnasts and athletes of both genders had a higher level of development of explosive power compared to the general population of the same gender and age, which was confirmed by the findings of previous studies (Paunović et al., 2018). Similar findings on a sample of female rhythmic gymnasts of the same age (Dobrijević et al., 2015) have indicated that in the

period between the ages of 9 and 10 work should be done to develop explosive power by applying various contents in order to timely initiate the development and create the favorable conditions for its expansion during the sensitive period which occurs in the following years. The gymnastics training program in the first year of training implies the preparation to master the technique elements in several different events, which partly requires a major engagement of the hands (horizontal and hanging apparatuses) and partly the use of the legs (floor, vault) so that the training sessions are dominated by exercises for the development of various motor abilities. Therefore, a training volume directed towards the development of explosive leg power during the initial preparation phase is smaller in relation to the athletes since work is simultaneously done to develop te explosive power of the arms and shoulders, coordination, flexibility.

Repetitive power has been indicated as a significant motor ability for both sports disciplines, so that both the gymnasts and the athletes proved to be superior in relation to the average population, whereas the differences between them were not significant. Similar results compared to the average population were shown by girls who take part in rhythmic gymnastics (Dobrijević at al., 2015); therefore, such results support the findings of the study which has pointed out that the power of the upper body is a characteristic determinant of gymnasts (Pion et al., 2014). This indicates the fact that the programs of basic sports, to which the aforementioned sports disciplines belong, imply work on the development of this motor ability which is of multiple significance both for mastering specific techniques of these sports disciplines as well as for proper child growth and development, especially in the period of their intense physical growth and development.

The age of 9-10 years is considered to be very sensitive for the development of agility in children (Caspersen, Pereira, & Curran, 2000; Bijelić & Simović, 2005); therefore the appropriate stimulation of its development can quickly lead to visible results regarding progress. According to the findings of this study, it may be concluded that athletics training represented a significantly better stimulus for the development of this motor ability than gymnastics training. This motor ability is not crucial for achieving results in sports gymnastics so it may be the reason why its development is not emphasized in the training process. Moreover, the findings of our study have indicated that the gymnasts of both genders showed a lower level of the development of this motor ability compared to the general population of children of the same age, which indicates that this ability has been neglected for the benefit of the development of some other athlete's qualities. Observing the results achieved by children of different genders within the same sport, it was noticed that there were no differences between them, which is contrary to some previous studies that support a higher level of development of this ability among boys (Lazarević, Milosavljević, Lazarević, Marković, & Savić, 2018).

Flexibility, as a motor ability, is inherent to the female gender (Valdivia, Ortega, Rodríguez, & Sánchez, 2009; Mier & Shapiro, 2013), which has been confirmed by the findings of this study as well, since the girls mostly showed better results on the Sit and Reach Test compared to the boys. This difference was not recorded between the gymnasts of different genders, which may be attributed to the specificity of the sport and its requirements regarding the development of this motor ability in both genders (Pion et al., 2014).

CONCLUSION

In the initial preparation phase, training is not primarily oriented towards a specific sport or sports discipline, but it is aimed at the general preparation; therefore, in this sense, a timely development of motor abilities and the preparation of an athlete's body for the next training phase is crucial. Athletics and sports gymnastics, as the basic sports, represent a good stimulus for the development of most motor abilities during this phase. It is characteristic of the girls to enter the sensitive periods of the development of most motor abilities earlier, so that athletics and gymnastics training sessions have contributed to a significantly higher level of motor development in relation to the general population, whereas, in the case of the boys, a significant progress is not recorded in power endurance and cardiorespiratory endurance, regardless of the sport they are engaged in. According to the sports disciplines, gymnasts were dominant compared to athletes in their manifestation of flexibility, while the athletes showed a significantly more developed explosive power and agility, regardless of gender.

Such studies can provide useful information which may help experts in physical education and sport as well as parents to guide their children through sports, so that specific results can be expected in later phases of their sports development. In this regard, such studies should be conducted on a sample of children engaged in other sports. Certainly, it should be added that this study is of a transversal character, so that further research should examine the effects of these training sessions and/ or training sessions in some other sports in a study with a longitudinal character.

Acknowledgement: *The paper is a part of the research done within the project of the Ministry of Education, Science and Technological Development of Republic of Serbia: Effects of applied physical activity in locomotion, metabolic, psychosocial and educational status of the population of R. Serbia. No. 47015, extended cycle of scientific projects 2011-2018.*

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RAZVOJ MOTORIČKIH SPOSOBNOSTI MLADIH SPORTISTA I GIMNASTIČARA U POČETNOJ FAZI PRIPREME

Cilj ove studije je da se utvrdi efekat sportske gimnastike i atletskog treninga na razvoj motoričkih sposobnosti sportista u početnoj fazi pripreme. Studija je sprovedena na uzorku od 81 devojčice i dečaka uzrasta 9 godina koji treniraju atletiku (N=34) i gimnastiku (N=47). Ukupno je praćeno 9 varijabli, tri za procenu antropometrijskih karakteristika (telesna visina, telesna masa i indeks telesne mase) i 6 za procenu motoričkih sposobnosti ispitanika (eksplozivna snaga nogu, repetitivna snaga, okretnost (agilnost), izdržljivost u snazi, fleksibilnost, kardiorespiratorna izdržljivost). U komparaciji srednjih vrednosti ispitanika istog uzrasta korišćen je t-test, dok je ANOVA metod korišćen za poređenje rezultata između sportista i gimnastičara različitog pola. Rezultati ukazuju da je nivo motoričkog razvoja devojčica znatno veći nego u opšte populacije, dok kod dečaka nije zabeležen značajan napredak u izdržljivosti u snazi i kardiorespiratornoj izdržljivosti, bez obzira na sportsku disciplinu kojom se bave. Bez obzira na pol, gimnastičari imaju bolju fleksibilnost u poređenju sa atletičarima, dok atletičari poseduju znatno veću eksplozivnu snagu i okretnost.

Ključne reči: *snaga, izdržljivost, okretnost, fleksibilnost, deca*

FACTA UNIVERSITATIS
Series: **Physical Education and Sport**, Vol. 18, No 2, 2020, pp. 509 - 514
https://doi.org/10.22190/FUPES200901048B

Professional article

GLUTEN-FREE DIET IN NON-CELIAC ATHLETES - BENEFITS AND POTENTIAL HARMFUL EFFECTS

UDC 615:796:36.015

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Abstract. *The aim of this paper is to present the latest scientific data related to a gluten-free diet, the justification of the introduction of a diet, the advantages and disadvantages of this dietary approach in the population of athletes. Non-celiac gluten sensitivity, previously defined as gluten sensitivity, is a relatively new clinical entity first defined in 2011. This disorder is characterized by intestinal symptoms (abdominal pain, bloating, diarrhea, and constipation) and extra intestinal symptoms such as headache, chronic fatigue, impaired concentration or "brain fog", numbness and muscle or bone pain are frequently reported. Since most of the symptoms are subjective without accompanying clinical signs, and since no specific biomarker for diagnostics exists in clinical practice, there is always a dilemma whether this is really a health problem. A gluten-free diet has become popular among athletes due to the opinion that it has ergogenic effects. It should also be borne in mind that the introduction of a gluten-free diet has its drawbacks. Several studies suggest that a gluten-free diet is deficient in whole grains, dietary fiber, micronutrients and minerals. The data collected from the National Health and Nutrition Examination Survey study indicate the existence of higher concentrations of heavy metals in urine and blood samples taken from people following a gluten-free diet as a result of narrowed food choices. These data remind us to keep in mind the justification of the introduction of a gluten-free diet and the potential damage to health when observed adherence to this pattern of nutrition in the long run.*

Key words: *Gluten-Free Diet, Athletes, Non-Celiac Gluten Sensitivity, Effects*

Received September 01, 2020 / Accepted October 04, 2020
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INTRODUCTION

Non-celiac gluten sensitivity (NCGS), previously defined as gluten sensitivity is a relatively new clinical entity first defined in 2011, examined in more detail by a group of scientists who gave the so-called Oslo definition of this health problem (Ludvigsson et al., 2013). In 2012, at the Second Meeting of Experts in Munich, the new gluten intolerance syndrome was given the current name of non-cellular gluten sensitivity (Capili, Chang, & Anastasi, 2014).

This disorder is characterized by over a hundred symptoms. The most common are intestinal symptoms, bloating, abdominal pain and discomfort, constipation, diarrhea. Extra intestinal symptoms such as headache, chronic fatigue, impaired concentration, tingling sensation in the arms, legs and muscles, and bone pain may also occur (Biesiekierski et al., 2011; Sapone et al., 2012; Di Sabatino & Corazza, 2012). The pathophysiology of NCGS remains unclear because most studies have been conducted on patients considered solely on the basis of subjective self-assessment of the existence of disease-specific symptoms. Under these circumstances, the NCGS subjective diagnosis resulted from a nocebo response. With the existence of such limitations, some studies have examined the consequences of the intake of certain components of flour and the possible mechanism underlying the dysfunction of the gastrointestinal tract, and the onset of symptoms. There have been suggestions that gluten is not the only trigger in the onset of NCGS symptoms; other components including fermentable oligo-, di-, and mono-saccharides and polyols (FODMAPs) and amylase trypsin inhibitors (ATIs) may have the same effects. FODMAPs are parts of flour that may play a role in the formation of NCGS. The results of double-blind placebo-controlled studies show that symptoms are reduced during a diet with reduced intake of FODMAPs (Biesiekierski et al., 2013). Attention has been focused on fructans, as components of FODMAPs; studies in controlled conditions where subjects ingested gluten, fructans or placebo indicated that the highest score of reported symptoms was observed in patients after the exposure to fructans (Skodje et al., 2018). ATIs represent 4% of total proteins, but are also the main cause of bakers' asthma (Gómez et al., 1990). The results of various studies indicate that ATIs may lead to the activation of natural immunity and various immune cells and may play a role in the pathophysiological mechanism of NCGS (Junker et al., 2012; Zevallos et al., 2017).

Gluten playing the role of a trigger in the appearance of characteristic symptomatology is confirmed in various studies. Di Sabatino and associates (2015) conducted a randomized placebo-controlled study on 59 subjects with NCGS symptoms, and reported worsening of symptoms in gluten-treated patients (4.375g) as compared to placebo subjects. In a large study that followed patients with functional gastrointestinal disorders, 14% were diagnosed with NCGS and worsening (5.6 g/day) after taking gluten (Elli et al., 2016)

Studies also confirm that this disorder is not uncommon in the pediatric population, in children with functional gastrointestinal disorders. Yet, on the other hand, studies suggest that in the case of a strong nocebo effect, the NCGS defining methodology should be carefully chosen. In controlled studies, only one-third of the subjects with self-reported NCGS had a confirmed diagnosis after a double-blind gluten challenge, which suggests that most self-reported NCGS patients should by no means be labeled as NCGS. It is an interesting fact that only a third of people classified as NCGS can react and recognize gluten from flour (Zanini et al., 2016).

The diagnosis of non-celiac gluten sensitivity remains unattainable due to the limited knowledge of the pathophysiological mechanism and the lack of reliable markers (Marković, Bjelaković, Jović, Ilić, & Popović, 2019). Biomarkers are regarded as measurable indicators of normal or pathological processes, but also of the pharmacological response within a certain therapeutic procedure. Identifying a specific biomarker would be a breakthrough in the field of non-celiac gluten sensitivity in terms of improving patient access and identifying subgroups of patients who respond to a gluten-free diet. For the time being, according to the consensus of experts from a conference held in Salerno, the gold standard in diagnosing is the Double-Blind Placebo-Controlled crossover gluten challenge (Catassi et al., 2015; Francavilla et al., 2018)

The disadvantage of this diagnostic procedure is the complex protocol, which is why it is not feasible in everyday clinical practice.

The aim of this paper is to present the latest scientific data that deal with a non-celiac gluten sensitivity, gluten-free diet, justification of introducing a diet, advantages and disadvantages of this dietary approach in a population of athletes.

THEORETICAL CONSIDERATIONS OF THE PROBLEM

Potential benefits of a gluten-free diet

Over recent years, there has been a growing interest in this health disorder. Gluten-free diet has become popular among athletes. Athletes believe that this diet is healthier and has ergogenic effects (Lis, Stellingwerff, Kitic, Ahuja, & Fell, 2015a). In a global study conducted on 910 athletes, 41% of the subjects reported that they adhered to this diet. More than half of the subjects believe that a gluten-free diet improves sports performance, 74% of the subjects believe that a gluten-free diet renders body composition more suited for better performance, and a minority who were not on a gluten-free diet have the same beliefs (Lis, Stellingwerff, Shing, Ahuja, & Fell, 2015b). Some of the top athletes publicly attribute their success to this diet. Novak Đoković is one of them, a tennis player with 17 Grand Slam titles and the most ardent supporter of this diet in his book *Serve for Victory*, talks about a gluten-free diet plan to which he owes his mental and physical excellence. There are no data on the incidence of the disease, although it is estimated that between 0.5 and 13% of the general population suffers from NCGS. There are also no literature data on the prevalence of gluten sensitivity in the population of athletes. Having in mind conflicting literature data on this health issue and the benefit of a gluten-free diet on sports performance, we can ask whether gluten really affects the physical fitness of athletes. For the time being, there is only one study that monitors the effects of a gluten-free diet in athletes, a study conducted by Lis and associates (2015a), where they pointed out that a short-term gluten-free diet has no effect on sports performance and the improvement of gastrointestinal symptoms, and has no effect on reducing inflammatory markers in cyclists. Also, prescribing a gluten-free diet is not based on evidence based on medical practice and Lis and associates (2015b) suggest that in fact the acceptance of a gluten-free diet in most cases is not proven necessary, but that the diet itself is accepted based on the subjective feeling that removing gluten from the diet allows health benefits.

Although most people on a gluten-free diet say they feel better without gluten in their diet, current knowledge suggests that this result is actually possible due to the increased attention to one’s diet in general, a strong placebo effect, or choosing healthier options

(e.g., using fruit instead of bread provides higher nutritional value and fewer empty calories). People on a gluten-free diet discover many healthier nutritional substitutes for gluten foods, but that does not mean that it is really necessary to completely eliminate gluten.

Disadvantages of a gluten-free diet

It should also be borne in mind that the introduction of a gluten-free diet has its drawbacks. The fact is that the introduction of this diet will inevitably lead to a change in nutritional intake (Martin, Geisel, Maresch, Krieger, & Stein, 2013). It should be noted that gluten-free foods vary significantly in nutritional composition as compared to food that contains gluten. Most gluten-free food is not fortified with iron and folic acid.

Food processors add sugar, salt and unhealthy fats during food processing. A good portion of the products contains refined gluten-free flour that lacks fiber. One of the studies suggests that a gluten-free diet, precisely because of its composition, can lead to a decrease in the number of intestinal bacteria and changes in the functioning of the immune system (De Palma, Nadal, Collado, & Sanz, 2009). Several studies suggest that a gluten-free diet is deficient in whole grains, dietary fiber, micronutrients (vitamin D, vitamin B12, folic acid) and minerals (iron, zinc, magnesium, and calcium). A higher content of both saturated and hydrogenated fatty acids in gluten-free food was determined, and an increase in the glycemic load of the meal and glycemic index (Vici, Belli, Biondi, & Polzonetti, 2016). Additionally, a gluten-free diet contains more sugar and fat, carrying risks for the development of type 2 diabetes (Zong et al., 2018). Research by Lebwohl and associates (2017) found a link between avoiding gluten intake and reduced intake of whole grains and cardiovascular health, i.e., a gluten-free diet is associated with the occurrence of coronary heart disease, thus, the promotion of a gluten-free diet in people who do not suffer from celiac disease should not be encouraged from the point of view of these researchers.

Data collected from the National Health and Nutrition Examination Survey study indicate the existence of higher concentrations of arsenic and cadmium in urine and increased concentrations of mercury, lead and cadmium in people on a gluten-free diet, which is a consequence of the increased intake of rice and fish where there are high concentrations of heavy metals (Raehsler, Choung, Marietta, & Murray, 2018). A strict gluten-free diet is associated with intestinal mucosa regeneration on the one hand, while on the other hand this diet is associated with the appearance of anxiety, insomnia and a reduced score of self-assessed health (Ludvigsson et al., 2018).

CONCLUSION

The presented data remind us that we should keep in mind the justification of the introduction of a gluten-free diet, and the potential damage to health when we observe adherence to this pattern of nutrition in the long run. Therefore, the recommendation is to weigh the possible benefits over the potential harm of gluten-free treatment. The questions posed are yet to be further answered through future studies designed for these purposes.

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BEZGLUTENSKA DIJETA NECELIJAČNIH SPORTISTA - BENEFITI I POTENCIJALNI ŠTETNI EFEKTI

Cilj ovog rada je da prikaže najnovije naučne podatke koji govore o bezglutenskoj dijeti, opravdanosti uvođenja dijete, prednostima i nedostacima ovakvog dijetarnog pristupa u populaciji sportista. Necelijačna glutenska senzitivnost (ranije definisana kao glutenska senzivnost) je relativno nov klinički entitet prvi put definisan 2011.godine. Ovaj poremećaj karakterišu intestinalni simptomi (abdominalni bol, nadimanje, proliv i zatvor) i ekstraintestinalni simptomi kao što su glavobolja, hronični umor, poremećaj koncentracije, osećaj trnjenja u rukama i nogama kao i bolovi u mišićima, zlobovima i kostima. S obzirom da je većina simptoma subjektivna bez pratećih kliničkih znakova, a kako ne postoji specifičan biomarker za dijagnostikovanje u kliničkoj praksi uvek postoji dilema da li se zaista radi o ovom zdravstvenom problemu. Bezglutenska dijeta je postala popularna među sportistima zbog mišljenja da ima ergogene efekte. Takođe treba imati na umu da uvođenje bezglutenske dijete ima svojih nedostataka. Više studija upućuju da je bezglutenska dijeta deficitarna u integralnim žitaricama, dijetnim vlaknim i pojedinim mikonutrijentima. Podaci prikupljeni iz NHANES studije (prema engl. the National Health and Nutrition Examination Survey), ukazuju na postojanje veće koncentracije teških metala u uzorcima urina i krvi uzetih od osoba na bezglutenskoj dijeti što je posledica suženog izbora namirnica. Ovi podaci podsećaju da treba imati na umu opravdanost uvođenja bezglutenske dijete i potencijalnu štetu po zdravlje kada dugoročno posmatramo pridržavanje ovakakvom obrascu ishrane.

Ključne reči: *bezglutenska dijeta, sportisti,necelijačna glutenska senzitivnost, efekti*

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

796/799

FACTA Universitatis. Series, Physical Education and Sport / University of Niš ; editor-in-chief Saša Bubanj. - [Štampano izd.]. - Vol. 1, no. 7 (2000)- . - Niš : University of Niš, 2000- (Niš : Unigraf-X-Copy). - 24 cm

Četiri puta godišnje. - Je nastavak: Facta Universitatis. = ISSN 0354-4745. - Drugo izdanje na drugom medijumu: Facta Universitatis. Series: Physical Education and Sport (Online) = ISSN 2406-0496
ISSN 1451-740X = Facta Universitatis. Series: Physical Education and Sport1. University of Niš
COBISS.SR-ID 113549324

FACTA UNIVERSITATIS

Series

Physical Education and Sport

Vol. 18, Nº 2, 2020

Contents